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Eating Patterns and Unhealthy Weight Control Behaviors are Associated with Loss of Control Eating following Bariatric Surgery

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Abstract

Background—Loss of control (LOC) eating is associated with poor weight loss outcomes following bariatric surgery. It is not clear whether eating patterns (e.g., total number of daily meals/snacks, eating after suppertime, eating when not hungry) and unhealthy weight control behaviors (e.g., smoking, using laxatives) are associated with or predictive of LOC eating.

Objective—To examine whether eating patterns and unhealthy weight control behaviors are associated with LOC eating, and, if so, whether they predict LOC eating in bariatric patients.

Setting—Multicenter study, United States.

Methods—This is a secondary analysis of the Longitudinal Assessment of Bariatric Surgery-2 study. Assessments were conducted at pre-surgery, and 12, 24, 36, 48, 60, and 84 months after surgery. Logistic mixed models were used to examine the longitudinal associations between eating patterns, unhealthy weight control behaviors, and LOC eating. Time-lag techniques were applied to examine whether the associated patterns and behaviors predict LOC eating.

Results—Participants (N=1,477) were mostly women (80%), white (86.9%), and married (62.5%). At the time of surgery, the mean age was 45.4±11.0 years, and mean body mass index was 47.8±7.5 kg/m^2. Total number of daily meals/snacks, food intake after suppertime, eating when not hungry, eating when feeling full, and use of any unhealthy weight control behaviors were positively associated with LOC eating ($p<0.05$). Food intake after suppertime, eating when not hungry, and eating when feeling full predicted LOC eating ($p<0.05$).

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Conflict of interest

The authors have no conflict of interest to disclose.

Conclusion—Meal patterns and unhealthy weight control behaviors may be important intervention targets for addressing LOC eating after bariatric surgery.

Keywords

loss of control eating; bariatric surgery; eating patterns; weight control behaviors

1. Introduction

Severe obesity, defined as a body mass index (BMI) ≥40 kg/m^2, is a major public health issue affecting over 9% of US adults [(1)]. As individuals with severe obesity generally do not respond to behavioral or pharmacological treatments in the long term, bariatric surgery has emerged as the most effective treatment [(2)]. Roux-en-Y gastric bypass (RYGB) is the second most commonly performed bariatric procedure worldwide [(3)], and it is highly effective in inducing initial weight loss [(4)]. Studies have shown that while some patients are able to maintain the weight loss over the long term, weight regain is frequent in many others [(5,6)]. Weight regain can occur as early as 6 months post-RYGB with the percent of patients who regain weight increasing over time, reaching 4-40% at 5 to 7 years [(7–9)] and 60-70% at 10 years post-surgery [(10–13)]. Weight regain is the main indication for revisional bariatric surgery, which is accompanied by higher rates of morbidity and mortality compared to the primary procedure [(14)].

Almost without exception, studies have shown that postoperative loss of control (LOC) eating predicts less weight loss [(15,16)] and greater weight regain in the extended surgical period [(15,17)]. LOC eating is characterized by a subjective experience of loss of control while eating, regardless of the amount of food consumed [(18)]. In the general adult population, evidence supports LOC eating as an independent construct that is uniquely associated with general and eating-related psychopathology [(19–21)]. In the bariatric population, depending on different samples and measurements used, LOC eating affects 6.6% [(22)] to 78.6% [(23)] of the preoperative and 2% [(15)] to 52.9% [(23)] of the postoperative patients.

In addition to LOC eating, several behavioral factors such as eating patterns and unhealthy weight control behaviors may also contribute to post-surgical weight regain [(24–27)]. An eating pattern is a general term used to describe the way people eat, including meal frequency (e.g., total number of daily meals/snacks, days of consuming breakfast/lunch/dinner per week), meal timing (e.g., eating after suppertime, eating when not hungry, eating when feeling full), and meal location (e.g., eating out at fast-food restaurants). Studies have shown that individuals who report irregular eating patterns—especially skipping breakfast, lunch, or dinner [(28,29)], having an increased food intake at night [(30)], and frequently eating at fast-food restaurants [(31)]—are more likely to have binge eating disorder. Research on the relationship between the total number of daily meals/snacks and binge eating has yielded inconsistent results. For example, in a sample of female undergraduate students (N=144), number of daily meals or snacks was associated with more binge eating symptoms [(32)]. However, the increased daily meals were associated with less binge eating in a sample of treatment seeking adults with bulimia nervosa (n=504) [(33)] and daily snacks were not related to binge eating episodes in a sample of patients with obesity and binge eating disorder

(N=173) [34]. Furthermore, eating when not hungry and eating when feeling full are two of the indicators of binge eating disorder in the Diagnostic and Statistical Manual of Mental Disorders (5th Edition, DSM-5) [35]. Although LOC eating has been associated with irregular eating patterns (e.g., skipping breakfast, eating when not hungry) in children and adolescents [36–38], it is not known whether these associations generalize to the bariatric population.

