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CLINICAL RESEARCH

Preoperative Predictors of Weight Loss Following Bariatric Surgery: Systematic Review

Masha Livhits · Cheryl Mercado · Irina Yermilov · Janak A. Parikh · Erik Dutson · Amir Mehran · Clifford Y. Ko · Melinda Maggard Gibbons

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Abstract
Background Obesity affects 32% of adults in the USA. Surgery generates substantial weight loss, but 20–30% fails to achieve successful weight loss. Our objective was to identify preoperative psychosocial factors associated with weight loss following bariatric surgery.
Methods We performed a literature search of PubMed® and the Cochrane Database of Reviews of Effectiveness between 1988 and April 2010. Articles were screened for bariatric surgery and weight loss if they included a preoperative predictor of weight loss: body mass index (BMI), preoperative weight loss, eating disorders, or psychiatric disorder/substance abuse. One thousand seven titles were reviewed, 534 articles screened, and 115 included in the review.
Results Factors that may be positively associated with weight loss after surgery include mandatory preoperative weight loss (7 of 14 studies with positive association). Factors that may be negatively associated with weight loss include preoperative BMI (37 out of 62 studies with negative association), super-obesity (24 out of 33 studies), and personality disorders (7 out of 14 studies). Meta-analysis revealed a decrease of 10.1% excess weight loss (EWL) for super-obese patients (95% confidence interval (CI) [3.7–16.5%]), though there was significant heterogeneity in the meta-analysis, and an increase of 5.9% EWL for patients with binge eating at 12 months after surgery (95% CI [1.9–9.8%]).
Conclusions Further studies are necessary to investigate whether preoperative factors can predict a clinically meaningful difference in weight loss after bariatric surgery. The identification of predictive factors may improve patient selection and help develop interventions targeting specific needs of patients.

Keywords Bariatric surgery · Predictors · Weight loss · Preoperative · Outcomes

M. Livhits · C. Mercado · I. Yermilov · J. A. Parikh · E. Dutson · A. Mehran · C. Y. Ko · M. M. Gibbons
Department of Surgery,
David Geffen School of Medicine at UCLA,
10833 LeConte Ave, 72-215 CHS,
Los Angeles, CA 90095, USA

M. Livhits (✉) · I. Yermilov · J. A. Parikh · C. Y. Ko · M. M. Gibbons
Department of Surgery,
VA Greater Los Angeles Healthcare System,
11301 Wilshire Blvd,
Los Angeles, CA 90073, USA
e-mail: mlivhits@mednet.ucla.edu

M. M. Gibbons
Department of Surgery, Olive View—UCLA,
14445 Olive View Dr, Rm 2B-156, Sylmar,
Los Angeles, CA 91342, USA

Introduction

Obesity has risen rapidly in the USA, with 32% of adults having a body mass index (BMI) greater than 30 kg/m^2 [1]. Surgical intervention has emerged as the most effective method of ensuring significant and sustained weight loss for the morbidly obese, with the added benefits of improving obesity-related comorbidities (i.e., hypertension, diabetes, and sleep apnea) as well as quality of life [2]. Despite these benefits, there are associated risks of surgery, including a mortality of <1% and morbidity rate of up to 20%.

Though the majority of patients achieve a successful degree of weight loss after surgery, typically defined as >50% excess

weight loss (EWL), there is a significant minority (15–20%) who fail to achieve this goal [3]. Failure to achieve successful weight loss after surgery is likely multi-factorial and involves provider level (technical factors, preoperative patient education) as well as patient level characteristics. Some patient factors cannot be modified, such as gender, age, and diabetes mellitus. Increasing emphasis is now placed on identifying behavioral patient factors that correlate with successful weight loss, including eating disorders such as binge or sweet eating and psychiatric conditions such as depression or personality disorders [4]. These factors can help guide patient selection or targeted follow-up plans for those at risk for losing less weight. Requesting that patients lose a modest degree of weight, generally 10–20 lb, in the weeks immediately prior to bariatric surgery has also been associated with improved postoperative weight loss. This mandatory preoperative weight loss is separate from the documentation of recent weight loss efforts that is required by many insurance companies.

Previous reviews have examined various psychosocial factors that may be associated with weight loss outcomes after bariatric surgery, but they have been limited in scope and non-systematic [5, 6]. This systematic review analyzes the evidence on potential preoperative patient level predictors of postoperative weight loss, including preoperative BMI, mandatory preoperative weight loss immediately prior to surgery and previous weight loss attempts, eating disorders/maladaptive eating habits, and psychiatric conditions/substance abuse.

Materials and Methods

Identification and Selection of Studies

Systematic literature search was performed to assess potential preoperative and postoperative patient level factors associated with the degree of postoperative weight loss. The current review is limited to preoperative factors. MEDLINE search (1/1/1988 to 4/22/2010) was conducted using terms “Bariatric Surgery” [Mesh:NoExp] or “weight loss surgery” or “obesity surgery” or “weight reduction surgery” or “Biliopancreatic Diversion” [Mesh] or “laparoscopic band” or “lap band” or “gastric band” or “Gastric Bypass” [Mesh] or “Gastroplasty” [Mesh] or “gastric sleeve” or “sleeve gastrectomy” and “Obesity” [Mesh] and (“preoperative weight loss” or “pre-operative weight loss” or “preoperative weight” or “pre-operative weight”). Potential preoperative predictors were included in this review: preoperative BMI, mandatory weight loss and previous weight loss attempts, eating disorders, and psychiatric disorders/substance abuse (individual lists of search terms provided in the Appendix).

Each article was evaluated with a standardized screener. The selection criteria included studies published in English with patients over the age of 18 years old (studies with patients both over and under 18 years old were accepted) who underwent bariatric surgery (open or laparoscopic gastric bypass, laparoscopic adjustable gastric banding, biliopancreatic diversion, vertical banded gastroplasty, or gastric sleeve). Reference lists of the screened studies were manually searched to identify additional publications. Accepted study designs included case series/cohort, case control, and randomized control trials; studies with a sample size of less than ten were excluded.

Data Extraction

Data abstracted from each study included study design, type of operation, baseline patient demographics, criteria for the predictive factors (preoperative BMI, mandatory preoperative weight loss and previous weight loss attempts, eating disorders, and psychiatric conditions/substance abuse), postoperative weight loss, and follow-up interval. Preoperative BMI included any measure of baseline weight that was reported in the study, as well as results for super-obesity (defined as BMI$\geq$50 kg/m^2). Preoperative weight loss included mandatory preoperative weight loss, defined as the weight that some programs require patients to lose in the immediate time interval just before undergoing surgery, and previous weight loss attempts. The eating disorder/maladaptive eating habit domains included in this review are binge eating, sweet eating, hunger, and other maladaptive eating habits such as emotional and night eating. The psychiatric domains include depression, anxiety, sexual abuse, self-esteem, alcohol use or abuse, and other psychiatric conditions (e.g., personality disorders).

Data Analysis

We report the number of studies that found a positive association with weight loss (presence of condition was associated with greater weight loss), no association, or a negative association (presence of condition was associated with less weight loss). Due to the wide variation between studies, overall associations were summarized based on the number of studies for each predictor from the systematic review, not accounting for sample size, duration of follow-up, and study design. We summarized the strength of the evidence for each potential predictor into two categories: based on the number of studies in each domain and the percentage of studies reporting a positive or negative association. We used a cut-off of at least seven studies for any domain as having consistent evidence because the median number of studies per domain was seven; therefore,

domains with less than seven studies were defined as having insufficient evidence.

