Published in final edited form as:

Int J Eat Disord. 2018 December ; 51(12): 1322–1330. doi:10.1002/eat.22979.

Eating pathology and associations with long-term changes in weight and quality of life in the longitudinal assessment of bariatric surgery study

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Abstract

Objective: This study examines the course of eating pathology and its associations with change in weight and health-related quality of life following bariatric surgery.

Method: Participants ($N = 184$) completed the eating disorder examination-bariatric surgery version (EDE-BSV) and the medical outcomes study 36-Item short form health survey (SF-36) prior to and annually following Roux-en-Y gastric bypass (RYGB) or laparoscopic adjustable gastric banding (LAGB) for up to 7 years.

Results: The prevalence of weekly loss of control (LOC) eating, picking/nibbling, and cravings declined post-RYGB and remained lower through 7 years (LOC: 5.4% at Year-7 vs. 16.2% pre-RYGB, $p = .03$; picking/nibbling: 7.0% vs. 32.4%, $p < .001$; and cravings: 19.4% vs. 33.6%, $p = .02$). The prevalence of picking/nibbling was significantly lower 7 years following LAGB vs. pre-LAGB (29.4% vs 45.8%, $p = .049$), while cravings ($p = .13$) and LOC eating ($p = .95$) were not. EDE-BSV global score and ratings of hunger and enjoyment of eating were lower 7 years following both RYGB and LAGB versus pre-surgery (p 's for all $< .05$). LOC eating following RYGB was associated with less long-term weight loss from surgery ($p < .01$) and greater weight regain from weight nadir ($p < .001$). Higher post-surgery EDE-BSV global score was associated with less weight loss/greater regain (both $p < .001$) and worsening/less improvement from surgery in the SF-36 mental component summary scores ($p < .01$).

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CONFLICT OF INTEREST

Drs. King and Yanovski and Ms. Hinerman report no competing interests.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Discussion: Initial improvements in eating pathology following RYGB and LAGB were sustained across 7 years of follow-up. Individuals with eating pathology post-RYGB, reflected by LOC eating and/or higher EDE-BSV global score, may be at risk for suboptimal long-term outcomes.

Keywords

bariatric surgery; body image; craving; feeding and eating disorders; gastric bypass; hunger; weight loss

1 | INTRODUCTION

The importance of obesity prevention and effective long-term treatment to address obesity-associated risks looms ever larger as the high prevalence of obesity continues unabated in the United States (Hales, Fryar, Carroll, Freedman, & Ogden, 2018) and worldwide (Hruby & Hu, 2015). Bariatric surgery has long been recognized as the most effective treatment for severe obesity, conferring significant long-term reduction in weight, and chronic disease burden (Buchwald et al., 2004; Colquitt, Pickett, Loveman, & Frampton, 2014). Although long-term follow-up data are limited (see Puzziferri et al., 2014 for a review of two to 5-year outcomes), recent findings from large-scale studies are promising.

In the controlled, non-randomized Swedish Obese Subjects (SOS) study, bariatric surgery has been found to yield significant and sustained benefits over a 10–15-year time period in weight, obesity-related illness (Carlsson et al., 2012; Sjöström et al., 2009; Sjöström et al., 2012) and health-related quality of life (HRQOL) (Karlsson, Taft, Rydén, Sjöström, & Sullivan, 2007). In the United States, the Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) study has yielded evidence of similar health benefits with 7-year follow-up (Ahmed et al., 2018; Courcoulas et al., 2018). Nonetheless, as underscored in the LABS-2 study, different weight loss patterns are observed following bariatric surgery among patients who have undergone the same procedure, and the identification of factors related to a suboptimal response, is of considerable clinical and public health interest.

Problematic eating behaviors are common prior to bariatric surgery (Mitchell et al., 2015). Uncontrolled eating, variably operationalized as binge eating (BE), binge-eating disorder (BED), or loss of control (LOC) eating, has emerged as a behavior of particular interest. Most available evidence relates to weight change at 3 years or less, and suggests that there is relatively little evidence linking presurgical uncontrolled eating to weight change post-surgery (Livhits et al., 2012). However, the continuation, reemergence, and development of uncontrolled eating following surgery, are associated with less net weight loss up to 3 years post-surgery (Meany, Conceição, & Mitchell, 2014; Wimmelmann, Dela, & Mortensen, 2014). In addition, the SOS study has shown that aspects of eating behavior and experience, as measured by the eating inventory (Stunkard & Messick, 1985), in the first year post-surgery predict long-term weight change from surgery. Specifically, lower levels of hunger and disinhibition, a construct related to LOC eating, at 6-months and 1-year post-surgery, as well as larger 1-year pre-surgery to post-surgery decreases in these measures, predicted more successful weight change at 2, 6, and 10 years following surgery (Kontinen, Peltonen,

Sjöström, Carlsson, & Karlsson, 2015). However, the majority of surgical patients in the SOS study underwent vertical banded gastroplasty, which is no longer commonly performed.

