Grazing and Loss of Control Related to Eating: Two High-risk Factors Following Bariatric Surgery

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Background: Gastric restrictive surgery induces a marked change in eating behavior. However, the relationship between preoperative and postoperative eating behavior and weight loss outcome has received limited attention.
Objective: This study assessed a range of eating behaviors before and 1 year after laparoscopic adjustable gastric banding (LAGB) and explored the nature and extent of change in eating patterns, their clinical associates, and impact on weight loss.
Methods and Procedures: A 12-month observational study assessed presurgical and postsurgical binge eating disorder (BED), uncontrolled eating, night eating syndrome (NES), grazing, nutrient intake and eating-related behaviors, and markers of psychological distress. A total of 129 subjects (26 male and 103 female, mean age 45.2 ± 11.5 and BMI 44.3 ± 6.8) participated in this study.
Results: Presurgical BED, uncontrolled eating, and NES occurred in 14%, 31%, and 17.1% of subjects, which reduced after surgery to 3.1%, 22.5%, and 7.8%, respectively ($P = 0.05$ for all). Grazing was prevalent before (26.3%) and after surgery (38.0%). Preoperative BED most frequently became grazers ($P = 0.029$). The average percentage weight loss (%WL) was 20.8 ± 8.5%; range –0.67 to 50.0% and percentage of excess weight loss (%EWL) 50.0 ± 20.7%; range –1.44 to 106.9% ($P < 0.001$). Uncontrolled eating and grazing after surgery showed high overlap and were associated with poorer %WL ($P = 0.008$ and $P < 0.001$, respectively) and elevated psychological distress.
Discussion: Consistent with recent studies, uncontrolled eating and grazing were identified as two high-risk eating patterns after surgery. Clearer characterization of favorable and unfavorable postsurgical eating behaviors, reliable methods to assess their presence, and empirically tested postsurgical intervention strategies are required to optimize weight loss outcomes and facilitate psychological well-being in at-risk groups.

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INTRODUCTION

The two most common bariatric procedures today are laparoscopic adjustable gastric banding (LAGB) and roux-en-Y gastric bypass. Both surgeries involve a gastric restrictive component that generates a predictable reduction in total energy intake (1–3), and a reliable, though variable, weight loss in the first postoperative year and beyond (4). In the case of LAGB, the primary weight loss mechanism is thought to be the induction of satiety (5). A marked reduction in hunger has also been reported (6). Increased feelings of satiety and low hunger levels would facilitate the sustained behavior modification that is required to achieve a long-term change in energy balance (7,8). It is currently in question whether certain preoperative eating behaviors render affected individual less responsive to these effects and influence the efficacy of bariatric surgery (9).

Binge eating disorder (BED) has been the focus of most studies to examine links between preoperative eating patterns and surgical outcome. BED involves repeated uncontrolled episodes during which objectively large amounts of food are consumed, in association with marked emotional disturbance (10). Prospective studies to assess preoperative BED reveal no consistent predictors of postsurgical weight loss (1,11–13). Following gastric restrictive the ability to consume objectively large amounts of food in a single sitting is impeded, and BED prevalence is greatly diminished (14,15). Yet feelings of loss of control (LOC) related to eating can still persist (16,17). It is uncertain whether preoperative binge eaters are more likely to experience postsurgical feelings of LOC or how recurrent episodes of LOC influence weight loss and psychological state. We have previously found that emotional disturbance related to feelings of LOC, even while eating subjectively large amounts of food, was common among surgical candidates, and predicted by markers of psychological distress (18).

The night eating syndrome (NES), characterized by morning anorexia, evening hyperphagia and sleep difficulty, and more recently by recurrent awakenings from sleep to eat (19),

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has received limited attention (20–22). This pattern of eating appears associated with obesity and prevalent among obese treatment seekers, yet the impact of NES on bariatric surgery is unknown (19).

The consumption of smaller amounts of food over extended periods of time has also been described before (6,8,11,12,17,23) and after obesity surgery (17). This eating pattern has been commonly termed "grazing." Preoperative binge eaters may be high risk to convert to postoperative grazing (11,17). As an eating pattern, and a potential contributor to weight gain, grazing has received minimal attention. This is particularly surprising in the surgical sphere, given that the consumption of small amounts of food continuously over extended periods is not precluded following bariatric surgery.

This study prospectively assessed characteristics of BED, uncontrolled eating, NES and grazing, before, and 1 year after LAGB. We aimed to explore the nature and extent of change in these eating patterns following surgery. The impact of presurgical and postsurgical eating behavior on weight loss was the primary outcome measure. Any associations between eating behavior and markers of psychological distress were also of interest. To provide further description, energy intake and additional eating-related factors were recorded.