Due to the variability in reported outcomes and insufficient number of studies in most domains, no predictors were considered to have strong evidence of an association with postoperative weight loss. The categories were suggestive evidence (≥7 studies and ≥50% reported a consistent association in the same direction) and unclear/no evidence (the majority of studies reported no association or associations in the opposite direction, or there were fewer than 7 studies). Weight loss was most commonly reported as % EWL, with success defined as ≥50% EWL and failure as <50% EWL.

A meta-analysis was performed to assess the association of super-obesity and binge eating on postoperative weight loss, calculated as % EWL. Due to heterogeneity in weight loss reporting, mean follow-up time, and instruments used to categorize patients, data pooling was not possible for the other predictors. Studies were included if they reported % EWL for patients who were super-obese vs. patients who were not super-obese, and patients who were binge eaters vs. those who were not. As weight regain is known to occur starting at 24 months after surgery, we also performed a separate meta-analysis just for studies with follow-up of 12–24 months. Super-obesity was defined as a BMI cut-off of 50 kg/m^2, while binge eating was defined by the criteria used in each individual study. The mean difference method in REVMAN (version 5.1) was used. A random effects model was used to calculate mean differences, 95% confidence intervals (CIs), a combined overall association with P value, and the P value for testing heterogeneity ($P<0.1$ was considered significant). When the standard deviation (SD) was not available, it was estimated using the mean SD from other studies.

Results

Description of the Selected Studies

Over one thousand studies ($n=1{,}007$) were identified assessing the relationship of one or more patient factors with degree of postoperative weight loss. Of these, 115 studies reported on the association between potential preoperative predictors of weight loss following surgery: 62 on preoperative BMI ($N=24{,}326$ patients), 15 studies on preoperative weight loss ($n=3{,}403$ patients), 38 studies on eating disorders/maladaptive eating habits ($n=5{,}012$ patients), and 64 studies on psychiatric disorders/substance abuse ($n=10{,}572$ patients) (Fig. 1). Some studies reported on multiple predictors in one or more domains.

The majority of articles reported on Roux-en-Y gastric bypass (RYGB) or laparoscopic adjustable gastric band procedures (LAGB) (Table 1). Mean follow-up time ranged from 13 to 24 months. Mean age ranged from 39 to 43 years, with all domains having a majority of female patients. Mean baseline BMI was between 46 and 50 kg/m^2.

Preoperative BMI

Sixty-two studies reported on the potential association between preoperative BMI and weight loss after bariatric surgery ($n=24{,}326$). The majority reported a negative association (37 studies) [7–43], 16 studies reported a positive association [44–59], and 9 studies found no association [4, 60–67] (Table 2). Follow-up time ranged widely from 6 to 144 months. Negative and no association studies reported longer follow-up and slightly higher baseline BMI (49 months and 47 kg/m^2) compared to positive association studies (29 months and 43 kg/m^2). Studies that found a negative association were more likely to report on RYGB as compared to LAGB procedures (17 studies on RYGB, 7 studies on LAGB), while the reverse was true for no or positive association studies (7 studies on RYGB, 9 studies on LAGB). The majority of negative and no association studies reported weight loss in terms of EWL rather than absolute values of BMI points (34 studies with EWL, 8 studies with BMI values), while most positive association studies used an absolute measure of weight loss such as BMI points or kilograms lost (9 studies) rather than EWL (5 studies).

Multiple studies reported that baseline BMI was a significant predictor of less weight loss in multivariate regression. These include Chau et al. [16], who found that increased baseline BMI was correlated with a greater odds ratio of poorer EWL (below the mean of 37% EWL for their study) at 12 months (OR 0.9, $P<0.001$), and Dixon et al. [15] and Hatoum et al. [28], who also reported a negative correlation with EWL (expressed as a continuous variable) at 12 months ($R=-0.22$ and β coefficient of -0.39, respectively, both $P<0.001$). Other studies divided patients into successful vs. failure groups (based on varying cut-offs such as EWL≥50% or weight loss above the mean for the study cohort) and reported a higher baseline BMI in the failure group [7, 8, 12]. Of studies that reported a positive association, several correlated baseline BMI with change in BMI after surgery, such as Black et al. [48] ($R^2=0.22$, $P<0.001$) and Powers et al. [54] ($R=0.56$, $P<0.0001$). Overall, there appears to be a negative association between preoperative BMI and postoperative weight loss, especially for studies on RYGB that report EWL (Table 3).

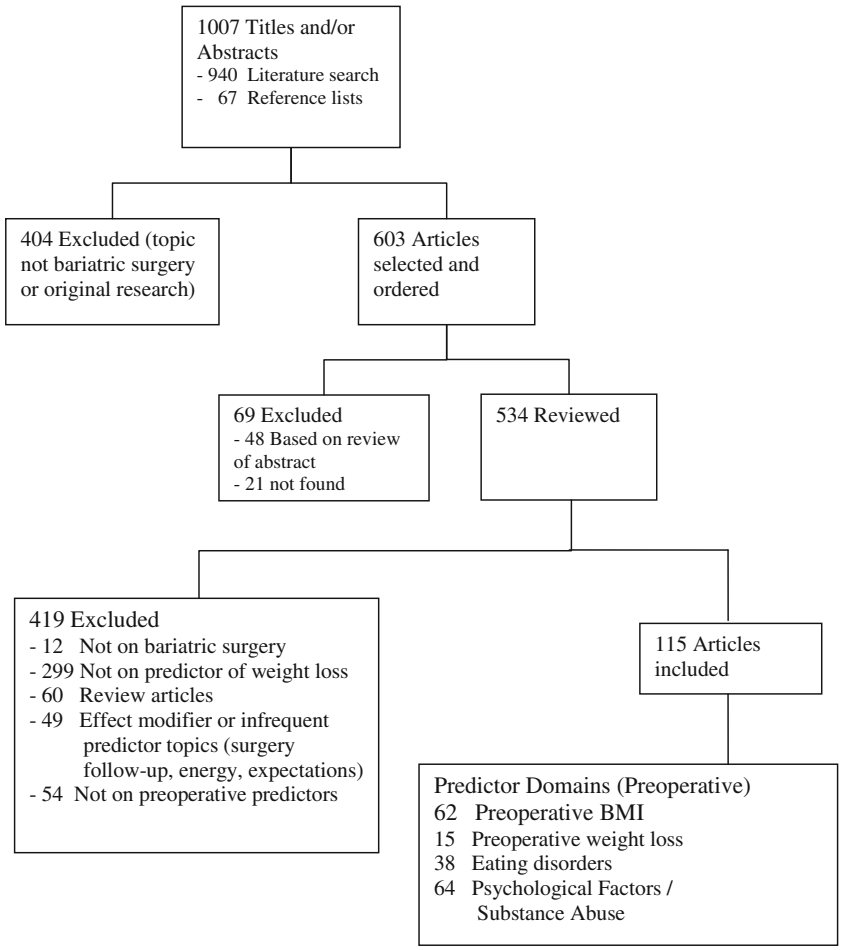


Fig. 1 Flow diagram of included articles

Super-obesity

Thirty-one studies reported on super-obesity, defined as a baseline BMI>50 kg/m^2 (n=13,999). Most studies found a negative association with postoperative weight loss (23 studies), while 5 studies found no association and 3 studies found a positive association. Multiple studies reported that patients who were super-obese preoperatively lost less

Table 1 Study characteristics and baseline patient demographics for potential preoperative predictors of weight loss following bariatric surgery