Unhealthy weight control behaviors refer to using extreme practices for weight control, including chewing and spitting out of food, smoking, self-inducing vomiting, and using laxatives [39]. Chewing and spitting is a pathological behavior of chewing food (usually food that is highly enjoyable), and then spitting it out before swallowing as a means to avoid ingesting unwanted calories [40]. In the general population, studies have shown that individuals with chewing and spitting are more likely to develop binge eating behaviors and LOC eating [41,42]. Smoking, largely being used as an appetite suppressant, has been positively associated with the frequency and severity of binge eating [43,44]. Self-induced vomiting and using laxatives have been predominantly examined as compensatory behaviors following binge eating; however, some studies have reported that those behaviors also increase the risk for binge eating disorders [45,46]. Unhealthy weight control behaviors have been minimally examined in bariatric patients, and their relationships with LOC eating are unclear in this population.

The first aim of this secondary data analysis was to examine the associations between eating patterns, unhealthy weight control behaviors, and LOC eating in data collected in the Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) study over a 7-year follow-up. It was hypothesized that: 1) food intake after suppertime, eating when not hungry, eating when feeling full, and frequency of eating at fast-food restaurants would be positively associated with LOC eating; 2) frequency of consuming breakfast, lunch, and dinner would be negatively associated with LOC eating (no hypothesis was specified for total number of daily meals/snacks due to inconsistent findings in the extant literature); and 3) use of any unhealthy weight control behaviors, including chewing and spitting out food, smoking, self-inducing vomiting, and using laxatives for weight control, would be positively associated with LOC eating.

The second aim of this study was to determine whether the associated eating patterns and unhealthy weight control behaviors predicted LOC eating in this sample over the 7-year period.

2. Material and Methods

2.1 Study design and participants

This is a secondary analysis of the LABS-2 study (registered at ClinicalTrials.gov: NCT00465829), and details on this prospective cohort study that evaluated the long-term efficacy of bariatric surgery in the adult population have been published previously [47]. In brief, LABS-2 was comprised of 2,458 adults who underwent RYGB, laparoscopic adjustable gastric band, biliopancreatic diversion, or sleeve gastrectomy at 1 of 6 clinical centers throughout the United States [48]. LABS-2 participants were recruited between

February 2006 and February 2009 and completed assessments at pre-surgery (30 days prior to scheduled surgery), and at 12, 24, 36, 48, 60, and 84 months after surgery, with baseline sample characteristics published previously [48]. The institutional review board at each of the 6 clinical centers approved the protocol, and participants gave written informed consent.

The eligibility criteria for this secondary analysis included participants who: 1) completed a pre-surgical behavioral assessment; 2) underwent RYGB (for participants who had multiple surgeries, the primary surgery type was RYGB); and 3) provided at least one follow-up behavioral assessment. The rationale for only including patients who underwent RYGB is that sleeve gastrectomy was rarely utilized in the LABS-2 cohort and that adjustable gastric band and biliopancreatic diversion are not commonly performed today. A total of 1,601 participants who had undergone RYGB completed the baseline behavioral assessment, and 124 of them did not provide any of the follow-up data thus were excluded from this analysis, resulting in a sample size of 1,477. This secondary data analysis was approved for exemption by Office for Human Subject Protection, University of Rochester.

2.2 Measurements

LOC eating was measured by the self-reported LABS-2 Behavior Form (available at http://www.edc.gsph.pitt.edu/labs). Consistent with previous studies [25,49,50], two questions were used to define LOC eating: "*During the past 6 months, have you had times when you eat continuously during the day or parts of the day without planning what and how much you would eat?*" and "*Did you experience a loss of control, that is you felt like you could not control your eating?*" Participants who answered yes to both questions were coded as having LOC eating.

Eight eating patterns were measured by several questions from the self-reported LABS-2 Behavior Form, which are summarized in Table 1.