We previously reported on eating pathology with 3-year follow-up data from the longitudinal assessment of bariatric surgery-3 (LABS-3) Psychosocial Study (Devlin et al., 2016). Using structured interview data from the eating disorder examination-bariatric surgery version (EDE-BSV) we documented that the prevalence of multiple pathological eating behaviors declined following Roux-en-Y gastric bypass (RYGB) or laparoscopic adjustable band (LAGB) insertion and remained lower than pre-surgery throughout the 3-year follow-up period. Furthermore, post-surgery LOC eating, hunger, and pathological eating and body-related attitudes as reflected by the EDE global score, were related to less favorable weight change from surgery. However, the effects of LOC eating were accounted for by the EDE global score and hunger when modeled jointly. These findings are consistent with the literature that pathological eating behaviors and experiences may contribute to suboptimal weight loss.

The current study, conducted in the same LABS-3 cohort, was designed to extend our 3-year findings by examining changes in eating pathology and experiences through 7 years following RYGB and LAGB. We also sought to examine associations between these variables and long-term (Years 4–7) pre-surgery to post-surgery changes in weight and HRQOL, as well as weight regain from weight nadir in the larger RYGB subsample.

2 | PATIENTS AND METHODS

2.1 | Design, setting, and participants

The current study is part of the LABS consortium, which has been described in detail (Belle et al., 2007). The LABS-3 Psychosocial study (Mitchell et al., 2012) was conducted in 202 adults, at three clinical centers: The Neuropsychiatric Research Institute, Fargo, ND; Columbia/Weill Cornell Medical Centers in New York, NY; and the University of Pittsburgh/Duquesne University in Pittsburgh, PA. The Institutional Review Boards at each center approved the protocol and consent forms, and all participants provided written informed consent prior to data collection. Assessments were conducted prior to surgery, independent of the surgery approval process, and annually following surgery, except for Year 6, which involved minimal data collection. To be included in this report LABS-3 participants had to have undergone RYGB or LAGB ($n = 199$) and completed the Eating Disorder Examination-Bariatric Surgery Version (EDE-BSV) assessment pre-surgery and at one or more follow-up assessments ($n = 184$; 92%).

2.2 | Measures

We obtained information on eating pathology and experiences using the EDE-BSV (de Zwaan et al., 2010), a modified version of the Eating Disorder Examination (EDE) (Berg, Peterson, Frazier, & Crow, 2002; Fairburn & Cooper, 1993), a semi-structured interview designed to assess eating disorder psychopathology, with additional factors of relevance to bariatric surgery patients such as plugging, dumping, craving, hunger, enjoyment of eating,

and night eating. Eating behavior/pathology variable definitions have been previously described (Devlin et al., 2016). Plugging is operationalized in the EDE-BSV as “the small opening in your stomach becoming plugged, or food becoming stuck in the small opening of your stomach.” Dumping refers to a variety of physical symptoms, such as feeling faint weak, or tired, experiencing palpitations, warmth, or clammy skin, that occur when individuals who have undergone RYGB consume highly osmotic foods that move too rapidly from the stomach to the duodenum.

The EDE-BSV assessed objective binge eating episodes (OBE), subjective binge eating episodes (SBE), LOC eating, and objective overeating episodes (OOE). OBE and SBE were assessed first by identifying eating episodes that the subject identified as excessive, then by probing for a sense of loss of control during the episode. LOC eating was assessed separately from these, based only on a sense of loss of control, regardless of the subject's perception regarding amount of intake. Based on DSM-5 (American Psychiatric Association, 2013) thresholds for clinical significance, but retaining the 6-month time-frame, participants were classified by whether they did or did not report each behavior at least four times per 28 days (i.e., weekly) on average over the past 6 months. Given the low frequency of compensatory methods (self-induced vomiting, chewing and spitting food, laxative misuse, diuretic misuse, or driven exercise), they were reported as present if the occurred at least once in the past 6 months. The remaining variables were assessed in reference to the past 28 days. Responses from night eating section of the EDE-BSV, based on the night eating questionnaire (NEQ), were used to calculate a night eating syndrome (NES) score (range: 1–52) (Allison et al., 2008). In addition, we used response to an individual NEQ item to report the prevalence of evening hyperphagia, defined as regular consumption of >25% of daily intake after supper, that is, the evening meal. We assessed “picking or nibbling” 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 4 days per 28 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 (Fairburn & Cooper, 1993).

Weight assessment has been previously described (Christian, King, Yanovski, Courcoulas, & Belle, 2013). Change in weight from surgery was calculated as percentage of pre-surgery weight, that is, $(100 * [\text{post-surgery weight} - \text{pre-surgery weight}] / \text{pre-surgery weight})$. Weight regain from post-surgery weight nadir was calculated as percentage of maximum weight lost, that is, $(100 * [\text{post-nadir weight} - \text{nadir weight}] / (\text{pre-surgery weight} - \text{nadir weight}))$.