	Preoperative BMI	Preoperative factors		
		Mandatory weight loss	Eating disorders/maladaptive eating habits	Psychological disorders/ alcohol use or abuse
Patient sample size	24,326	3,403	5,012	10,572
Total # studies	62	15	38	64
Procedure type				
RYGB	26	13	13	21
LAGB	15	0	14	10
Mix/other	21	2	11	22
Mean follow-up time (months)	44.7	13.5	20.7	24.3
Range of follow-up time	6–144	3–48	4–60	6–98
Mean baseline BMI (kg/m^2)	47.5	50.0	49.5	45.7
Mean age (years)	42.0	43.2	40.7	39.4
Mean % female	82.1	80.4	86.4	81.8

RYGB Roux-en-Y gastric bypass, *LAGB* laparoscopic adjustable gastric band, *BMI* body mass index

Table 2 Association between potential preoperative psychosocial predictors and weight loss following bariatric surgery

Preoperative predictor[a]	Number of articles	Number of articles associated with weight loss		
		Positive association	No association	Negative association
Preoperative BMI	62	16	9	37
Super-obesity (BMI≥50 kg/m^2)	33	3	6	24
Preoperative weight loss				
Mandatory preoperative weight loss	14	7	6	1
Previous weight loss attempts	2	0	2	0
Preoperative eating disorders/ maladaptive eating habits				
Binge eating	20	3	13	4
Sweet eating	4	1	2	1
Hunger	2	0	0	2
Other maladaptive eating habits				
Other	6	2	3	1
Emotional eating	6	0	3	3
Preoperative psychiatric/ substance abuse				
Depression	19	1	14	4
Anxiety	2	0	2	0
Sexual abuse	8	1	5	2
Self-esteem	3	1	1	1
Alcohol use or abuse	3	2	1	0
Other psychiatric disorders				
Other	11	0	10	1
Personality disorders	14	4	3	7

BMI body mass index

[a] Some studies reported on multiple predictors in one or more domains

weight compared to the non-super-obese, such as Anthone et al. [21] (64% vs. 76%, $P<0.05$), Jan et al. [31] (48% vs. 70%, $P<0.05$), and Diniz et al. [37] (63% vs. 74%, $P<0.01$). Korenkov et al. reported the opposite, with super-obese patients losing more weight at 12 months after LAGB (90% vs. 54%, $P<0.001$) [46], and the remaining two positive association studies reported weight loss in terms of absolute BMI units [49, 50].

Table 3 Strength of evidence for preoperative predictors of weight loss after bariatric surgery based on systematic review

Suggestive evidence	Unclear/no evidence
Preoperative BMI (negative association)	Previous weight loss attempts
Super-obesity (negative association)	Binge eating
Mandatory preoperative weight loss (positive association)	Sweet eating
Personality disorders (negative association)	Hunger
	Other maladaptive eating habits
	Emotional eating
	Depression
	Anxiety
	Sexual abuse
	Self-esteem
	Alcohol use/abuse
	Other psychiatric disorders

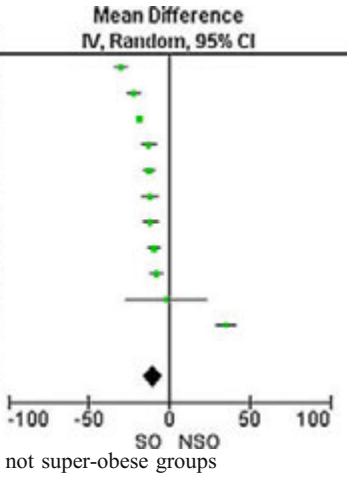
Suggestive evidence: ≥7 studies and ≥50% of studies reported an association in the same direction; unclear/no evidence: majority of studies reported no association or <7 studies

Data from 11 studies that reported on a total of 3,292 patients were pooled for meta-analysis (Table 4). They included seven studies on RYGB, two studies on LAGB, and two studies on a mix of RYGB, LAGB, and VBG and had a mean follow-up time of 30 months (range 12–72 months). The super-obese group overall lost a mean of 10.1% less EWL compared to the non-super-obese (95% CI [−3.7% to −16.5%], $P=0.002$); however, the results should be interpreted with caution as there was significant heterogeneity ($P<0.001$). Five of the 11 studies which reported postoperative weight loss 12 months after RYGB were pooled separately for meta-analysis. A negative association of preoperative super-obesity on postoperative weight loss was found (mean 7.2% EWL, 95% CI [−20.4% to +6.0%]); however, the results were not significant ($P=0.29$). There appears to be a negative association between baseline super-obesity and postoperative weight loss (especially when measured in EWL rather than absolute values), though super-obese patients also lost significant weight after bariatric surgery.

Table 4 Meta-analyses of postoperative weight loss for super-obese vs. not super-obese groups

Study or Subgroup	Super-obese (SO) Mean	SD	Total	Non Super-obese (NSO) Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Lutfi 2006	61.6	13.9	59	91.7	13.8	121	9.6%	-30.10 [-34.42, -25.78]
Jan 2005	48	16	120	70	16	99	9.6%	-22.00 [-26.26, -17.74]
Puzziferri 2008	60.41	0.71	300	79.03	0.85	350	10.0%	-18.62 [-18.74, -18.50]
Farkas 2005	51	7	21	64	13	57	9.5%	-13.00 [-17.51, -8.49]
Biertho 2003	41.5	13.9	80	54	13.8	708	9.8%	-12.50 [-15.71, -9.29]
Tichansky 2005	58	13	27	70	16	300	9.4%	-12.00 [-17.23, -6.77]
Diniz 2009	62.8	13	102	74.4	14.9	68	9.6%	-11.60 [-15.95, -7.25]
Carlin 2008	58.5	14.5	87	68	13.8	213	9.7%	-9.50 [-13.07, -5.93]
Bloomston 1997	53	13.9	78	61	13.8	79	9.6%	-8.00 [-12.33, -3.67]
Angrisani 2004	52.3	33.2	7	54.3	21.9	310	4.0%	-2.00 [-26.71, 22.71]
Korenkov 2004	89.5	13.9	27	54.3	13.8	79	9.2%	35.20 [29.14, 41.26]
Total (95% CI)			908			2384	100.0%	-10.10 [-16.47, -3.73]

Heterogeneity: Tau² = 105.48; Chi² = 417.75, df = 10 (P < 0.00001); I² = 98%
Test for overall effect: Z = 3.11 (P = 0.002)



Forest plots of random effects meta-analyses of % EWL, separately for super-obese (BMI≥50 kg/m2) vs. not super-obese groups

Preoperative Weight Loss

Mandatory Preoperative Weight Loss

Fourteen studies reported on mandatory preoperative weight loss in the weeks immediately preceding surgery (n=3,254). There was considerable variation in the amount of preoperative weight loss required by each study (e.g., 7.5 kg or percent of total body weight), and some assessed multiple categories of preoperative weight loss (i.e., <5%, 5–10%, or >10% total body weight loss). The most common recommendations for preoperative weight loss were 5–10% or >10% EWL.

Seven studies showed a positive association between preoperative and postoperative weight loss [18, 68–73], six showed no association [26, 74–78], and one showed a negative association [79]. There was some heterogeneity among the studies, including the follow-up time and degree of postoperative weight loss. While the majority of studies had at least 12-month follow-up, there were two studies that reported a positive association that had 3- and 6-month follow-up with the remainder having 12- to 36-month follow-up, while studies with no association had 12- to 48-month follow-up and the study with a negative association had 12-month follow-up. Studies with a positive association reported 48% to 74% EWL at 12 months, while studies with no association reported 57% to 70% EWL and the negative association study reported 72% EWL at 12 months. Baseline BMI ranged from 43 to 58 kg/m^2, with no significant difference based on direction of association with postoperative weight loss (positive association 47–53 kg/m^2, no association 43–58 kg/m^2, negative association 49 kg/m^2).