The four unhealthy weight control behaviors were measured by the self-reported LABS-2 Behavior Form. Single questions that asked participants whether or not they have chewed and spit out food, smoked cigarettes, self-induced vomiting, and used laxatives for weight control in the past 6 months were used to determine whether or not the participant self-reported the unhealthy weight control behaviors (yes or no). Because the prevalence of each of the four unhealthy weight control behaviors was low throughout the 7-year surgical period, those behaviors were combined into one variable for analysis, delineated as the use of any unhealthy weight control behaviors.

2.3 Data analysis

Statistical analysis was performed using PROC GLIMMIX in SAS version 9.4 (SAS Institute Inc., Cary, NC). Continuous variables were described as means and standard deviations; categorical variables were described in number and percentage. A p-value of <0.05 was considered statistically significant. Missing data were assumed as missing at random, and no imputation was applied.

The longitudinal associations between each of the eating patterns and use of any unhealthy weight control behaviors and LOC eating were first examined in separate univariate logistic

mixed models. Significant variables ($p<0.05$) identified in this step were carried on to a multivariate model (model 1). Covariates in the univariate and multivariate models included age, gender, race (white, black, other), household income (<$ 49,999, $ 50,000-$ 99,999, >$ 99,999), education (high school or lower, bachelor's degree, graduate or professional degree), and marital status (never married, married, separated, divorced, or widowed). Since a previous study that used LABS-2 dataset has reported that surgery site, depression, recording eating, and taking medications for emotional/psychiatric problems were related to LOC eating [(49)], those variables were also controlled as covariates. Each of the eating patterns, use of any unhealthy weight control behaviors, and time (categorical) were treated as fixed effects, the intercept at the subject level was set as the random effect.

To determine whether the eating patterns and use of any unhealthy weight control behaviors (identified in model 1) predicted LOC eating, a multivariate logistic mixed model with a time-lag technique (model 2) was applied to ensure that the time dependent variables happened before LOC eating. More specifically, the eating patterns and use of any unhealthy weight control behaviors of one year before were treated as the fixed effects to predict the LOC eating of the current year, controlling for the same covariates as in the model 1. Because the data for the pre-surgery (baseline assessment) would be automatically ignored due to a lack of lagged predictors, a technique that distinguished the first assessment and the other assessments was applied in order to retain the pre-surgery data [(51)].

3. Results

3.1 Sample Description

Description of the sample characteristics is shown in Table 2. Participants (N=1,477) were mostly women (80%), white (86.9%), married (62.5%), had a baccalaureate degree (62.9%), and had a household income ≥ $50,000 (51.5%). At the time of surgery, the mean age was 45.4±11.0 years and the mean BMI was 47.8±7.5 kg/m^2.

3.2 Description of LOC Eating, Eating Patterns, and Unhealthy Weight Control Behaviors before Surgery through 7 Years after Surgery

At 12 months after surgery, the prevalence of LOC eating was 22.3%, a decrease from 34.0% before surgery. After 12 months, the prevalence of LOC eating showed an upward trend that peaked at 36 months (31.4%), then gradually decreased reaching 27.2% at 84 months after surgery (Table 3).

With respect to eating patterns (Table 3), participants consumed a mean of 5 total meals/snacks per day throughout the 7-year follow-up, and over 80% of them consumed a range of 3-6 total meals/snacks per day. Before and after surgery, breakfast was the least consumed meal, and most participants ate lunch (>70%) and dinner (>85%) 6-7 times a week. The majority of post-surgical patients reported consuming up to a quarter of daily food intake after suppertime (>85%), eating when not hungry up to once a week (>80%), eating when feeling full up to once a week (>90%), and eating out at fast-food restaurants up to two times a week (>75%).

Regarding unhealthy weight control behaviors (Table 3), except for chewing and spitting out food that increased from before (1%) to 3.4%-8.9% for different years after surgery, other behaviors remained at a low level throughout the 7-year follow-up: smoking (<3%), vomiting (<2%), and using laxatives (<1.5%). When considering the use of any unhealthy weight control behaviors, the prevalence increased from 4.4% before surgery to 11.6% at 12 months after surgery, then declined to 7.1% at 72 months after surgery.