METHODS AND PROCEDURES

Study design

The study was of a prospective observational design. Data were collected primarily via a series of self-report questionnaires, completed before and 12 months after LAGB. At baseline, confirmation of the presence of features of BED, feelings of LOC, NES, and grazing took place during a semistructured clinical interview. At 12-month follow-up eating behaviors were confirmed during a semistructured phone interview.

The study was approved by the Monash University Standing Committee on Ethics in Research involving Humans and was conducted in accordance with the Helsinki Declaration of 1975, as revised in 1983.

Subjects

Between August 2004 and December 2005, severely obese persons accepted into the bariatric surgery program at The Avenue Hospital, Melbourne, were invited to participate. Subjects were male or female aged between 18 and 65 years. Individuals were not eligible to take part, if they had undergone previous bariatric surgery. All participants provided informed, written consent.

A single experienced surgeon placed the Lap-Band System (Allergan Health, Irvine, CA) along the pars flaccida pathway. The band was secured around the upper part of the stomach just below the gastroesophageal junction to create a small upper gastric pouch. After a 5-week perioperative period, the balloon of the band was gradually inflated to induce gastric restriction and promote feelings of between-meal satiety and early satiation (24). According to standard clinic protocol, in the first year, subjects were encouraged to visit the clinic every 2 weeks for the first 1–2 months, then monthly, and quarterly as required.

Measures/Materials

Anthropometry. Height was recorded at baseline to the closest millimeter using a wall-mounted stadiometer. Body weight was recorded at baseline, 4 and 12 postsurgical months to the nearest 0.1 kg, using the electronic Tanita Wedderburn TBF-305 (Lake Worth, FL), in light clothing without shoes. Weight loss was reported as the percentage weight loss (%WL) at 12 months after LAGB. For further description, the percentage of excess weight loss (%EWL) has also been reported. The %EWL was calculated by dividing the weight loss in kilograms by the excess weight (the initial weight minus weight at BMI 25) and multiplying this figure by 100.

Assessment of BED and an LOC related to eating. The Questionnaire on Eating and Weight Patterns–Revised (QEWP-R) (25,26) was used to screen for binge eating behavior. Subjects who reported any characteristics of a binge underwent a semistructured clinical interview at baseline and a phone interview at 12-month follow-up. A single, experienced clinician performed all interviews. The quantity of food consumed, whether a sense of LOC was present, the extent of the associated distress, and the frequency of objective and subjective binge episodes was established. To assess the extent of distress associated with feelings of LOC related to eating, subjects self-rated their emotional disturbance on a scale measuring distress. Scores ranged from 1 (no disturbance) to 5 (extreme disturbance). A score of 4 or 5 was considered to indicate a high level of self-reported emotional disturbance (18).

Before and after surgery, "Full BED" subjects met all diagnostic criteria for BED as outlined in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (10). They reported a frequency of ≥2 objective bulimic episodes/week over the previous 6 months in association with behavioral markers of LOC and significant psychological distress. The term "Uncontrolled Eaters" was given to the group who experienced feelings of LOC during the consumption of either a subjectively or objectively large amount of food at a frequency of ≥1/week over the previous 6 months but did not meet full BED criteria. The level of psychological distress associated with the bulimic episodes was variable. After reassessment of eating behavior at 12 months, the few subjects who met full BED were combined with those meeting the criteria for "Uncontrolled Eaters." The postsurgical group was labeled "Uncontrolled Eaters_12." "Uncontrolled Eaters_12" represented a group who experienced postsurgical feelings of LOC related to eating. "Non-binge eaters" reported no sense of LOC during the consumption of either subjectively or objectively large amounts of food.

The NES. A self-made survey screened for NES based on the proposed diagnostic criteria of Stunkard *et al.* in 1996 (27). NES diagnosis required that persons usually (i) had no appetite for breakfast, (ii) consumed 50% or more of total energy intake after 7 p.m., and (iii) had trouble getting to sleep or staying asleep on three or more nights of the week within the previous 3-month period. The consumption of nocturnal snacks during night time awakenings was also assessed. NES behaviors were confirmed by interview.

"Grazing" behavior. A pattern of "grazing" was measured primarily to investigate the association between small amounts of food eaten over continuous periods and postsurgical energy intakes and weight loss outcomes. The definition of grazing was based on that reported by Saunders (8,17). Grazing was defined by the consumption of smaller amounts of food continuously over an extended period of time, eating more than the subjects considers best for them. At baseline and follow-up, subjects were asked whether they had often engaged in a grazing pattern of eating during the previous 6 months. Grazing was confirmed by interview.