Alami et al. showed a significant positive effect of preoperative weight loss in the short-term (3 and 6 months postoperatively) [71]. Several studies also found a benefit of preoperative weight loss on long-term postoperative weight loss. For example, Still et al. reported that patients with greater than 10% preoperative weight loss were more likely to achieve 70% EWL at 12 months as compared to those with 0% to 5% preoperative weight loss (hazard ratio of 2.1, 95% CI 1.5–3.0) [68]. Alger-Mayer et al. found a positive correlation between preoperative and postoperative EWL (expressed as a continuous variable) at 3 years (r=0.225, P=0.006) [69]. Only one study found a negative association, with greater postoperative % EWL at 12 months seen in patients who did not lose at least 4.5 kg of weight preoperatively [79].

Previous Weight Loss Attempts

Two studies reported no association between previous weight loss attempts and weight loss after surgery (n=533). Ray et al. reported that patients had attempted an average of 7–10 preoperative diets, and better success at previous weight loss attempts had no effect on weight loss at 12 months (58% vs. 63% EWL, P=0.20) [80]. Jantz et al. found that patients had attempted an average of four preoperative diets and there was no correlation between the number of previous weight loss attempts and EWL from 1 to 4 years after RYGB (R^2 range 0.004–0.03) [75].

Eating Disorders/Maladaptive Eating Habits

Binge Eating

Twenty studies reported on the relationship between preoperative binge eating and postoperative weight loss

(n=2,661), with 417 patients identified with binge eating. Three studies reported that patients with preoperative binge eating lost more weight postoperatively than those without binge eating [4, 9, 81]. Thirteen studies reported no association [45, 54, 65, 82–91] and four studies reported a negative association [92–95]. Follow-up time varied widely among the studies, with studies that had a positive association having 6-, 16-, and 50-month follow-up, respectively, negative association studies having 6-, 12-, and 60-month follow-up, and the no association studies having 6–60-month follow-up. There was also a significant variability in how weight loss was reported, with seven studies reporting EWL, eight studies reporting change in BMI, and the remainder reporting pounds or kilograms lost. Baseline BMI was relatively homogeneous among the studies (positive association 44–54 kg/m^2, negative association 44–57 kg/m^2, no association 47–54 kg/m^2).

The majority of studies used validated survey instruments to assess binge eating, such as the Gormally Binge Eating Scale (BES) [96], which measures binge eating severity, the Eating Disorder Examination (EDE) [97], which identifies patients with anorexia nervosa and bulimia nervosa, and the Questionnaire on Eating and Weight Patterns-Revised (QEWP-R), which assesses dieting and weight history and identifies the presence of binge episodes [98]. However, instruments such as the BES and QEWP-R which rely on patient self-reporting have been shown to over-diagnose binge eating disorder (BED) as well as other eating disorders in bariatric surgery candidates. They are useful in measuring the severity of binge eating but are less accurate than interview data in diagnosing BED [99]. Only five studies used a standardized interview-based survey to identify patients with binge eating. Of the positive association studies, one used the BES, one used the EDE, and the third used a non-validated semi-structured interview. Of the negative association studies, two used the QEWP-R, one used DSM-IV criteria, and the fourth did not use a validated survey. Of the no association studies, one used DSM-IV criteria and one used a non-validated survey, while the remainder used a variety of validated surveys including the BES (two studies), EDE (three studies), and QEWP-R (one study). Studies that found a negative association include Dymek et al., who reported that patients with binge eating lost less weight compared to non-binge eaters at 6 months after surgery using the QEWP (38.5% vs. 53.9%, P=0.012) [95]. Positive association studies include Boan et al., who found that patients with binge eating lost more weight compared to those without binge eating at 6 months using the BES (28.1% vs. 24.9%, P<0.05) [81].

Data from seven studies that reported on a total of 888 patients were pooled for meta-analysis. They included five studies on RYGB and two studies on LAGB, and had a mean follow-up time of 17 months (range 6–60 months). There was no significant difference in EWL between the binge eating and non-binge eating groups (mean difference=0.5% EWL in favor of binge eating group, 95% CI [−4.4% to 5.3%]). Four studies which reported postoperative weight loss at 12 months were also pooled separately for meta-analysis (Table 5). This included 412 patients, with three studies on RYGB and one study on LAGB. The binge eating group overall lost a mean of 5.9% greater EWL (95% CI [1.9% to 9.8%]). There was no significant heterogeneity (P=0.61).

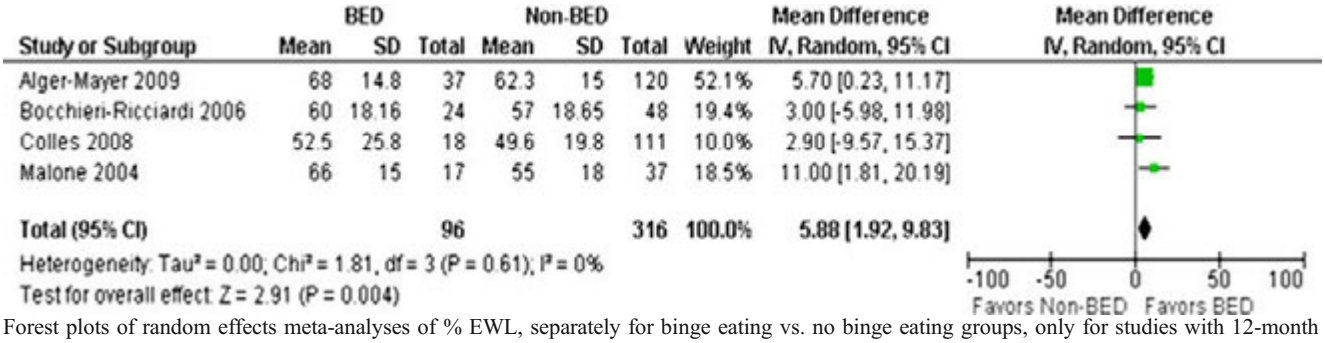
Sweet Eating

Four studies (n=1,139 patients) reported on sweet eating as a possible predictor of weight loss. One reported a positive association, two reported no association, and one reported a negative association. Both studies that reported either a positive or negative association did not use a validated survey instrument. Busetto et al. [23] reported that patients with sweet eating had a decreased relative risk (RR) of weight loss failure (RR 0.8, 95% confidence interval 0.68–0.96), while Angrisani et al. [60] found a higher weight loss failure rate (EWL<20%) in sweet eaters (P<0.05). Korenkov et al. [46] used the modified Sugerman criteria [100], which defines patients who consume >300 cal of sweet foods or beverages per day as sweet eaters, and Hudson et al. [101] used the sweet section of the Anti-Cancer Council of Victoria Food Frequency Questionnaire [102]. Neither of these studies found an association between sweet eating and postoperative weight loss. As there were few studies on sweet eating with variable results, no clear association was found with postoperative weight loss.

Hunger

Hunger was reported to have a negative association with postoperative weight loss in two studies (n=89 patients). Ryden et al. [103] found that patients with weight loss failure (<50% EWL) scored higher on the hunger factor of the Three Factor Eating Questionnaire (TFEQ) [104], which measures three subscales of maladaptive eating behavior including hunger, restraint, and disinhibition, and Israel et al. reported that poor EWL (less than the third quartile for the study) was correlated with evening sensations of hunger in a non-validated survey (OR 0.2, P=0.02) [13].