3.3 Longitudinal Associations between Eating Patterns, Use of any Unhealthy Weight Control Behaviors, and LOC Eating throughout the 7-year Follow-up

In the univariate logistic mixed model, the total number of daily meals/snacks ($F=11.84$, $p<0.01$), food intake after suppertime ($F=27.79$, $p<0.01$), eating when not hungry ($F=115.06$, $p<0.01$), eating when feeling full ($F=85.23$, $p<0.01$), and use of any unhealthy weight control behaviors ($F=4.97$, $p=0.03$) were associated with LOC eating. Therefore, those variables were carried on to the multivariate logistic mixed model (model 1).

In model 1 (Table 4), the total number of daily meals/snacks ($F=4.90$, $p<0.01$), food intake after suppertime ($F=14.91$, $p<0.01$), eating when not hungry ($F=24.67$, $p<0.01$), and eating when feeling full ($F=16.22$, $p<0.01$) were significantly and positively associated with LOC eating.

For the total number of daily meals/snacks, the OR [95% CI] increased linearly from the first category (< 3 meals, reference), to the second (3-6 meals, 1.24 [0.83, 1.87]), and third category (> 6 meals, 1.75 [1.11, 2.77]). For food intake after suppertime, the OR [95% CI] increased from the first category (none, reference), to the second (up to a quarter, 1.78 [1.46, 2.17]), third (about half, 2.81 [2.03, 3.89]), fourth (more than a half, 3.86 [2.22, 6.73]), and fifth category (almost all, 3.79 [1.61, 8.95]). For eating when not hungry, the OR [95% CI] increased linearly from the first category (rarely or never, reference), to the second (once per week, 2.23 [1.79, 2.78]), third (more than once per week, 3.71 [2.68, 5.14]), and fourth category (nearly every day, 3.82 [2.00, 7.29]). Similarly, for eating when feeling full, the OR [95% CI] increased linearly from the first category (rarely or never, reference), to the second (once per week, 1.83 [1.48, 2.27]), third (more than once per week, 3.01 [2.11, 4.28]), and fourth category (nearly every day, 4.59 [2.20, 9.57]).

3.4 Predictors of LOC Eating throughout the 7-year Follow-up

In the multivariate logistic mixed model with time-lag technique (model 2, Table 4), food intake after suppertime ($F=3.39$, $p<0.01$), eating when not hungry ($F=3.04$, $p=0.03$), and eating when feeling full ($F=8.38$, $p<0.01$) predicted LOC eating.

For food intake after suppertime, the OR [95% CI] increased from the first category (none, reference), to the second (up to a quarter, 1.52 [1.21, 1.91]), third (about half, 1.21 [0.81, 1.79]), fourth (more than a half, 1.29 [0.69, 2.34]), and fifth category (almost all, 1.61 [0.53, 4.93]). For eating when not hungry, the OR [95% CI] increased from the first category (rarely or never, reference), to the second (once per week, 1.32 [1.01, 1.71]), third (more than once per week, 1.66 [1.12, 2.44]), and fourth category (nearly every day, 0.95 [0.46, 1.96]). For eating when feeling full, the OR [95% CI] increased linearly from the first category (rarely or never, reference), to the second (once per week, 1.62 [1.25, 2.11]), third

(more than once per week, 2.63 [1.73, 4.02]), and fourth category (nearly every day, 4.10 [1.84, 9.16]).

4. Discussion

This study examined the longitudinal associations between eating patterns, unhealthy weight control behaviors, and LOC eating in a large, national cohort of patients who underwent RYGB. Results showed that the total number of daily meals/snacks, food intake after suppertime, eating when not hungry, eating when feeling full, and use of any unhealthy weight control behaviors were all positively associated with LOC eating. Additionally, food intake after suppertime, eating when not hungry, and eating when feeling full predicted LOC eating.

In this study, over 80% of participants consumed 3-6 total daily meals/snacks both before and after surgery, which was higher than the 34.9% reported in another pre-bariatric sample [52]. Patients who have undergone bariatric surgery are usually recommended to consume frequent, small meals/snacks (3-6) to alleviate symptoms such as plugging and vomiting [53]; however, an increased total number of meals/snacks was associated with a higher risk of LOC eating. Observational studies have produced mixed findings of the association between meal frequency and binge eating—while some studies reported the number of daily meals/snacks was positively associated with binge eating frequency [32,54], others reported a negative association [33], or no association [34].