Other eating behavior. The Cancer Council Victoria Food Frequency Questionnaire (28,29) was used to assess subject's usual dietary habits and derive a total energy intake. Validity of the Cancer Council Victoria Food Frequency Questionnaire relative to 7-day food records has proven acceptable (28). The highest and lowest 2% of calculated energy intakes at baseline and 12 months were excluded from statistical analysis. The Three-Factor Eating Questionnaire (30) collected information on cognitive dietary restraint, disinhibition of eating, and subjective feelings of hunger. A series of multiple choice questions and dichotomous response items collected additional information. Before and after surgery, subjects indicated how many times a day they ate, considering all meals and snacks as a separate "eating episode." The frequency of gastrointestinal symptoms after surgery was also assessed. Based on

the definition of Busetto *et al.* (1), vomiting was defined as disgorging the contents of the stomach or esophagus through the mouth. Obstruction was defined as a temporarily blockage of the Lap-band outlet. At analysis, the reported frequency of both symptoms were combined. After surgery, subjects were asked to indicate from a list, situational or emotional factors that predisposed them to consume types of foods or quantities of food they knew to be not best for them. The fear of weight regain, and the perceived return of "old eating habits," were also assessed. At four postsurgical months, subjects were sent a short questionnaire asking how many times a day they ate and the frequency of gastrointestinal symptoms. Failure to return the 4-month questionnaire did not result in study exclusion.

Psychological health and quality of life (QoL). The Beck Depression Inventory (31) assessed for the presence of symptoms of depressive illness. A score of 0–9 was considered "Normal"; 10–16 "Mild depression"; 17–29 "Moderate depression"; and 30–63 "Severe depression" (32). The Multidimensional Body Self-Relations Questionnaire (33) provided a measure of body image distress. The difference between the appearance orientation subscale (how one values physical appearance in general) and the appearance evaluation subscales (how one rates their own physical appearance) was used to indicate the degree of appearance dissatisfaction (34). The Medical Outcomes Trust Short Form-36 (SF-36) was used to assess health-related QoL (35,36). Results of the survey are presented as the SF-36 physical and mental summary scales (36).

Postsurgical complications. Any band slippage and port access problems requiring revisional surgery were noted.

Data analyses

Descriptive statistics were used to express the mean ± s.d. for continuous, normally distributed variables. Baseline and 12-month Beck Depression Inventory scores and the Three-Factor Eating Questionnaire hunger score at 12 months were not normally distributed and required log transformation. Differences between anthropometric, psychological, and eating-related measures before and after surgery were tested using paired Student's *t*-tests for continuous variable and χ^2-test for categorical variables. Differences between respondents and non-respondents (those who did not return the 12-month survey), and between the eating subgroups and the remainder of the cohort were tested using Independent *t*-tests for continuous variables, χ^2-test for categorical values, and Mann–Whitney *U*-test for ordinal data. The change in eating category before and after surgery, and differences in postsurgical emotional and situational eating triggers between groups were assessed using the χ^2-test. Forward and backward linear regression explored which preoperative and postoperative factors predicted weight loss outcome. Both models controlled for age, gender, baseline BMI, and insulin resistance (37). Key variables were grouped according to postoperative eating pathology, energy intake, eating behavior, and markers of psychological distress. SPSS version 12.0.1 was used for statistical analysis. A P value of <0.05 was considered statistically significant. A P value of >0.05 and <0.10 was considered a statistical trend.

RESULTS

Respondents and non-respondents

Of 180 subjects recruited at baseline, 6 did not go on to have surgery, 1 died of myocardial infarction, and 44 failed to return the 12-month survey. All eligible subjects (n = 173) were notified by phone before the 12-month survey was sent and then contacted by phone to prompt survey completion between one and three times. In total, 129 subjects returned the baseline and 12-month surveys, representing a response rate of 75%. The postoperative survey was returned on average 12.29 ± 1.1 months after surgery. Comparison of eligible subjects who returned and who did not return the final questionnaires showed a lower %WL (P = 0.009) in non-responders. This group was also more likely to have been diagnosed with BED preoperatively (P = 0.033) and to have attended less clinic appointments (P = 0.017).

Participant description

Mean age of the participants was 45.2 ± 11.5 years, with a gender distribution of 103 females (80%) and 26 males. **Table 1** lists clinical, behavioral, and psychological characteristics of subjects at baseline and 12 months. Over the first postsurgical year mean body weight reduced from 122.2 ± 20.5 kg (range 75.1–201.2) to 98.5 ± 18.2 kg (range 56.8–152.9) (P < 0.001). The mean %WL was 20.8 ± 8.5% (range −0.67 to 50.0%) and mean %EWL was 50.0 ± 20.7% (range −1.44 to 106.9%). Concurrent with the average decline in body weight, the prevalence of BED and NES, and severity of subjective hunger and dietary disinhibition, symptoms of depression, and appearance dissatisfaction all reduced significantly. Dietary restraint and health-related QoL increased. The prevalence of grazing did not alter.

Subjects attended clinic 11.75 ± 3.7 times and underwent 7.88 ± 3.4 band adjustments. The annual number of clinic visits or band adjustments did not differ according to baseline or postsurgical eating pathology. Anterior prolapse of the band occurred in two subjects (1.6%), and port access problems requiring replacement occurred in three subjects (2.4%). The complication rate was too low to assess for any association with eating behavior.