Table 5 Meta-analyses of postoperative weight loss for binge eating vs. no binge eating groups



Forest plots of random effects meta-analyses of % EWL, separately for binge eating vs. no binge eating groups, only for studies with 12-month follow-up

Other Maladaptive Eating Habits

Six studies analyzed the association between other maladaptive eating habits and weight loss (n=1,045 patients). These disorders included grazing (two studies) [4, 86], night eating (one study) [54], compensatory eating (one study) [42], anorexia (one study) [105], and loss of control (one study) [106]. Two studies reported a positive association with other maladaptive eating habits, three reported no association, and one reported a negative association (with atypical eating disorder). The majority of the studies determined the presence of eating disorders by means of validated instruments such as the Questionnaire on Eating and Weight Patterns, which is used to diagnose binge eating disorder, bulimia nervosa, and related eating disorders [107].

Emotional eating was found to have either a negative association (three studies) [108–110] or no association (three studies) [45, 111, 112] with postoperative weight loss (n=612 patients). Mathus-Vliegen et al. used The Dutch Eating Behaviour Questionnaire [113], which assesses eating behaviors such as emotional eating and conscious restriction of intake, and reported a significant inverse relationship between weight change and emotional eating scores [109]. Gentry et al. used the Eating Behavior Questionnaires II (series of open-ended questions about patient's history of obesity) and III (structured interview regarding food and activity patterns) and found that patients who ate in response to stress lost less weight after surgery compared to patients who ate in response to pleasant feelings or a sense of accomplishment (P<0.005) [110]. Delin et al. found that eating in response to emotional cues such as anxiety or loneliness was negatively correlated with EWL (expressed as a continuous variable) using the TFEQ (r=0.4, P=0.05) [108].

Psychiatric Disorders/Substance Abuse

Depression

Four of 19 studies reported a negative association between depression and postoperative weight loss [45, 51, 108, 114], 14 reported no association [10, 15, 23, 25, 48, 51, 60, 62, 82, 91, 95, 115–117], and one reported a positive association [47] (n=5,209 patients). Follow-up time was relatively consistent among the studies, with studies that had a negative association having 12–36-month follow-up, the positive association study having 12-month follow-up, and the no association studies having 6–60-month follow-up (two studies with 6-month follow-up, six studies with 12-month follow-up, and the remainder with >12-month follow-up). Studies with a negative association reported 50% EWL at 12 months, while the positive association study reported 49%, and the no association studies reported 40–65% EWL at 12 months. Baseline BMI ranged from 42 to 57 kg/m^2, with no significant difference based on direction of association with postoperative weight loss (negative association 42–46 kg/m^2, positive association 53 kg/m^2, no association 43–57 kg/m^2).

The most common validated survey used to measure depression was the Back Depression Inventory (BDI), which assesses the presence and severity of depressive symptoms [118]. Three studies that reported a negative association used the BDI including Ryden et al., who reported that patients with <50% EWL had a higher score compared to patients with ≥50% EWL (P=0.04) [51]. The fourth study with a negative association determined depression through a semi-structured interview without the use of a validated survey. Averbukh et al. showed a positive correlation between EWL (expressed as a continuous variable) and depression, as measured by the BDI

(r=0.4, P=0.04) [47]. The remaining studies found no association using a variety of surveys including the BDI (four studies), Minnesota Multiphasic Personality Inventory-2 which includes a scale of depressive symptoms [119] (one study), and clinical evaluation by a psychiatrist (four studies).

Anxiety

Two studies examined the association between anxiety and postoperative weight loss (n=2,425 patients), both of which showed no association. Wolfe and Terry did not see a difference in weight loss at 20 months between patients with high levels of anxiety and those without, using a non-validated survey (no mean weight loss reported) [82]. Ryden et al. used the Karolinska Scales of Personality [120], which identifies susceptibility to multiple personality and psychiatric disorders including anxiety, and found no difference in preoperative anxiety between patients who lost less than or greater than 20 kg at 2 years (mean weight loss was 28 BMI points). However, there was a trend towards decreased incidence of postoperative anxiety in the latter group (14% vs. 24%, P value not reported) [51].

Sexual Abuse

Eight studies examined the association between a self-reported history of preoperative sexual abuse and postoperative weight loss: five showed no association [9, 121–124], one a positive association [114], and two a negative association [77, 80] (n=874 patients). Rowston et al. described that patients with a history of sexual abuse had a lower mean weight at 24 months after surgery compared to those without a history of abuse (P=0.02) [114]. Ray et al. reported the opposite, with patients who were previously abused losing less weight at 12 months compared to those not abused (53% vs. 62% EWL, P<0.05) [80]. Fujioka et al. found that patients with an abuse history lost less weight at 12 months after RYGB compared to patients without an abuse history (57.7% vs. 66.3%, P<0.05), but this was not significant at 24 months [77]. Oppong et al. also found a trend towards poorer weight loss at 12 months in the sexual abuse group (57.7% vs. 60.2% EWL, P>0.05) [122], and the remaining studies found no difference. As there was such variability among the studies, no clear association was found between sexual abuse and postoperative weight loss.

Self-esteem

Three studies reported on the relationship between self-esteem and postoperative weight loss; one reported a positive association, one no association, and one a negative association (n=134 patients). The most common validated surveys used were the Rosenberg Self-Esteem Scale [125], which measures overall self-esteem and separates patients into low or normal self-esteem, and the Coopersmith Self-Esteem Inventory [126], which groups patients into below average, average, or above average self-esteem. Delin et al. showed a positive correlation between self-esteem and EWL (expressed as a continuous variable) at 24 months (r=0.7, P=0.001) [108]. van Gemert et al. reported that patients with low self-esteem lost more weight at 86 months (R^2=0.154, P=0.002) [127], while Tsushima et al. reported no difference in the incidence of low self-esteem between patients with greater or less than 50% EWL at 12 months [62]. As such, the impact of self-esteem appears to be inconclusive.

Alcohol Use/Abuse

Two studies demonstrated a positive association between alcohol intake and weight loss after bariatric surgery [15, 128], and one study demonstrated a non-significant positive trend [48] (n=497 patients). Dixon et al. reported that patients with a moderate current intake of alcohol (greater than 100 g/week) lost more weight at 12 months compared to those with no alcohol intake (50.4% vs. 40% EWL) [15]. Black et al. suggested a positive correlation between a history of alcohol abuse or dependence and BMI change at 6 months, though this was non-significant (R^2=0.05, P<0.08) [48]. None of the studies reported on the details of alcohol abuse history in their patients, or their participation in support networks (i.e., substance abuse counseling, Alcoholics Anonymous, or support groups with other bariatric patients).

Other Psychiatric Disorders

Eleven studies assessed the association between other psychiatric disorders and weight loss after bariatric surgery, the majority found no association [9, 15, 54, 61, 88, 90, 110, 114, 129, 130] and one study found a negative association [4] (n=1,163 patients). Kinzl et al. reported that patients with at least two psychiatric disorders lost less weight at 50 months compared to patients with one or no disorders (P=0.047) [4]. Sanchez-Cabezudo et al. found a trend of decreased incidence of abnormal preoperative psychiatric exam in patients with ≥50% EWL compared to those with <50% EWL at 5 years (71.2% vs. 77.7%, P>0.05) [61].