The finding that increased meal frequency relates to a higher risk of LOC eating contradicts the dietary restraint theory of LOC eating [55], which posits that body or shape concerns trigger cognitive attempts to restrict food intake [56,57], thus increasing food cravings [58] and contributing to the onset and maintenance of LOC eating [59–63]. The dietary restraint theory of LOC eating has been studied in children [62], adolescents [61,63], and young adults [57,59,60] who have not undergone bariatric surgery. In the context of bariatric surgery, research on the relationship between dietary restraint and LOC eating has been limited with mixed results. For example, one study of 99 patients who underwent RYGB 2 to 7 years previously reported a positive association [64], but a more recent investigation of 226 adult candidates for bariatric surgery found no association [65]. Therefore, although more research is needed, the dietary restraint theory of LOC eating may not necessarily apply to the bariatric population. In addition to being positively associated with LOC eating, extant literature has shown that the increased frequency of meals/snacks after bariatric surgery is associated with less weight loss and more weight regain [66,67]. Therefore, researchers have suggested that healthcare providers should be cautious when recommending a “multiple meal” pattern after surgery [66,67].

More than 85% of participants reported consuming up to a quarter of their daily food intake after dinner, which is generally in line with other studies that reported a prevalence of 2%-20% of night eating in bariatric surgery samples [68]. The daily food consumed after dinner was positively associated with and also predicted LOC eating, which supports night eating as a risk factor for LOC eating [65]. In a cohort of 206 bariatric candidates, participants with LOC eating had a significantly higher level of night eating [65]. In other

populations such as adults with obesity and treatment-seeking patients with eating disorders, night eating is consistently related to more frequent or more severe binge eating [30,69]. This finding implies that evenings may present a particularly vulnerable time for LOC eating, and future interventions may consider targeting night eating in the context of treatment.

Eating when not hungry and eating when feeling full are two indicators of binge eating disorder, and as expected, those patterns were associated with and predicted LOC eating. Ivezaj et al. [70] examined the correlates of LOC eating among 61 patients who had undergone sleeve gastrectomy and reported that for those who had LOC eating, 58.3% reported eating when not hungry, and 72.2% reported eating until uncomfortably full. In other samples such as young women [36], children [38], and adolescents [38], eating when not hungry has been associated with LOC eating. Furthermore, in qualitative studies with college-age women and adult women, participants with LOC eating also recognized eating when not hungry and eating when feeling full as salient experiences that accompany LOC eating [71,72]. Multiple strategies have been shown effective in helping individuals use hunger and satiety signals to initiate and stop eating, such as mindfulness training, meditation, and body scan [73], which may potentially be applied to bariatric patients to decrease their LOC eating [74].

More than 80% of participants reported consuming breakfast/lunch/dinner regularly, and most participants (62.5% before surgery; >75% after surgery) reported eating out at fast-food restaurants up to 2 times a week. Surprisingly, the frequency of consuming breakfast/lunch/dinner and the frequency of eating out at fast-food restaurants were not associated with LOC eating, which is contrary to existing literature. One study examined the meal patterns in 574 youths and found that compared to those without LOC eating, youths with LOC eating were less likely to consume lunch and evening meals [37]. Similarly, several other studies reported that regular meal eaters were less likely to engage in binge eating while those who skipped breakfast, lunch, or dinner had a significantly greater number of binge episodes [28,29,34]. Although the literature on eating out and LOC eating is limited, studies have reported that half of the binge episodes occurred in restaurants, and restaurants may present a high-risk food environment for LOC eating [31,75]. Even though the frequency of consuming breakfast/lunch/dinner and eating out at fast-food restaurants did not appear to influence LOC eating in this study, keeping a regular meal pattern and avoiding eating out are considered important for bariatric patients because they are essential for weight loss and weight loss maintenance [27].

Up to 12% of participants reported using any of the unhealthy weight control behaviors (chewing and spitting out food, smoking, self-inducing vomiting, and using laxatives), and those behaviors were positively associated with LOC eating (in the univariate model). This finding is in line with studies reporting adolescents who used any of these unhealthy weight control behaviors were at increased risk for LOC eating [76,77]. It is worth noting that although there have been no comparable studies that examined unhealthy weight control behaviors in the bariatric population, the percentage of participants engaged in these behaviors in this study appeared to be lower than has been reported in the general population. For example, in a sample of 5,552 young adults with overweight or obesity, Nagata et al. [78] reported that 17.6% of participants used at least one of the unhealthy

weight control behaviors (e.g., vomiting, laxative/diuretic) to lose weight. It is also worth noting that the positive association between use of any unhealthy weight control behaviors and LOC eating became nonsignificant in the multivariate model, which highlights the need for more studies to confirm (or reject) this finding.