Table 1 Clinical, behavioral and psychological characteristics of the total cohort before and 12 months after LAGB (n = 129 paired results)

	Baseline	12 Months
Mean BMI	44.3 ± 6.8[a]	35.0 ± 6.0***
Binge eating disorder	18 (14.0%)	4 (3.1%)*
Uncontrolled eaters	40 (31.0%)	29 (22.5%)*
Night eating syndrome	22 (17.1%)	10 (7.8%)*
Grazer	34 (26.4%)	49 (38.0%)
BDI score	15.0 (10–21)[b]	6.0 (4–11)[b,***]
AD score	1.7 ± 1.0	0.91 ± 1.0***
Appearance orientation	3.5 ± 0.69	3.5 ± 0.64
Appearance evaluation	1.8 ± 0.66	2.6 ± 0.82***
SF-36 MCS	46.9 ± 8.1	48.9 ± 7.3*
SF-36 PCS	37.2 ± 10.0	49.2 ± 9.8***
Restraint	8.3 ± 3.9	13.0 ± 4.2***
Disinhibition	11.5 ± 3.4	6.2 ± 3.9***
Hunger	9.0 (6–12)	2.0 (1–5)[b,***]

Statistical analysis using paired Student's *t*-tests for continuous variables and Chi-square for categorical variables.
AD, appearance dissatisfaction; BDI, Beck depression Inventory; MCS, mental health component score; PCS, physical component score.
[a]Mean ± s.d. (all such values); [b]Data presented as median (IQR); analysis based on log transformed values. *P < 0.05, **P < 0.01, ***P < 0.001.

Baseline BED

At baseline BED was diagnosed in 18 study participants (14%). Compared to the remainder of the cohort, baseline BED were distinguished by higher symptoms of depression ($P = 0.033$), appearance dissatisfaction ($P = 0.05$), dietary disinhibition ($P < 0.001$), and hunger ($P < 0.001$). They reported more frequent daily eating episodes ($P = 0.001$) and consumed a higher usual energy ($P = 0.023$) and percentage fat ($P = 0.006$) intake compared to the remainder of the cohort. Despite these initial differences, the group with baseline BED were not characterized by any eating-related or psychological measure after surgery. A statistical trend toward a higher monthly frequency of gastrointestinal symptoms (vomiting or obstruction) was evident at 4 postsurgical months ($P = 0.068$) but not at 12 months. Baseline BED achieved a similar weight loss to the remainder of the cohort (%WL 21.9 ± 11.1% vs. 20.6 ± 8.1% and %EWL 52.5 ± 25.8% vs. 49.6 ± 19.8%). After surgery the majority of baseline BED ($n = 11$; 61.1%) were newly categorized as grazers, and eight subjects (44%) were classified as "Uncontrolled Eaters_12" (Table 2). Seven of the eight "Uncontrolled Eaters_12" were also classed as postoperative grazers. One-third of baseline BED ($n = 6$) reported no postsurgical eating pathology.

Postsurgical BED

Twelve months after surgery four subjects (3.1%) met full BED criteria. Two of these subjects had been diagnosed with baseline BED, and two had not. As they were too few for statistical analysis, those with BED were combined with "Uncontrolled Eaters_12."

Table 2 Overlap between presurgical and postsurgical eating behaviors

	Presurgical BED ($n = 18$)	Uncontrolled eaters ($n = 40$)	Presurgical grazer ($n = 34$)
Postsurgical BED			
$n = 4$	$n = 2$	$n = 1$	$n = 3$
	$P = 0.035$	NS	$P = 0.025$
Uncontrolled Eaters_12[a]			
$n = 33$	$n = 8$	$n = 14$	$n = 22$
	$P = 0.048$	$P = 0.018$	$P < 0.001$
Postsurgical Grazer			
$n = 49$	$n = 11$	$n = 16$	$n = 32$
	$P = 0.029$	NS	$P < 0.001$
Postsurgical Upset re: LOC			
$n = 25$	$n = 5$	$n = 10$	$n = 10$
	NS	NS	$P = 0.085$
No Grazing or LOC after surgery			
$n = 73$	$n = 6$	$n = 20$	$n = 1$
	$P = 0.032$	NS	$P < 0.001$

Statistical analysis using χ^2 for categorical variables.
BED, binge eating disorder; LOC, loss of control; NS, not significant.
[a]Group numbers include four subjects with postsurgical BED.