Of the 14 studies analyzing the association between personality disorders and postoperative weight loss (n=3,360 patients), 7 reported a negative association [27, 49, 51, 62, 103, 131, 132], 3 reported no association [54,

109, 133], and 4 reported a positive association [48, 52, 134, 135]. Tsushima et al. [62] reported that patients with ≥50% EWL compared to those with <50% EWL at 12 months had a significantly lower incidence of personality disorder subscales including phobia and paranoia, using the MMPI-2 [119]. Conversely, Leombruni et al. [134] and De Panfilis et al. [135] reported a positive correlation in multivariate regression between weight loss and subscales of the Temperament and Character Inventory, which measures normal and abnormal behavior patterns including harm avoidance and cooperativeness [136]. The overall association between other psychiatric disorders and weight loss appears to be inconclusive, while personality disorders may have a negative association.

Discussion

Preoperative patient level factors that may be associated with weight loss after bariatric surgery include preoperative BMI and particularly super-obesity, mandatory preoperative weight loss in the weeks immediately preceding surgery (but not previous weight loss attempts), and personality disorders. Meta-analysis suggested that super-obese patients have less EWL compared to non-super-obese patients, though there was significant heterogeneity likely due to the mix of bariatric procedures and follow-up times among the pooled studies resulting in significant differences in postoperative weight loss. Binge eating was associated with greater EWL at 12-month follow-up in meta-analysis, though the effect was not significant when studies with all follow-up times were included. Factors that do not have clear evidence to support an association include a history of sexual abuse and other psychiatric disorders.

Predictors with suggestive evidence to support an association with postoperative weight loss included preoperative BMI and mandatory preoperative weight loss. Higher preoperative BMI (and in particular super-obesity) was found in the majority of studies to be associated with less weight loss after bariatric surgery, especially when weight loss was measured in relative terms (i.e., EWL). Some studies that only reported absolute weight loss (BMI points or kilograms lost) found a positive association with postoperative weight loss, highlighting the need for consistent reporting of outcomes in bariatric surgery. Heavier patients tend to lose more pounds after surgery since they have a greater amount of weight to lose at baseline, but this weight loss is less significant and their final BMI is higher than that of lighter bariatric patients. Though super-obese patients lost less weight compared to patients with BMI <50 kg/m^2, they still lost 30–60% of their excess weight depending on the type of surgery. Further studies are necessary to determine which interventions can best help the heaviest patients achieve optimal weight loss, since they are the ones who stand to benefit most from surgery. One possibility is mandatory preoperative weight loss, which appears to be associated with greater total postoperative weight loss. This review examines acute weight loss immediately prior to surgery, not the insurance-mandated requirement for documenting previous weight loss attempts (which were not associated with postoperative weight loss in this review, though only two studies were identified). This concept is controversial, in part due to questions regarding the safety of relatively rapid weight loss in obese patients prior to undergoing major surgery. This review suggests that obese patients can lose 10% of their excess body weight in the weeks immediately prior to undergoing surgery. Due to the variety in how weight loss was achieved preoperatively (informal vs. formal nutrition consult, liquid diet, low calorie diet), there is little insight into the best way to achieve this weight loss upfront. Future studies are necessary to determine the components of a successful program, which will likely include both exercise and nutritional counseling, as well as the most effective dietary plan to achieve a significant amount of rapid weight loss in the bariatric population.

There is some evidence to suggest an association between specific eating habits (hunger and emotional eating) and alcohol use/abuse and postoperative weight loss, though there were insufficient numbers of studies to make a clear association. The stress of surgery and the emotional and physical consequences of dramatic weight loss can trigger maladaptive responses in patients with preexisting eating disorders. The effects of moderate alcohol consumption may be mediated by increased insulin sensitivity and protection against diabetes, which is associated with less weight loss after surgery [15]. Patients with a history of alcohol abuse may lose more weight due to having struggled with and overcome addiction, and possibly having undergone counseling. However, as none of the studies reported substance abuse counseling or attendance of support groups, it is difficult to interpret which aspect of alcohol use may be associated with weight loss. In addition, the small number of studies (ranging from two to six) limits the strength of the association with psychosocial predictors, and further studies are necessary to validate a consistent correlation. Many studies reported a correlation but did not necessarily identify patients with weight loss failure (e.g., EWL<50%), which would be a more clinically significant outcome. Currently,

there are insufficient data to suggest that patients with preoperative psychosocial disorders such as those included in this review are unlikely to achieve significant weight loss after bariatric surgery.

This review has some limitations mainly related to the heterogeneity of the studies. The variations in defining the potential predictors (i.e., what qualifies as a significant degree of preoperative weight loss, which patients are sweet eaters, and the use of different validated and non-validated surveys) prevented the ability to pool data and compare across studies in most domains. Due to this variability, overall associations were summarized based on the number of studies not accounting for differences between the studies, though some studies (e.g., prospective with greater sample size) may have deserved greater weight. Equally challenging was the variability in measuring postoperative weight loss, with some studies reporting kilograms or BMI points lost while others include the percentage of excess weight loss. Though studies found an association between some preoperative factors and postoperative weight loss, this does not prove that a causal relationship exists. Preoperative weight loss may be an indicator of greater patient compliance or motivation rather than a reason for greater weight loss after surgery. Furthermore, many of the studies had a small sample size (41 studies with <100 patients) and may have been under-powered to detect some correlations. There may be a publication bias with studies that found inconclusive or no association being under-represented in the literature. In addition, little data are reported on the effect of other patient factors, such as race, gender, or age.

In summary, preoperative psychosocial factors that may be associated with weight loss after bariatric surgery include preoperative BMI and super-obesity, mandatory weight loss, and personality disorders. Further studies are necessary to determine whether other psychosocial disorders are associated with weight loss failure, as the current evidence is inconclusive to determine a consistent correlation. The identification of predictive factors will help to develop interventions targeting specific needs of patients. Establishing some uniformity in reporting outcomes for bariatric surgery (i.e., follow-up time, weight loss reporting, and survey instruments) may allow for better comparison among studies and further clarify these associations.

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Conflict of Interest The authors declare that they have no conflict of interest.

Disclosures None

Appendix 1. MEDLINE Search Terms

Preoperative Weight Loss

(1/1/1988 to 2/13/2008 and 2/14/2008 to 4/22/2010)

"Bariatric Surgery" [Mesh:NoExp] OR "weight loss surgery" OR "obesity surgery" OR "weight reduction surgery" OR "Biliopancreatic Diversion" [Mesh] OR "laparoscopic band" OR "lap band" OR "gastric band" OR "Gastric Bypass" [Mesh] OR "Gastroplasty" [Mesh] OR "gastric sleeve" OR "sleeve gastrectomy" AND "Obesity" [Mesh] and ("preoperative weight loss" or "pre-operative weight loss" or "preoperative weight" or "pre-operative weight")

Maladaptive Eating

(1/1/1988 to 2/11/2008 and 2/12/2008 to 4/22/2010)

"Bariatric Surgery" [Mesh:NoExp] OR "weight loss surgery" OR "obesity surgery" OR "weight reduction surgery" OR "Biliopancreatic Diversion" [Mesh] OR "duodenal switch" OR "laparoscopic band" OR "lap band" OR "gastric band" OR "Gastric Bypass" [Mesh] OR "Gastroplasty" [Mesh] OR "gastric sleeve" OR "sleeve gastrectomy" AND "Obesity" [Mesh] AND "Feeding Behavior" [Mesh] OR "Eating Disorders" [Mesh] OR "Bulimia Nervosa" [Mesh] OR "Adaptation, Psychological" [Mesh] OR "Self Efficacy" [Mesh] OR "Bulimia" [Mesh] OR "Serotonin Uptake Inhibitors" [Mesh] OR "Volume Eater" OR "Maladaptive Eating" OR "Binge Eating" OR " Sweet Eater" OR "Portion Size"