This secondary analysis has several clinical implications. First, during pre- and post-surgical psychosocial assessments, healthcare providers should pay close attention to patients who report irregular eating patterns (especially increased total number of daily meals/snacks, increased food intake after suppertime, increased frequency of eating when not hungry, and increased frequency of eating when feeling full) and who report using unhealthy behaviors to lose weight as they could be indicative of the presence of LOC eating. Second, food intake after suppertime, eating when not hungry, and eating when feeling full predicted LOC eating in this study. Therefore, targeting these behaviors may be beneficial LOC eating prevention strategies. Third, future interventions of LOC eating may benefit from including strategies that promote a regular eating pattern and prevent using unhealthy behaviors to lose weight.

Several limitations should be considered when interpreting results. First, this secondary analysis only included patients who underwent RYGB as it was the most common procedure in the LABS-2 cohort. However, sleeve gastrectomy is the dominant procedure today and warrants future examination. Second, LOC eating was dichotomized in the two questions, although the questions were used in many studies [25,49,50], recent evidence suggests that LOC eating should ideally be assessed in a continuous manner [79]. Third, this secondary analysis did not control for other factors that may confound the association between eating patterns, unhealthy weight control behaviors, and LOC eating, such as body dissatisfaction and weight suppression.

5. Conclusions

In this secondary data analysis of patients from before to 7 years after RYGB, results showed that the total number of daily meals/snacks, food intake after suppertime, eating when not hungry, eating when feeling full, and use of any unhealthy weight control behaviors were positively associated with LOC eating. Additionally, food intake after suppertime, eating when not hungry, and eating when feeling full predicted LOC eating. Future development of prevention and intervention strategies of LOC eating may consider including meal patterns and unhealthy weight control behaviors as a target.

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Highlights

- Unhealthy weight control behaviors were associated with LOC eating
- Total number of daily meals/snacks was associated with LOC eating
- Food intake after suppertime predicted LOC eating
- Eating when not hungry/feeling full predicted LOC eating

Table 1.

Eating Pattern Measurements

Eating patterns	Measurements/Questions	Responses
Total number of daily meals/snacks	Think about your usual week, counting all meals and any snacks you may have, how many times a day do you eat?	——times/day. For analysis, because a total number of 3-6 meals/snacks per day is generally recommended for achieving a regular eating pattern, this variable was categorized into 3 groups (< 3 meals, 3-6 meals, and > 6 meals) *.
Days of consuming breakfast per week	Think about your usual week, how many days out of the 7-day week do you eat breakfast?	——times/week
Days of consuming lunch per week	Think about your usual week, how many days out of the 7-day week do you eat lunch?	——times/week
Days of consuming dinner per week	Think about your usual week, how many days out of the 7-day week do you eat dinner?	——times/week
Daily food intake after suppertime	During the past 3 months, how much of your daily food intake did you consume after suppertime?	0 – none; 1 – up to a quarter; 2 – about half; 3 – more than half; 4 – almost all
Eating when not feeling hungry	During the past 3 months, how often did you keep eating a meal even though you were not hungry anymore?	0 – rarely or never; 1 – occasionally (once per week); 2 – frequently (more than once per week); 3 – nearly every day
Eating when feeling full	During the past 3 months, how often did you keep eating a meal even though you felt full?	0 – rarely or never; 1 – occasionally (once per week); 2 – frequently (more than once per week); 3 – nearly every day
Days of eating out at fast-food restaurants per week	How many days a week do you eat out at fast-food restaurants for breakfast, lunch, or dinner?	——days/week. For analysis, the sum of days a week that participants ate out at fast-food restaurants for breakfast, brunch/lunch, or dinner was calculated.

Eating patterns in the Longitudinal Assessment of Bariatric Surgery-2 study (LABS-2) were measured by several questions from the self-reported LABS-2 Behavior Form, which is available at http://www.edc.gsph.pitt.edu/labs.

* For analysis, because a total number of 3-6 meals/snacks per day is generally recommended for achieving a regular eating pattern [Murphy R, Straebler S, Cooper Z, Fairburn CG. Cognitive behavioral therapy for eating disorders. Psychiatr Clin North Am. 2010;33(3):611-627] this variable was categorized into 3 groups (< 3 meals, 3-6 meals, and > 6 meals).