Baseline uncontrolled eaters

"Uncontrolled Eaters" were common before surgery (31%). This group reported elevated preoperative hunger ($P < 0.001$) and disinhibition ($P < 0.001$), consumed a higher usual energy intake ($P = 0.035$) and tended to a higher percentage fat intake ($P = 0.068$) compared to non-binge eaters. No presurgical psychological or weight-related measures distinguished "Uncontrolled Eaters." However, Table 2 shows that a significant percentage of this group were identified with this eating pattern after surgery. Ten of the fourteen subjects who continued uncontrolled eating after surgery also met criteria for grazing. Baseline "Uncontrolled Eaters" lost a similar %WL to non-binge eaters.

Postsurgical uncontrolled eaters

After surgery, 29 subjects (22.5%) reported feelings of LOC ≥1/week during the consumption of a subjectively or objectively large amount of food, during the previous 6 months. This group and the four subjects with BED were combined and labeled "Uncontrolled Eaters_12." Table 3 shows that "Uncontrolled Eaters_12" were a distinctive group who achieved a significantly lower weight loss, equating to a mean loss of 21.6 kg vs. 26.7 kg in the remainder of the group. The "Uncontrolled Eaters_12" consumed a higher usual energy intake and percentage of energy as fat and ate more often over the day. They reported less dietary restraint and greater hunger and disinhibition. Importantly, symptoms of depression were also higher, and mental health-related QoL was poorer compared to the remainder of the cohort. Results were similar when the four subjects with BED were excluded from analysis (data not shown).

Severe distress related to uncontrolled eating

Twenty-five subjects (76% of "Uncontrolled Eaters_12") reported a high level of emotional disturbance related to their feelings of LOC. This subset of "Uncontrolled Eaters_12" was significantly younger than the remainder of the cohort; mean age 39.1 ± 12.4 years compared to 46.7 ± 10.8 years ($P = 0.003$). They also reported great dissatisfaction with appearance ($P < 0.001$), recorded a higher BMI at every time point (all $P < 0.05$), and showed a statistical trend toward female gender ($P = 0.090$).

Baseline NES

At baseline, 22 subjects (17.1%) fulfilled NES criteria, and 10 subjects (7.8%) reported frequent nocturnal snacking. Men were more likely to be night eaters than women ($P = 0.008$), and NES was commonly associated with BED ($P = 0.048$), as previously reported (38). Baseline NES were not distinguished from the remainder of the cohort by any psychological or eating-related measure and lost a similar %WL. Baseline NES did not predict postsurgical night eating, uncontrolled eating, or grazing (data not shown).

Postsurgical NES

Ten subjects (7.8%) reported NES at 12 months (Table 1). Of these, only four were baseline NES (18.1%), and an additional

Table 3 Comparison of the group who reported uncontrolled eating with the remainder of the cohort 12 months after LAGB

	Uncontrolled Eaters_12	Remainder of cohort
n	33 (25.6%)	96
Male/female	4/29	22/74
Age (years)	44.1 ± 11.8[b]	45.6 ± 11.4
BMI at 0 months (kg/m²)	44.8 ± 6.9	44.1 ± 6.8
BMI at 4 months (kg/m²)[a]	39.2 ± 6.5	38.1 ± 5.6
BMI at 12 months (kg/m²)	37.0 ± 7.1	34.3 ± 5.4*
%WL	17.4 ± 8.2	22.0 ± 8.3**
%EWL	52.6 ± 19.4	42.5 ± 22.6**
BDI score[c]	9 (5–19)	6 (3–10)**
AD score	1.0 ± 1.0	0.86 ± 1.0
Appearance orientation	3.3 ± 0.69	3.6 ± 0.64**
Appearance evaluation	2.3 ± 0.85	2.8 ± 0.76**
SF-36 PCS	47.5 ± 9.3	49.9 ± 10.0
SF-36 MCS	46.5 ± 7.8	49.8 ± 6.9*
Restraint	10.9 ± 3.7	13.7 ± 4.1**
Disinhibition	10.1 ± 3.1	4.8 ± 3.2***
Hunger	6 (3–9)[c]	2 (1–4)[c],***
Energy (Kj)	4370 ± 1544	3807 ± 1356*
% Fat	34.3 ± 5.6	30.3 ± 6.4**
% Protein	21.3 ± 3.3	22.8 ± 4.5
% CHO	39.1 ± 5.6	39.3 ± 7.4
Eat per day at 4 months[c,d]	3.0 (2.5–4)	3.0 (2–3)*
Eat per day at 12 months[c,d]	3.0 (3–4)	3.0 (2–4)*

Statistical analysis using independent *t*-tests for continuous variables, χ^2 for categorical variables, and Mann–Whitney *U* test for ordinal variables.
%EWL, percentage of excess weight lost; %WL, percentage of weight lost; AD, appearance dissatisfaction; BDI, Beck depression Inventory; CHO, carbohydrate; MCS, mental health component score; PCS, physical component score.
[a]*n* = 93; [b]mean ± s.d. (all such values) unless specified; [c]Data presented as median (IQR); [d]Frequency of daily eating episodes. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

six subjects began experiencing this cluster of behaviors after surgery. There were no gender differences in this postsurgical group; however they reported lower cognitive restraint ($P = 0.042$) and a lesser consumption of "hard" foods ($P = 0.032$) and protein ($P = 0.05$). Weight loss was not statistically significantly different to non-NES, yet the mean %WL in night eaters was 16.9% compared to 21.1%WL in non-NES, and 43.3%EWL vs. 50.6%EWL, respectively. A statistical trend toward fewer band adjustments in NES was noted ($P = 0.069$). Reports of nocturnal snacking reduced to four subjects (3.1%) postoperatively ($P = 0.033$).