Participants completed the Medical Outcomes Study 36-item short-form health survey (SF-36), a widely-used measure of HRQOL with well documented validity and sensitivity to

change (Frendl & Ware Jr., 2014). Norm-based methods were used to transform the mental component summary (MCS) and physical component summary (PCS) scores to a mean of 50 and standard deviations of 10 in general U.S. population samples (range 0–100) (Ware, Kosinski, & Keller, 1994). Higher scores imply less disability/better function. Change in score was calculated as post-surgery score—pre-surgery score.

2.3 | Statistical analysis

All analyses were stratified by surgical procedure. Analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC). Statistical significance was set at $p < .05$; tests were two-sided. Descriptive statistics (frequencies and percentages for categorical variables; medians, 25th–75th percentiles, and ranges for continuous variables) were used to summarize pre-surgery characteristics. Participants who were excluded from the analysis due to missing data were compared to those in the analysis sample using the Chi square or Fisher's Exact test for categorical variables, Cochran-Armitage test for ordinal variables, and the Wilcoxon rank sum test for continuous variables.

Descriptive statistics were used to summarize eating behaviors and pathology by surgical procedure and time point. Longitudinal analyses were performed using mixed models using all available data with a person-level random intercept, controlling for site, baseline age, and smoking status, which were associated with missing follow-up data, as fixed effects. Log binomial mixed models were used to compare the prevalence of the most common eating behaviors/pathology (i.e., LOC, picking/nibbling, and cravings), between the last assessment (Year 7) and pre-surgery, with time (i.e., assessment) entered as fixed effects. Similarly, linear mixed models via maximum likelihood (LMM) were used to compare eating scores.

Among the larger RYGB sample, a LMM was also used to test, and estimate associations between pre-surgery and post-surgery status of LOC, picking/nibbling, and cravings with long-term (i.e., 4 years) weight change from surgery, also controlling for sex, race, and pre-surgery body mass index (Coleman & Brookey, 2014; Livhits et al., 2012), with time since surgery entered as a continuous fixed effect. At each post-surgery assessment, the comparison groups were (a) current eating behavior/pathology, and (b) eating behavior/pathology pre-surgery but not current, versus (c) no eating behavior/pathology pre-surgery or currently (as the reference). A second LMM also included the EDE global score, level of hunger score, and level of enjoyment score to determine if they were independently related to weight change after taking LOC, picking/nibbling, and craving into account. A LMM was also used to investigate associations between concurrent eating behaviors/pathology with weight regain, with time since weight nadir entered as a continuous fixed effect, controlling for the same baseline factors.

LMM were also constructed with long-term change from surgery in the SF-36 MCS and PCS scores, respectively, as outcomes. These models controlled for the same baseline factors, as well as the respective pre-surgery score.

3 | RESULTS

3.1 | Participant characteristics and retention

A comparison of pre-surgery characteristics between those included ($N = 184$) versus excluded ($N = 15$) from the analysis sample due to missing data is provided in Supporting Information (Table S1). Those who were excluded had a lower median BMI than those included (42.9 vs. 45.2 kg/m²; $p = .046$).

Among the analysis sample, 111 underwent RYGB (median age 45 years [IQR, 35–53]; 82.0% female; 93.6% white) and 73 underwent LAGB (median age 47 years [IQR, 40–54]; 84.9% female; 91.8% white). Additional pre-surgery characteristics are shown in Table 1. EDE-BSV data were available for 91.0% (101/111), 81.1% (90/111), 71.2% (79/111), 72.1% (80/111), 70.3% (78/111), and 69.2% (74/107) of RYGB participants in post-surgical Years 1, 2, 3, 4, 5, and 7, respectively, excluding the deceased. Corresponding data for the LAGB participants was 95.9% (70/73), 90.3% (65/72), 73.6% (53/72), 70.8% (51/72), 70.8% (51/72), and 51.4% (36/70).