Table 2.

Baseline Sample Description (N=1,477)

Demographic characteristics	Values
Age (years), mean ± SD (n)	45.37±11.04 (1477)
Body mass index, mean ± SD (n)	47.78±7.52 (1477)
Gender (women), n (%)	1182 (80.0)
Race, (n)	1477
White, n (%)	1283 (86.9)
Black, n (%)	166 (11.2)
Other	28 (1.9)
Education, (n)	1471
High school or lower, n (%)	350 (23.8)
College graduate or bachelor's degree, n (%)	926 (62.9)
Graduate or professional degree, n (%)	195 (13.3)
Household income, (n)	1430
≤ $ 49, 999, n (%)	692 (48.4)
$ 50,000-$ 99,999, n (%)	548 (38.3)
> $ 99, 999, n (%)	190 (13.3)
Marital status, (n)	1468
Never married, n (%)	244 (16.6)
Married or marriage-like relationship, n (%)	917 (62.5)
Separated, divorced, or widowed, n (%)	307 (20.9)

Table 3.

Description of Loss of Control Eating, Eating Patterns, and Unhealthy Weight Control Behaviors before Surgery through 7 Years after Surgery (N=1,477)

	0	12	24	36	48	60	84
Loss of control eating No./Total No. (%)	496/1457 (34.0)	270/1211 (22.3)	320/1074 (29.8)	322/1024 (31.4)	306/1013 (30.2)	302/1015 (29.8)	202/743 (27.2)
Eating patterns							
Days eat breakfast a week, mean±SD	5.1±2.2	6.0±1.7	5.8±1.9	5.7±1.9	5.5±2.0	5.4±2.1	5.3±2.1
6-7 times per week No./Total No. (%)	766/1468 (52.2)	878/1225 (71.7)	749/1081 (69.3)	693/1046 (66.3)	641/1030 (62.2)	614/1040 (59.0)	429/758 (56.6)
Days eat lunch a week, mean±SD	6.0±1.6	6.5±1.2	6.4±1.3	6.3±1.4	6.2±1.4	6.1±1.5	6.0±1.6
6-7 times per week No./Total No. (%)	1053/1466 (71.8)	1042/1223 (85.2)	900/1083 (83.1)	820/1045 (78.5)	784/1030 (76.1)	769/1040 (73.9)	550/759 (72.5)
Days eat dinner a week, mean±SD	6.7±0.9	6.8±0.8	6.7±0.9	6.7±0.9	6.6±1.0	6.6±1.1	6.6±1.0
6-7 times per week, No./Total No. (%)	1346/1469 (91.6)	1144/1224 (93.5)	999/1084 (92.2)	955/1045 (91.4)	911/1030 (88.4)	921/1037 (88.8)	673/760 (88.6)
Total meals/snacks per day	4.9±1.9	5.1±1.5	5.2±1.6	5.2±1.7	5.1±1.8	5.0±1.8	4.9±1.7
3-6 meals per day, No./Total No. (%)	1168/1438 (81.2)	1074/1222 (87.9)	912/1067 (85.5)	857/1030 (83.2)	836/1012 (82.7)	840/1021 (82.2)	636/750 (84.8)
Food intake after supper time	1253/1460	1160/1221	1004/1079	956/1035	905/1019	934/1038	673/757
≤ a quarter, No./Total No. (%)	(85.8)	(95)	(93)	(92.4)	(88.8)	(90.0)	(88.9)
Eat when not hungry	885/1461	1145/1228	972/1094	916/1046	873/1032	892/1044	656/760
≤ once/week, No./Total No. (%)	(60.6)	(93.2)	(88.8)	(87.6)	(84.6)	(85.4)	(86.3)
Eat when full	1038/1467	1177/1234	1019/1095	966/1051	921/1032	944/1046	690/760
≤ once/week, No./Total No. (%)	(70.6)	(95.4)	(93.1)	(91.9)	(89.2)	(90.2)	(90.8)
Fast food restaurant/week, mean±SD	2.5±3.0	1.1±1.9	1.4±2.1	1.6±2.4	1.7±2.4	1.7±2.6	1.7±2.6
≤ 2 times, No./Total No. (%)	874/1399 (62.5)	978/1137 (86)	765/963 (79.4)	708/915 (77.4)	658/876 (75.1)	688/898 (76.6)	471/626 (75.2)
Unhealthy weight control behaviors No./Total No. (%)							
Chewing and spitting out food	15/1473 (1.0)	108/1220 (8.9)	76/1085 (7.0)	53/1035 (5.1)	48/1027 (4.7)	46/1036 (4.4)	26/755 (3.4)
Smoking cigarettes	32/1470 (2.2)	24/1207 (2.0)	25/1077 (2.3)	18/1025 (1.8)	27/1016 (2.7)	27/1026 (2.6)	22/751 (2.9)
Self-inducing vomiting	8/1473 (0.5)	15/1219 (1.2)	20/1084 (1.8)	11/1033 (1.1)	4/1023 (0.4)	17/1036 (1.6)	6/757 (0.8)
Using laxatives	15/1474 (1.0)	6/1218 (0.5)	9/1084 (0.8)	10/1035 (1.0)	11/1025 (1.1)	10/1034 (1.0)	10/756 (1.3)
Use of any unhealthy behaviors	66/1460 (4.5)	139/1199 (11.6)	115/1070 (10.8)	83/1017 (8.2)	80/1011 (7.9)	82/1026 (7.9)	53/750 (7.1)