Baseline grazing

Prior to surgery, 34 subjects (26.4%) reported a grazing pattern of eating. Grazing was associated with lower dietary restraint ($P = 0.025$), higher dietary disinhibition ($P < 0.001$) and hunger ($P = 0.034$), and more frequent daily eating episodes ($P = 0.05$). At 12-month follow-up, baseline grazers reported significantly more symptoms of depression ($P = 0.033$) and had lost less weight (%WL 15.7 ± 7.8% vs. 22.6 ± 8.0% and %EWL 37.3 ± 19.0% vs. 54.6 ± 19.3%) compared to the remainder of the cohort ($P < 0.001$). Presurgical grazers were highly likely to continue grazing; 94.1% of preoperative grazers continued to report this eating pattern after surgery (Table 2). In addition to postsurgical grazing, 65% of baseline grazers also met criteria for "Uncontrolled Eaters_12."

Postsurgical grazing

After surgery, 49 subjects (38%) reported grazing (Table 1). Although this figure was not statistically different from baseline, it represents an increase in grazing prevalence by 31%. At 12 months, the overlap between the grazers and "Uncontrolled Eaters_12" was high, with 26 subjects (20.2% of the total cohort) meeting criteria for both categories ($P < 0.001$). This number represents 53.1% of the grazers and 78.8% of "Uncontrolled Eaters_12." As a result, these two groups shared many characteristics compared to the remainder of the cohort. Grazers lost a lower %WL; 17.3 ± 7.6% vs. 22.9 ± 8.4% and %EWL 40.9 ± 18.6% vs. 55.6 ± 20.0% ($P < 0.001$), reported less dietary restraint ($P = 0.031$), greater hunger ($P < 0.001$) and disinhibition ($P < 0.001$), a higher number of daily eating episodes ($P = 0.005$), and showed a statistical trend toward a higher total energy intake ($P = 0.057$). More symptoms of depression ($P = 0.024$) and poorer mental health–related QoL ($P = 0.027$) were also reported. Unlike "Uncontrolled Eaters_12," grazers reported a higher number of gastrointestinal symptoms at 12-month follow-up ($P = 0.013$).

Postsurgical emotional and situational eating triggers

Table 4 shows the extent to which different emotions and situations triggered eating in certain groups, compared to the remainder of the cohort. Fear of weight regain and the perceived return of old eating habits were also assessed. Those who reported baseline grazing remained a distinctive postsurgical group who (over)ate in response to numerous emotional triggers, continued eating regardless of feeling full, were aware of the return of old eating habits and fearful of weight regain. Of the postsurgical groups, the "Uncontrolled Eaters_12" and the subset with a high level of emotional disturbance related to feelings of LOC reported eating in response to emotional triggers, ignoring satiety cues and difficulty maintaining behavior change. Those with NES at 12 months were also more likely to eat in social situations and when tired.

Presurgical factors predicting %WL

A linear regression model was used to determine presurgical factors predicting %WL. After controlling for baseline BMI, age, gender, and an indirect measure of insulin resistance, all baseline eating pathology groups, followed by baseline energy intake, then eating-related behaviors, and finally psychological variables were entered into the model. Forward and backward linear regression identified baseline grazing, $\beta = -0.385$, $P < 0.001$ as an independent predictor of %WL. In addition to a higher baseline BMI, $\beta = 0.236$, $P = 0.008$, preoperative grazing predicted 19.5% of variance in %WL.

Table 4 Situations where, or reasons why, the disordered eating groups were more likely to consume types of foods or quantities of food they knew to be not best for them, 12 months following LAGB. Fear of weight gain and the return of "old eating habits" among the groups was also assessed