3.2 | Eating pathology prior to and following surgery

The observed prevalence of eating behaviors and pathology by surgical procedure and time point are shown in Table 2. Overall, pathological eating behaviors and experiences, with the exception of picking/nibbling and craving, were rare in Years 4–7. Modeled data for these behaviors and LOC eating is available in Supporting Information (Table S2). Among the RYGB subsample all three behaviors were less common 7 years post-surgery versus pre-surgery (LOC eating: 5.4%, 95% CI, 1.4–10.8, vs 16.2%, 95% CI, 9.2–23.9, $p = .03$; picking/nibbling: 7.0%, 95% CI, 1.6–13.8, vs. 32.4%, 95% CI, 24.3–40.5, $p < .001$; and cravings: 19.4%, 95% CI, 9.7–28.8, vs. 33.6%, 95% CI, 25.0–42.7, $p = .02$). Likewise, in the LAGB subsample, prevalence of picking/nibbling was significantly lower in Year 7 versus baseline (29.4%, 95% CI, 14.3–46.2, vs. 45.8%, 95% CI, 34.4–58.2, $p = .049$), while cravings (31.4%, 95% CI, 15.6–46.9, vs. 43.8%, 95% CI, 33.8–55.2, $p = .13$) and LOC eating (8.3%, 95% CI, 2.6–18.2, vs. 9.6%, 95% CI, 3.7–17.6, $p = .95$) were not (Supporting Information Table S2). However, given the sample size and low prevalence of these eating behaviors/pathologies there was limited statistical power.

To understand how pre-surgery and post-surgery status of eating behaviors and pathology are related, the distribution of pre-surgery and post-surgery eating pathology status (i.e., neither, resolved, developed, continued) by post-surgery assessment was examined (Supporting Information Table S3). Although pathological eating behaviors and experiences were uncommon overall prior to surgery, and prevalence generally dropped following surgery and throughout the follow-up period, the small number of participants who did exhibit these symptoms post-surgery included both those with presurgical eating pathology who continued to display symptoms, as well as those who did not have symptoms at the time of surgery but developed the symptoms following surgery.

Modeled EDE scores by surgical procedure and time point are shown in Table 3; observed data is available in Supporting Information (Table S4). All EDE scores, level of hunger, and level of enjoyment were significantly lower 7 years post-surgery versus pre-surgery among

the RYGB and LAGB subgroups, respectively (Table 3). The NES score was also lower 7 years post-surgery versus pre-surgery among the RYGB subgroup only.

3.3 | Associations between eating pathology and long-term changes in weight and quality of life following RYGB

Associations between pre-surgery and post-surgery status of the most common eating behaviors/pathology and post-surgery eating scores with long-term weight change from surgery among the RYGB subgroup are shown in Table 4. LOC eating post-surgery (vs. not having LOC eating pre-surgery or post-surgery) was significantly related to 6.2% less weight loss from surgery (95% CI, 1.5–10.8), whereas change in weight from surgery did not differ by LOC eating pre-surgery only versus neither pre-surgery nor post-surgery. Neither picking/nibbling nor cravings post-surgery, or pre-surgery only versus neither, were significantly related to long-term weight change. Each unit higher on the EDE global score post-surgery was significantly related to 4.1% less weight loss from surgery (95% CI, 2.3–5.8), independent of LOC and other factors. Level of hunger and level of enjoyment were not independently associated.

Associations were similar for weight regain from weight nadir (which occurred a median (IQR) of 2.1 (2.0–3.0) years post-RYGB), in that concurrent LOC eating and higher EDE global score, but not other factors, were significantly related to weight regain (Table 4). Specifically, LOC eating was related to regaining 20.0% of maximum weight lost (95% CI, 8.7–31.3). Controlling for LOC eating and other factors, each one point higher on the EDE global score was associated with regaining 8.2% of maximum weight lost (95% CI, 4.0–12.3). In reference, median (IQR) weight regain was 22.0% (12.7–38.2) of maximum weight lost by Year 7.

With regard to long-term changes from surgery in HRQOL, there was only one significant association (Supporting Information Table S5); each unit higher on the EDE global score post-surgery was related to a 4.8 point (95% CI, 1.4–8.2) decline or less of an improvement from surgery in the SF-36 MCS score.

4 | DISCUSSION

This study is among the first to report long-term improvements following modern-day bariatric surgical procedures in eating pathology using a widely accepted rigorous interview-based assessment measures. Additionally, this is one of the first studies to test and estimate associations between eating behaviors/pathology with long-term pre-surgery to post-surgery weight change and weight regain from post-surgery weight nadir. Similar to our earlier report (Devlin et al., 2016), post-surgical LOC eating and pathological eating and body-related attitudes, as reflected by the EDE global score, were identified as important risk factors. In addition, we found that post-surgery LOC eating was associated with regaining 20% of maximum weight lost, a particularly important finding given median weight regain was 23% of maximum weight lost at Year 7.

The long-term (4–7 years) changes in eating behavior/pathology in this report were largely consistent with earlier follow-up (Devlin et al., 2016), in that a variety of measures of eating

pathology and eating-related experience continued to be less common at Year 7 compared with pre-surgery values. However, stratification by surgical procedure in this report revealed that LOC eating decreased following RYGB but not following LAGB. The same was true for cravings, although cravings remained fairly common throughout follow-up among both surgical groups, affecting 1 in 5 RYGB participants and 1 in 3 LAGB participants at Year 7. In contrast, picking/nibbling was less common, and the global EDE score was lower, 7 years following both RYGB and LAGB versus pre-surgery. However, in juxtaposing changes in eating pathology following RYGB and LAGB, it is important to note that participants were not randomly assigned to surgical procedure, making differences across procedure difficult to interpret.