Table 4.

Multivariate Logistic Mixed Models without (Model 1) and with Lagged Technique (Model 2) for LOC Eating, Eating Patterns, and Unhealthy Weight Control Behaviors throughout the 7-year Follow-up (N=1,477)

	Model 1		Model 2	
	Odds ratio	**95% CI**	**Odds ratio**	**95% CI**
Intercept	<0.01†	<0.01-0.89	0.01	<0.01-0.24
Age	1.02†	1.01-1.03	1.02†	1.01-1.03
Sex (women)	1.62†	1.24-2.13	1.57†	1.19-2.07
Race				
Black	0.79	0.55-1.16	0.82	0.55-1.22
Other	1.67	0.72-3.88	1.73	0.73-4.12
Marital status				
Married	0.89	0.65-1.21	0.76	0.55-1.04
Separated/divorced/widowed	1.04	0.74-1.47	0.96	0.67-1.37
Household income				
$ 50,000-$99,000	0.79	0.62-1.01	0.86	0.67-1.10
>=$100,000	0.71	0.49-1.01	0.87	0.61-1.24
Education				
Some college or bachelor's degree	0.87	0.68-1.13	0.95	0.73-1.24
Graduate or professional degree	1.06	0.74-1.52	1.25	0.86-1.81
Body mass index	1.02†	1.01-1.04	1.03†	1.01-1.04
Self-reported depression	1.01	0.99-1.03	1.04†	1.03-1.06
Record eating	1.30†	1.07-1.58	1.31†	1.07-1.60
Medication for psychiatric disease	1.22†	1.08-1.38	1.16‡	1.01-1.34
Total meals/snacks per day				
3-6 meals	1.24	0.83-1.87	1.03	0.63-1.66
>6 meals	1.75†	1.11-2.77	1.36	0.79-2.32
Food intake after suppertime				
Up to a quarter	1.78†	1.46-2.17	1.52†	1.21-1.91
About half	2.81†	2.03-3.89	1.21	0.81-1.79
More than half	3.86†	2.22-6.73	1.29	0.69-2.39
Almost all	3.79†	1.61-8.95	1.61	0.53-4.93
Eat when not hungry				
Occasionally (once per week)	2.23†	1.79-2.78	1.32	1.01-1.71
Frequently (more than once pe week)	3.71†	2.68-5.14	1.66‡	1.12-2.44
Nearly everyday	3.82†	2.00-7.29	0.95	0.46-1.96
Eat when feeling full				

	Model 1		Model 2	
	Odds ratio	**95% CI**	**Odds ratio**	**95% CI**
Occasionally (once per week)	1.83†	1.48-2.27	1.62†	1.25-2.11
Frequently (more than once per week)	3.01†	2.11-4.28	2.63†	1.73-4.02
Nearly everyday	4.59†	2.20-9.57	4.10†	1.84-9.16
Use of any unhealthy behaviors (yes)	1.24	0.94-1.64	-	-

Reference groups: sex (men); race (white); marital status (never married); household income (<$50,000); education (high school or below); total meals/snacks per day (<3 meals); food intake after suppertime (none); eat when not hungry (rarely or never); eat when feeling full (rarely or never); use of any unhealthy behaviors (no)

†: $p<0.01$

‡: $p<0.05$