	Baseline BED	Uncontrolled Eaters_12	12-month upset re: LOC	12-month NES	Baseline grazer	12-month grazers
Anxiety	NS	9.89 ($P = 0.002$)	16.52 ($P < 0.001$)	NS	10.26 ($P = 0.001$)	6.33 ($P = 0.012$)
Fatigue	4.46 ($P = 0.035$)	15.01 ($P < 0.001$)	NS	4.48 ($P = 0.034$)	16.33 ($P < 0.001$)	NS
Boredom	NS	13.48 ($P < 0.001$)	8.41 ($P = 0.004$)	NS	12.21 ($P < 0.001$)	NS
Stress	NS	18.77 ($P < 0.001$)	13.61 ($P < 0.001$)	NS	13.30 ($P < 0.001$)	3.68 ($P = 0.05$)
Anger	NS	11.60 (P = 0.001)	6.38 ($P = 0.012$)	NS	13.02 (P < 0.001)	NS
Upset/depression	NS	9.48, ($P = 0.002$)	14.09 ($P < 0.001$)	NS	4.97 ($P = 0.026$)	NS
Habit	16.20 ($P < 0.001$)	NS	NS	NS	NS	NS
When socializing	NS	NS	NS	8.32 (P = 0.004)	NS	NS
Continue to eat when full	NS	26.69 ($P < 0.001$)	18.96 ($P < 0.001$)	NS	30.71 ($P < 0.001$)	3.70 ($P = 0.05$)
Return of old patterns	NS	7.52 ($P = 0.006$)	NS	NS	10.73 ($P = 0.001$)	NS
Fear weight gain	NS	10.36 ($P = 0.001$)	15.53 ($P < 0.001$)	NS	11.25 ($P = 0.001$)	8.25 ($P = 0.004$)

Statistical analysis using χ^2. Each group was compared to the remainder of the cohort.
BED, binge eating disorder; LOC, loss of control; NES, night eating syndrome; NS, not significant.

Postsurgical factors predicting %WL

A linear regression model determined postoperative factors most strongly predicting %WL. Baseline BMI, age, gender, and insulin resistance were entered as controlling variables. Higher appearance dissatisfaction, $\beta = -0.278$, $P = 0.002$, subjective hunger, $\beta = -0.254$, $P = 0.006$, postsurgical grazing, $\beta = -0.186$, $P = 0.032$, and total energy intake $\beta = -0.182$, $P = 0.041$ all independently predicted a poorer %WL. In addition to baseline BMI, $\beta = 0.194$, $P = 0.029$, these postoperative factors predicted 29.6% of variance in %WL.

DISCUSSION

This study assessed a range of eating behaviors before and 12 months after LAGB. Associations between presurgical and postsurgical eating patterns, weight loss outcome, and psychological distress were investigated. First, irrespective of measured eating behavior, all groups achieved a significant weight loss, far in advance of that achievable by behavioral (39,40) and medical (41) weight loss therapies. Second, while variance in eating behaviors was evident and linked to significant differences in weight outcomes, the extent of these differences may not always be *clinically* significant.

Baseline BED as a distinct group, were not associated with poorer postoperative weight loss. This finding agrees with most (1,11,12,15,21,42–44) but not all (13,14,45) prospective studies. However, preoperative BED were at higher risk of postsurgical uncontrolled eating and grazing. During the first 6–12 postsurgical months, over 60% of baseline BED reported recurrent grazing, and 44% were considered uncontrolled eaters. More than one third of baseline BED met criteria for both postoperative eating patterns. Several other studies support this tendency for preoperative binge eaters to continue aberrant eating behaviors after surgery (11,15,17,43,46). Given the difficulty consuming objectively large amounts of food following gastric restrictive surgery, Saunders has suggested that postsurgical grazing may fulfill a similar function to binge eating (17).

Feelings of LOC related to eating have been reported as early as four postsurgical months (15), and as late as 13.8 mean years after bariatric surgery (47). Kalarchian *et al.* observed greater weight regain in 46% of subjects who reported feelings of LOC associated with either objective or subjective bulimic episodes between 2 and 7 years after roux-en-Y gastric bypass (16). In the current study, the number of "Uncontrolled Eaters" reduced after surgery; however, one quarter of subjects were classified as uncontrolled eaters 12 months after LAGB. This group lost significantly less weight. A number of factors may have influenced this outcome. The "Uncontrolled Eaters_12" consumed more energy and proportionately more fat, reported higher hunger and disinhibition, less dietary restraint, and more frequent eating episodes. A higher frequency of eating in response to emotional triggers was also reported. Others have observed this tendency toward "emotional eating" among surgical patients (23,48). Eating in response to emotions may stimulate a preference for fatty and sweet foods (49–51).

Three quarters of "Uncontrolled Eaters_12" reported a high level of emotional disturbance directly related to the experience of loss of eating control. We have previously found that emotional disturbance related to feelings of LOC was associated with markers of psychological distress. This association was consistent in persons reporting objective or subjective bulimic episodes (18). In this study, this postoperative subgroup was distinguished by poorer weight loss, younger age, higher dissatisfaction with appearance, and a tendency to be female. The causality vs. counter-causality of the association remains in question; however, these findings suggest that uncontrolled eating after bariatric surgery is relatively common and linked to poorer weight and psychological outcomes.