The associations of post-surgery LOC eating with less long-term weight loss and greater regain are largely consistent with previous reports (Meany et al., 2014; Wimmelmann et al., 2014). Furthermore, this study demonstrates that this association holds when LOC is ascertained prospectively using rigorous interview-based assessment of eating pathology at long-term follow-up. As was found in the 3-year follow-up of this sample (Devlin et al., 2016), and consistent with most but not all previous studies as reviewed by Meany et al. (2014), LOC eating prior to surgery was not associated with weight outcome over the 7-year follow-up period.

In addition to LOC eating, use of the EDE-BSV also allowed for investigation of the EDE global score, an index of core eating disorder psychopathology (Fairburn, Cooper, & Shafran, 2003). Although the EDE global score has not been as widely examined as LOC eating in bariatric surgery samples, its associations with weight outcome seen in both our 3-year (Devlin et al., 2016) and 7-year follow-up studies suggest its utility in future studies of bariatric surgery. The observed association of the EDE global score with the mental component of HRQOL further supports its relevance to RYGB outcome. Notably, although strongly associated with weight outcome and HRQOL mental component summary score, mean EDE global scores were relatively low, reflecting modest levels of distress or preoccupation with weight, shape, and eating. Additional studies are needed for better understanding of the meaning of the EDE global score in individuals undergoing bariatric surgery.

This study utilized a prospective design, but it is important to note that the reported associations of post-surgical LOC eating and global EDE score with weight and mental HRQOL do not prove a causal relationship. While there is evidence that binge eating may be a marker of quality of life impairment in adolescents with obesity (Ranzenhofer et al., 2012), and those changes in eating disorder-related symptoms predict improved weight-related quality of life following treatment for BED (Mason et al., 2017), the relationships between eating disorder psychopathology and, weight and HRQOL changes following weight loss treatment are not yet fully understood. It is possible that the associations are bidirectional, with eating pathology both resulting from and contributing to unfavorable weight and mental HRQOL outcome. Larger samples and more fine-grained temporal analyses will be needed to test hypotheses regarding predictors of outcome. Nonetheless, even concurrent associations provide symptom targets that may be relevant to clinical management.

An additional consideration in understanding the clinical significance of LOC eating and related phenomena in patients who have undergone bariatric surgery is the time course of pathology. For example, if only patients who showed LOC eating prior to surgery were at risk for LOC eating following surgery, there would be a relatively easily identifiable and relatively small subgroup that might merit closer follow-up for early detection of ongoing or re-emergent pathology. However, those exhibiting post-surgery pathology were substantially divided between those with continued and developed symptoms from pre-surgery. This both complicates the task of identifying an at-risk group and raises questions, particularly regarding those with emergent symptoms post-surgery, a phenomenon that has received considerable attention in recent years (Conceição et al., 2013; Marino et al., 2012). One possibility is that more stringent dietary guidelines or restricted intake following surgery can lead to new eating behaviors/pathology. Identifying factors related to eating pathology that appears following surgery would be of great clinical benefit. However, given the low frequencies of eating pathology post-surgery, a large sample size or targeted study of those who already have post-surgery eating pathology would be required.

Strengths of this study include its multicenter sample, stratification by surgical procedure, follow-up over a 7-year postsurgical period, and use of a widely accepted rigorous interview-based assessment of eating pathology, the EDE-BSV. A sophisticated typology of pathological eating behavior following bariatric surgery can be developed only with the use of fine-grained assessment tools such as the EDE-BSV. There are also several limitations. Although the EDE was adapted for bariatric surgery patients, there may be other relevant eating behaviors and attitudes it does not assess. We did not assess lifetime eating pathology at the baseline assessment; therefore, we do not know whether those who develop pathological eating experience or behaviors following bariatric surgery may have had these eating pathologies at some time prior to their baseline assessment. Because pathological eating behaviors and experiences are sufficiently uncommon, a larger sample size may be needed to detect additional presurgical and postsurgical predictors of outcome. Additionally, as the study enrollment, there have been notable changes in the proportions of different surgical procedures. Specifically, sleeve gastrectomy (SG), now the most common procedure in the United States (Khorgami et al., 2017), was uncommon, and LAGB was used much more frequently. However, RYGB continues to be a commonly performed procedure, and there remains a sizable population of adults who have undergone the LAGB and require long-term follow-up care. Studies of eating pathology in individuals receiving SG will be of great importance in view of its increasingly widespread use.