Psychiatric Disorders

(1/1/1988 to 2/13/2008 and 2/14/2008 to 2/18/2010)

"Bariatric Surgery" [Mesh:NoExp] OR "weight loss surgery" OR "obesity surgery" OR "weight reduction surgery" OR "Biliopancreatic Diversion" [Mesh] OR "Duodenal switch" OR "laparoscopic band" OR "lap band" OR "gastric band" OR "Gastric Bypass" [Mesh] OR "Gastroplasty" [Mesh] OR "gastric sleeve" OR "sleeve gastrectomy" AND "Obesity" [Mesh] AND "Depressive Disorder" [Mesh] OR "Depression" [Mesh] OR "Depressive Disorder, Major" [Mesh] OR "Depression, Chemical" [Mesh] OR "Bipolar Disorder" [Mesh] OR "Adjustment Disorders" [Mesh] OR "Dysthymic Disorder" [Mesh] OR "Seasonal Affective Disorder" [Mesh] OR "Affective Disorders, Psychotic" [Mesh] OR "Psychiatric Counseling" OR "counseling" OR "Psychiatric evaluation"

Appendix 2

Table 6 Description of studies included in the review

Author (year)	Operation	# of patients	Mean age, years (SD)	% female	Baseline BMI (SD)	F/U (mo)	Weight loss (SD)	Weight loss predictors reported
Alami [71] (2007)	Lap RYGB	61	43.8 (9.0)	83.6	49.0 (6.5)	6	52.2 (12.2) % EWL	Mandatory preop WL
Alger-Mayer [69] (2008)	RYGB	150	45.3 (8.9)	80	52.2 (9.8)	36	55.1 (20.2) % EWL	Mandatory preop WL
Alger-Mayer [91] (2009)	RYGB	157	45 (10)	86	50.7 (8.0)	12	63 (16) % EWL	Binge eating depression
Ali [72] (2007)	Lap RYGB	351	42.7	92	46.7	6	60.5% EWL	Mandatory preop WL
Alvarado [18] (2005)	Lap RYGB	90	42	90	48.1	12	74.4% EWL	Preop BMI
								Mandatory preop WL
Angrisani [60] (2004)	LAGB	573	37.9 (11.8)	83	43.4 (6.5)	60	53.9 (24.0) % EWL	Preop BMI
								Sweet eating
								Depression
Anthone [21] (2003)	Duodenal switch	701	42.3 (10.4)	78.3	52.3 (9.6)	60	66 (17) % EWL	Preop BMI
Averbukh [47] (2003)	RYGB	47	40.4 (12.3)	85.0	52.9 (12.1)	12	49 (0.13) % EWL	Preop BMI
								Depression
Barrash [27] (1987)	VBG	138	35.6 (10)	100	NR	12	48 (16) % EWL	Preop BMI
								Personality d/o
Biertho [30] (2003)	LAGB, lap RYGB	1,261	41.2 (10.8)	79.1	44.8 (6.1)	18	52.8% EWL	Preop BMI
Biron [22] (2004)	BPD	1,271	38 (10)	78.5	48.4 (9.4)	94.8 (50.4)	68.6 (21.4) % EWL	Preop BMI
Black [48] (2003)	VBG	41	37.7 (10.6)	77	50 (7.4)	6	NR	Preop BMI
								Depression
								Alcohol
								Personality d/o
Bloomston [32] (1997)	VBG, RYGB	157	40.5 (9.5)	84.5	52.2	72	NR	Preop BMI
Boan [81] (2004)	RYGB	40	41.2 (9.1)	85	52.9 (8.9)	6	26.7% TWL	Binge eating
Bocchieri-Ricciardi [85] (2006)	RYGB	72	41.2 (9.5)	79	54 (9.5)	18	58% EWL	Binge Eating
Branson [50] (2005)	LAGB	404	42 (0.5)	79	42.1 (0.2)	48	26.0 (0.5) % EWL	Preop BMI
Buddeberg-Fischer [130] (2004)	LAGB, lap RYGB	119	37.9 (10.2)	76.5	43.9 (5.78)	10	21.1 (9.7) % BMI decrease	Psychiatric—other
Bueter [12] (2007)	LAGB	85	40	81.2	49	27	43.2% EWL	Preop BMI
Burgmer [86] (2005)	VBG or LAGB	149	38.8 (10.3)	69	50.9 (8.1)	12	24.4 (10.3) % TWL	Binge eating
								Other eating—grazing
Buser [123] (2004)	RYGB	42	44.9	100	51.9 (11.0)	10–14	27.0% BMI decrease	Sexual abuse
Busetto [23] (2002)	LAGB	260	37.6 (10.8)	72	46.6 (7.1)	12	39.7 (19.4) % EWL	Preop BMI
								Sweet eating

Table 6 (continued)

Author (year)	Operation	# of patients	Mean age, years (SD)	% female	Baseline BMI (SD)	F/U (mo)	Weight loss (SD)	Weight loss predictors reported
								Depression
Busetto [83] (2005)	LAGB	379	37.5 (10.7)	74.1	46.9 (7.3)	60	39 (9) % EWL	Binge eating
Campos [34] (2008)	Lap and open RYGB	310	45 (10.4)	86.1	52 (12)	12	60.2% EWL	Preop BMI
Carlin [26] (2008)	Lap RYGB	295	45 (10)	89.0	51 (7)	12	66% EWL	Preop BMI
								Mandatory preop WL
Carrasco [63] (2007)	RYGB	31	36.3 (10.5)	87.1	44.4 (4.8)	6	59.7 (12.3) % EWL	Preop BMI
Champault [14] (2006)	LAGB	152	38.4	78	44.3	12	40.5% EWL	Preop BMI
Chau [16] (2005)	LAGB	200	44	80	45	12	37% EWL	Preop BMI
Chen [43] (2009)	RYGB	72	40.5 (9.5)	80.6	54.7 (8.6)	15.8	32.5% BMI decrease	Preop BMI
Chen [42] (2009)	RYGB	199	40.4 (9.6)	77.4	52.9 (9.0)	12	NR	Preop BMI
								Other eating—compensatory eating
Choban [39] (2002)	Open RYGB	133	37 (2)	79.7	50.1 (1.2)	36	58	Preop BMI
Colles [45] (2008)	LAGB	129	45.2 (11.5)	80	44.3 (6.8)	12	50.0 (20.7) % EWL	Preop BMI
								Depression
								Binge eating
								Emotional eating
Czupryniak [57] (2007)	RYGB	68	36.4 (10.2)	57.4	44.4 (6.8)	15 (4)	38.0 (9.0) % EWL	Preop BMI
Dallal [59] (2009)	RYGB	1,168	45.2 (12)	81.3	47	36	76% EWL	Preop BMI
De Panfilis [135] (2006)	LAGB	35	41.2 (8.3)	88.6	45.5 (5.8)	12	16.9% BMI decrease	Personality d/o
Delin [108] (1995)	RYGB	20	41.5 (9.3)	80	118.1 (17.5) kg	24.5	89.6 (24.7) % EWL	Emotional eating
								Self-esteem
								Depression
Diniz [37] (2009)	Open RYGB	193	37	73.5	52.0 (8.1)	60	61.6 (19.7) % EWL	Preop BMI
Dixon [116] (2003), Dixon [128] (2001)	LAGB	487	41.2 (9.7)	85	44.1 (7.4)	12	45.8 (18) % EWL	Depression
								Alcohol
Dixon [15] (2001)	LAGB	440	40 (9.5)	87	45.6 (7.5)	12	45.8 (17) % EWL	Preop BMI
								Depression
								Alcohol
								Psychiatric—other
Dymek [95] (2001)	RYGB	32	39.1 (8.47)	81	56.7 (11.5)	6	49.1 (11.2) % EWL	Binge eating
								Depression
Farkas [29] (2005)	Lap RYGB	213	37.9 (9.8)	87.3	52.4 (5.6)	12	60.5 (11.4) % EWL	Preop BMI
Favretti [19] (2007)	LAGB	1,791	38.7 (10.9)	75.1	46.2 (7.7)	144	49.2 (49.5)	Preop BMI