After surgery, a significant number of subjects (20.2% of the total cohort) were identified as both uncontrolled eaters and grazers. This highlights a significant proportion of persons who are likely to experience feelings of poor control over eating behaviors, which include both larger portions of food within distinct periods and smaller portions of food over extended periods. Saunders has also observed an element of poor control over grazing and defined this eating pattern as "smaller, subjective episodes of overeating," (17). Among other factors, elevated hunger, which was identified as an independent risk factor for poorer weight loss, was greater in persons reporting these behaviors. Hunger suppression and increased satiety are important weight loss mechanisms after LAGB. Frequent clinic follow-up and band adjustments to manage hunger are of prime importance. However, not all LAGB recipients achieve optimal hunger control. Higher markers of psychological distress and eating in response to emotional cues were also present among uncontrolled eaters and grazers. It is possible that those with poorly controlled physical or emotional hunger are more likely to graze and experience an LOC related to eating. These factors may in turn promote a poorer psychological state.

Grazing was common before and after surgery. All but two (5.9%) preoperative grazers continued this eating pattern after LAGB. Although not statistically significant, grazing prevalence was 31% higher after surgery compared to baseline. Not only does gastric restriction permit the repeated intake of smaller amounts of food, it may facilitate this eating pattern. Furthermore, both preoperative and postoperative grazing independently predicted poorer postsurgical weight loss. At 6 months after roux-en-Y gastric bypass Saunders has also described persistent grazing among those who reported this presurgical behavior (17). Burgmer *et al.* reported that the prevalence of preoperative grazing ("permanent eating") was 19.5% among a cohort seeking gastric restrictive surgery (6). Although this figure is similar to ours, no difference in mean weight loss was found between preoperative grazers and the remainder of the group one year after surgery. Busetto *et al.* defined grazing as consumption of "small quantities of foods repetitively between meals, typically triggered by inactivity and/or loneliness" (12). This pattern was present in 42.5% of surgical candidates but did not predict 3-year weight outcomes after LAGB.

After surgery, the incidence of NES and nocturnal snacking reduced significantly. The presence of baseline NES was not associated with postoperative NES or any other eating pattern. Interestingly, 6 of 10 subjects with postsurgical NES commenced night eating after surgery. Adami *et al.* prospectively assessed NES using similar criteria (20). Their baseline prevalence estimate of 8% was similar to the 6% reporting NES 3 years following BPD. Our findings do not support the supposition of Adami *et al.* that NES remains stable following obesity surgery. Research involving NES is in its infancy and currently thwarted by inconsistent diagnostic criteria (19).

This manuscript represents one of the first attempts to measure changes in eating behavior, and characterize "non-normative" eating patterns after bariatric surgery. Given that this was a primary aim, the lack of agreed group definitions and substantial overlap between some groups is a limitation. This study used a self-report survey followed by a semistructured phone interview to assess eating behavior after surgery. Although clinical interview may be considered the method of choice to assess "disordered" eating behavior (52), Saunders (17) notes that patients could be too ashamed to admit feelings of LOC or aberrant eating behaviors to their surgeon. Individuals experiencing a LOC may also be more inclined to avoid clinical follow-up. In this study, we found 12-month non-respondents were more likely to have reported presurgical BED, to have lost less weight and attended less clinic appointments. Although this bias affects the ability to generalize our results, it skews the study participants toward less postsurgical eating pathology. The actual incidence of deviant eating behaviors may have been higher. Strengths of this study include the measurement of body weight in a clinical setting, the use of validated questionnaires, paired measurement of a wide range of eating patterns and behaviors, and inclusion of several measures of non-eating-related psychological distress.

Limitations notwithstanding, this study highlights that aberrant eating patterns before and after bariatric surgery are associated with poorer postoperative outcomes. However, it is important to acknowledge that all groups achieved a significant weight reduction, and good evidence supports that LAGB and roux-en-Y gastric bypass facilitate excellent sustained weight loss in the medium term (53). Furthermore, the difficulty of achieving and maintaining even minor weight loss in those with BED is well documented (54,55). Therefore, the best opportunity to attain a significant weight change in obese binge eaters may be bariatric surgery. The focus on, and sometimes exclusion of, presurgical BED appears misdirected. Yet preoperative binge eaters are a group at high risk to become postoperative grazers and uncontrolled eaters, and as such should receive close ongoing monitoring after surgery. Young females may be a group at higher risk of uncontrolled eating and psychological distress linked to poorer weight outcomes.

Ongoing postoperative review, band adjustments, and clinical management are imperative to optimize weight loss outcomes and facilitate psychological well-being after LAGB. Clearer characterization of favorable and unfavorable postsurgical eating behaviors, and further definition of the clinical significance of different patterns of uncontrolled eating and grazing, is required. Future research should include subjects undergoing other bariatric procedures and address the need for reliable methods to assess postsurgical eating behavior and empirically tested postsurgical intervention strategies to manage at-risk populations.

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DISCLOSURE

The authors declared no conflict of interest.

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