In conclusion, the decline in pathological eating-related behaviors and experiences following RYGB and LAGB remains robust at 7-year follow-up, a finding that adds to a large and growing body of literature on the positive effects of bariatric surgery. Moreover, the associations of postsurgical LOC eating and global EDE score, with change in weight, including net weight change from surgery and weight regain from surgery remain strong over the long-term. This suggests that, although it has been difficult to identify causal linkages between presurgical disordered eating and bariatric surgery outcome, eating pathology, and experiences may be of considerable importance in the post-surgery evaluation and management of individuals receiving bariatric surgery. Our findings lend credence to the idea that inquiry regarding eating pathology, particularly LOC eating, and

about concern with weight, shape, and eating should be a part of bariatric postsurgical follow-up.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGMENTS

Dr. Devlin receives royalties from Wolters Kluwer Health and from Guilford Press. Dr. Kalarchian reports receiving funding for research in bariatric surgery from The Obesity Society (TOS)/Nutrisystem, and the American Society for Metabolic and Bariatric Surgery (ASMBS). Dr. Marcus serves on the Scientific Advisory Board of Weight Watchers International, Inc. Dr. Mitchell serves on the Shire International Advisory Board and receives royalties from Routledge and Guilford Press.

Funding information

National Institute of Diabetes and Digestive and Kidney Diseases, Grant/Award Numbers: U01-DK66471DSS-U01DK066557R01 DK084979U01-DK66585U01-DK66667, R01 DK084979, DSS-U01DK066557; Columbia, U01-DK66667; National Institutes of Health, Grant/Award Number: UL1-RR0241531UL1-RR024996; University of Pittsburgh Medical Center, Grant/Award Numbers: UL1-RR0241531, U01-DK66585; Neuropsychiatric Research Institute, Grant/Award Number: U01-DK66471

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TABLE 1

Demographic and clinical characteristics of adults prior to bariatric surgery, by planned surgical procedure

	RYGB (N = 111)	LAGB (N = 73)
	No. (%)^a	No. (%)^a
Age, years		
Median (25th–75th %-ile)	45 (35, 53)	47 (40, 54)
Range	21–68	23–67
Female	91 (82.0)	62 (84.9)
Race	(n = 110)	
White	103 (93.6)	67 (91.8)
Black	7 (6.4)	5 (6.8)
Other	0 (0.0)	1 (1.4)
Hispanic ethnicity		
No	103 (92.8)	73 (100.0)
Yes	8 (7.2)	0 (0.0)
Married or living as married	(n = 107)	(n = 67)
No	45 (42.1)	21 (31.3)
Yes	62 (57.9)	46 (68.7)
Education		
High school or less	21 (19.6)	10 (15.2)
Some college	47 (43.9)	26 (39.4)
College degree	39 (36.5)	30 (45.5)
Employed for pay	(n = 106)	(n = 68)
No	31 (29.2)	19 (27.9)
Yes	75 (70.8)	49 (72.1)
Household income, US \$		
Less than 25,000	20 (18.9)	10 (14.9)
25,000–49,999	35 (33.0)	17 (25.4)
50,000–74,999	26 (24.5)	16 (23.9)
75,000–99,999	12 (11.3)	12 (17.9)
> 100,000	13 (12.3)	12 (17.9)
Body mass index, kg/m ²		
Median (25th–75th %-ile)	47.1 (43.0, 52.1)	43.5 (40.9, 46.9)
Range	36.1–76.0	33.5–65.8
SF-36 mental component summary score	(n = 107)	(n = 68)
Median (25th–75th %-ile)	50.5 (42.6, 55.4)	52.1 (45.9, 57.5)
Range	20.8–69.4	23.8–62.8
SF-36 physical component summary score	(n = 107)	(n = 68)
Median (25th–75th %-ile)	35.1 (26.5, 42.3)	37.1 (31.3, 45.9)
Range	13.4–54.2	15.9–55.9

Notes. LAGB = laparoscopic adjustable gastric banding; RYGB = Roux-en-Y gastric bypass, SF-36 = short-form health survey.

^aUnless otherwise indicated.

Observed prevalence of eating behaviors and pathology among adults prior to bariatric surgery through 7 years post-surgery, by surgical procedure

TABLE 2

	Time in relation to surgery, no./Total (%)						
	Pre-surgery	Year 1	Year 2	Year 3	Year 4	Year 5	Year 7
RYGB	(n = 111)	(n = 101)	(n = 90)	(n = 79)	(n = 80)	(n = 78)	(n = 74)
Episodes of bulimia and overeating ^a							
Objective bulimic episodes	9 (8.1)	0 (0.0)	2 (2.0)	2 (2.5)	1 (1.3)	1 (1.3)	0 (0.0)
Subjective bulimic episodes	6 (5.4)	2 (2.0)	2 (2.2)	1 (1.3)	4 (5.0)	2 (2.6)	3 (4.1)
Loss of control eating	18 (16.2)	2 (2.0)	3 (3.3)	4 (5.1)	4 (5.0)	2 (2.6)	4 (5.4)
Objective overeating episodes	9 (8.1)	0 (0.0)	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Any compensatory method ^b	8 (7.2)	5 (5.0)	6 (6.7)	5 (6.3)	4 (5.0)	1 (1.3)	2 (2.7)
Regular evening hyperphagia ^c	17 (15.3)	2 (2.0)	6 (6.7)	4 (5.2)	0 (0.0)	3 (4.8)	4 (5.6)
Picking or nibbling ^d	35 (32.4)	20 (20.0)	16 (18.0)	19 (25.0)	20 (31.3)	11 (18.0)	5 (7.0)
Cravings ^e	37 (33.6)	33 (32.7)	31 (34.4)	19 (24.7)	22 (33.3)	19 (30.7)	14 (19.4)
LAGB	(n = 73)	(n = 70)	(n = 65)	(n = 53)	(n = 51)	(n = 51)	(n = 36)
Episodes of bulimia and overeating ^a							
Objective bulimic episodes	4 (5.5)	2 (2.9)	0 (0.0)	2 (3.8)	1 (2.0)	1 (2.0)	0 (0.0)
Subjective bulimic episodes	6 (8.2)	3 (4.3)	4 (6.2)	5 (9.4)	3 (5.9)	5 (9.8)	2 (5.6)
Loss of control eating	7 (9.6)	5 (7.1)	3 (4.6)	5 (9.4)	3 (5.9)	5 (9.8)	3 (8.3)
Objective overeating episodes	8 (11.0)	1 (1.4)	1 (1.5)	0 (0.0)	1 (2.0)	0 (0.0)	0 (0.0)
Any compensatory method ^b	6 (8.2)	3 (4.3)	2 (3.1)	2 (3.8)	5 (9.8)	1 (2.0)	0 (0.0)
Regular evening hyperphagia ^c	13 (18.1)	9 (12.9)	4 (6.3)	4 (7.8)	4 (8.7)	7 (15.2)	1 (2.9)
Picking or nibbling ^d	33 (45.8)	21 (30.0)	17 (27.9)	14 (28.0)	16 (35.6)	11 (26.2)	10 (29.4)
Cravings ^e	32 (43.8)	25 (35.7)	23 (36.0)	13 (25.5)	9 (19.6)	13 (28.3)	11 (31.4)

Notes. LAGB = laparoscopic adjustable gastric banding; RYGB = Roux-en-Y gastric bypass.

^a At least weekly over the past 6 months.

^b Defined as having 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.

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^c Defined as regular consumption of >25% of daily intake after supper (i.e., evening meal) over the last 28 days.

^d At least weekly over the last 28 days.

^e Rated their cravings strength as 4 or 5 on a 0 [none]-5 [extreme] scale over the last 28 days.

Modeled eating behaviors, pathology and related feelings^a among adults prior to bariatric surgery through 7 years post-surgery, by surgical procedure

TABLE 3

Time since surgery, n, %							
	Baseline	Year 1	Year 2	Year 3	Year 4	Year 5	Year 7
RYGB							
NES score (0–52) ^b	13.1 (12.0–14.2)	10.0 (9.1–11.0)	10.6 (9.7–11.6)	10.7 (9.5–11.8)	11.0 (9.7–12.3)	11.3 (9.9–12.7)	11.5 (10.3–12.8)
EDE scale scores (0–6)							
Restraint score	1.3 (1.1–1.5)	0.9 (0.7–1.1)	0.6 (0.5–0.8)	0.8 (0.6–1.0)	0.8 (0.5–1.0)	0.6 (0.4–0.9)	0.5 (0.3–0.7)
Eating concerns score	0.7 (0.5–0.8)	0.3 (0.2–0.4)	0.3 (0.2–0.5)	0.2 (0.1–0.2)	0.2 (0.1–0.2)	0.2 (0.1–0.3)	0.1 (0.0–0.2)
Shape concerns score	2.7 (2.6–2.9)	1.4 (1.3–1.6)	1.4 (1.2–1.7)	1.3 (1.1–1.6)	1.4 (1.1–1.6)	1.5 (1.2–1.8)	1.3 (1.1–1.6)
Weight concerns score	2.7 (2.6–3.0)	1.5 (1.3–1.7)	1.2 (1.0–1.5)	1.3 (1.1–1.5)	1.3 (1.0–1.5)	1.4 (1.2–1.7)	1.2 (1.0–1.5)
Global score	1.9 (1.7–2.0)	1.0 (0.9–1.2)	0.9 (0.8–1.1)	0.9 (0.7–1.1)	0.9 (0.8–1.1)	0.9 (0.8–1.1)	0.8 (0.7–0.9)
Experience ratings (0–5)							
Level of hunger	2.7 (2.5–2.9)	2.0 (1.8–2.2)	2.2 (2.0–2.4)	2.3 (2.1–2.6)	2.1 (1.8–2.4)	2.2 (1.9–2.4)	2.3 (2.1–2.6)
Level of enjoyment	3.2 (2.9–3.4)	2.7 (2.4–2.9)	2.9 (2.7–3.1)	2.9 (2.6–3.1)	2.8 (2.6–3.0)	2.8 (2.5–3.0)	2.7 (2.4–3.0)
LAGB							
NES score (0–52) ^b	12.4 (11.2–13.6)	10.8 (9.5–12.0)	10.3 (9.1–11.8)	10.7 (9.4–12.1)	11.0 (9.7–12.3)	10.5 (9.3–11.8)	10.7 (9.1–12.2)
EDE scale scores (0–6)							
Restraint score	1.2 (0.9–1.4)	1.3 (1.1–1.5)	1.0 (0.8–1.2)	0.9 (0.7–1.2)	0.9 (0.6–1.2)	0.7 (0.5–1.0)	0.7 (0.4–1.1)
Eating concerns score	0.6 (0.4–0.8)	0.4 (0.3–0.6)	0.5 (0.3–0.6)	0.3 (0.2–0.5)	0.3 (0.2–0.4)	0.3 (0.2–0.5)	0.3 (0.1–0.4)
Shape concerns score	2.6 (2.3–2.9)	1.8 (1.5–2.1)	1.8 (1.5–2.0)	1.8 (1.5–2.1)	1.8 (1.5–2.1)	2.0 (1.6–2.3)	1.7 (1.4–2.0)
Weight concerns score	2.8 (2.6–3.1)	2.2 (1.9–2.5)	1.9 (1.6–2.1)	1.9 (1.6–2.2)	1.6 (1.4–1.9)	1.7 (1.3–2.0)	1.5 (1.2–1.8)
Global score	1.8 (1.6–2.0)	1.4 (1.3–1.6)	1.3 (1.1–1.5)	1.2 (1.0–1.4)	1.1 (1.0–1.3)	1.2 (1.0–1.4)	1.0 (0.9–1.2)
Experience ratings (0–5)							
Level of hunger	2.6 (2.4–2.9)	2.2 (1.9–2.4)	2.4 (2.1–2.7)	2.4 (2.0–2.7)	2.3 (2.0–2.6)	2.4 (2.1–2.8)	2.1 (1.8–2.5)
Level of enjoyment	3.4 (3.1–3.7)	3.1 (2.8–3.3)	3.0 (2.8–3.3)	3.0 (2.6–3.3)	3.0 (2.7–3.3)	3.0 (2.7–3.3)	3.0 (2.6–3.3)

Note. EDE = eating disorder examination; LAGB = laparoscopic adjustable gastric banding; NES = night eating syndrome; RYGB = Roux-en-Y gastric bypass.

^a All factors assessed for the previous 28 days.

^b A score of at least 30 is a strong indication of NES.

TABLE 4

Associations between the most common eating behaviors/pathology with 7-year weight change from surgery and weight regain from nadir, respectively, among adults who underwent roux-en-Y gastric bypass

	Weight change from surgery ^a			Weight regain from nadir ^b		
	B (95% CI)	P		B (95% CI)	P	
Model 1 ^c						
Loss of control (ref = no current)		<0.01				<0.001
Pre-surgery only	-1.27 (-6.88-4.35)			Not applicable ^e		
Current post-surgery	6.17 (1.51-10.83)			19.98 (8.69-31.27)		
Picking and nibbling (ref = no current)		0.96				0.50
Pre-surgery only	0.37 (-3.34-4.08)			Not applicable ^e		
Current post-surgery	0.43 (-2.59-3.46)			2.22 (-4.25-8.70)		
Cravings (ref = no current)		0.30				0.57
Pre-surgery only	-2.37 (-5.83-1.10)			Not applicable ^e		
Current post-surgery	-1.73 (-4.13-0.66)			-1.48 (-6.59-3.62)		
Model 2 ^d						
Post-surgery EDE scores						
Global score, per 1 unit higher	4.06 (2.28-5.84)	<0.001		8.15 (3.99-12.32)		<0.001
Level of hunger, per 1 unit higher	0.17 (-0.79-1.12)	0.73		0.35 (-2.08-2.78)		0.78
Level of enjoyment, per 1 unit higher	0.86 (-0.22-1.93)	0.12		0.65 (-1.99-3.29)		0.63

Note. EDE = eating disorder examination.

^aPercentage of baseline weight. A negative number indicates greater weight loss.

^bPercentage of maximum weight lost regained. A negative number indicates less weight regain.

^cAdjusting for pre-surgery factors related to missing follow-up data (i.e., site, age, and smoking status), and sex, race and pre-surgery body mass index.

^dModel 1 plus post-surgery EDE scores.

^eIn the weight regain model, only concurrent (i.e., post-surgery) status was evaluated.