Table 6 (continued)

Author (year)	Operation	# of patients	Mean age, years (SD)	% female	Baseline BMI (SD)	F/U (mo)	Weight loss (SD)	Weight loss predictors reported
Fein [33] (2009)	Lap RYGB	60	45.1 (10.2)	56.7	53.7 (8.7)	≥6 weeks	54.3 (19.7) % EWL	Preop BMI
Fischer [112] (2007)	RYGB	144	40.3	81	54.4 (9.4)	8	25.2% BMI decrease	Emotional eating
Fujioka [77] (2008)	Open and lap RYGB	121	48	83.0	49.2	12	63% EWL	Mandatory preop WL Sexual abuse
Gentry [110] (1984)	"Gastric bypass"	33	32	97	289 lb	24	22–93% EWL	Emotional eating Psychiatric—other
Gould [36] (2006)	Lap RYGB	288	45	84.3	49.6 (5.1)	24	69.9 (14.9) % EWL	Preop BMI
Green [94] (2004)	RYGB	65	39.3 (9.9)	74	54.8 (10.1)	6	44.0 (11.5) % EWL	Binge eating
Grilo [121] (2006)	"Gastric bypass"	137	42.3 (10.2)	89	51.8 (7.9)	12	35.6% BMI decrease	Sexual abuse
Guerdjikova [111] (2007)	RYGB	50	41.5 (10.5)	74	49.1 (14.6)	6	26.4 (6.8) % TWL	Emotional eating
Hafner [52] (1990)	RYGB	71	NR	100	42.7	12	30.7% BMI decrease	Preop BMI Personality d/o
Harnisch [73] (2008)	Lap RYGB	203	42.5	84.7	317.4 lb	12	63.7% EWL	Mandatory preop WL
Hatoum [28] (2008)	Lap or open RYGB	246	45.1 (11.1)	74.8	52.3 (8.7)	12	64.8 (20.5) % EWL	Preop BMI
Hernandez-Estefania [11] (2000)	VBG	67	20–60	83.6	47.5 (7.7)	12	32.6% BMI decrease	Preop BMI
Hess [66] (1998)	BPD with duodenal switch	440	40	78.4	50	96	70	Preop BMI
Hsu [90] (1996)	VBG	24	37.8 (8.6)	100	48.8 (8.1)	0–42	30.3% TWL	Binge eating Psychiatric—other
Hudson [101] (2002)	LAGB	200	41.5 (9.9)	82	45.1 (7.8)	12	47.7 (16) % EWL	Sweet eating
Huerta [78] (2008)	Open RYGB	40	50.0 (1.3)	30	49.0 (1.0)	24	59% TWL	Mandatory preop WL
Israel [13] (2005)	VBG	69	32.1 (8.5)	81	43.4 (5.3)	6	62.8 (12.7) % EWL	Preop BMI Hunger
Jan [31] (2005)	LAGB, lap RYGB	373	43.7 (9.8)	87.1	50.4 (7.8)	36	58.8	Preop BMI
Jantz [75] (2008)	Lap RYGB	384	43.3 (9.3)	82.6	48.0 (5.9)	12	72.3 (15.3) % EWL	Mandatory preop WL WL attempts
Jeng [55] (1994)	RYGB, VBG, BPD, gastric banding	3,355	37.4 (9.4)	87.7	NR	48	37.9% TWL	Preop BMI
Kalarchian [89] (1999)	RYGB	50	38	76	52.8 (10.4)	3.8	20.6% BMI decrease	Binge eating
Kim [64] (2006)	Lap RYGB, LAGB	392	39.8	83.3	47.2	24	59.6% EWL	Preop BMI
Kinzl [4] (2006)	Gastric band	140	44	100	43.7	50	14.6 BMI points	Preop BMI Binge eating Other eating—grazing Psychiatric—other
Korenkov [46] (2004)	LAGB	106	40.6	73	48.1	12	52.1% EWL	Preop BMI

Table 6 (continued)

Author (year)	Operation	# of patients	Mean age, years (SD)	% female	Baseline BMI (SD)	F/U (mo)	Weight loss (SD)	Weight loss predictors reported
								Sweet eating
Kruseman [105] (2010)	RYGB	80	40 (10)	100	46.0 (7.0)	12	71.7 (19.1) % EWL	Other eating—anorexia
Larsen [131] (1990)	Horizontal gastric band	90	35.4	73.3	41.5	36	31.5 kg	Personality d/o
Larsen [49] (2004)	LAGB	168	37.3 (8.7)	85.1	45.9 (5.6)	18	21.8% BMI decrease	Preop BMI
								Personality d/o
Latner [9] (2004)	"Gastric bypass"	65	39.5	100	54.1 (10.2)	16	71% EBMIL	Preop BMI
								Binge eating
								Sexual abuse
								Psychiatric—other
Larsen [124] (2005)	LAGB	157	40 (7.9)	91.7	45.5 (5.7)	34	22.7% BMI decrease	Sexual abuse
Leombruni [134] (2007)	VBG	38	39.8 (9.9)	84.2	43.5 (5.5)	6	24.0% BMI decrease	Personality d/o
Love [117] (2008)	RYGB	116	41.1 (10.9)	94.5	47.7 (7.8)	12	81.7 (28.6) % EBMIL	Depression
Lutfi [8] (2006)	Lap RYGB	180	43.7 (10.4)	85	48	12	70.1 (17.3) % EWL	Preop BMI
Ma [25] (2006)	Lap RYGB	377	44 (9.6)	83.8	51.5 (8.5)	12	65 (15.2) % EWL	Preop BMI
								Depression
Maclean [53] (1993)	VBG, gastric bypass	106	39.5 (8.6)	NR	49 (7)	31.4 (10.3)	NR	Preop BMI
Maclean [24] (1993)	RYGB	274	NR	NR	48.7 (4.2)	66 (18)	35.4% BMI decrease	Preop BMI
Malone [87] (2004)	RYGB	109	45 (10)	84	47.7 (17.3)	12	58 (16) % EWL	Binge eating
Martikainen [65] (2004)	Open gastric band or LAGB	123	44	69	49	12	36 (24) % EWL	Preop BMI
								Binge eating
Martin [74] (1995)	Open RYGB	100	39.5 (8.8)	84	55.5 (9.3)	48	NR	Mandatory preop WL
Mathus-Vliegen [109] (2007)	VBG, "gastric bypass"	236	42.9 (10.2)	89	35.2 (7.0)	98.4	45.2 (29.3) % EWL	Emotional eating
								Personality d/o
Melton [7] (2008)	Open RYGB	495	42	82	55	24	67 (18) % EWL	Preop BMI
Mrad [70] (2008)	VBG, RYGB, LAGB	146	39.5	84.2	52.6	12	29.3% TWL	Mandatory preop WL
Oppong [122] (2006)	RYGB	187	40 (10)	81	52 (11)	24	60 (18) % EWL	Sexual abuse
Pajecki [17] (2007)	RYGB	75	NR	76	56.7 (10)	87	71.8 (21.6) % EWL	Preop BMI
Papageorgiou [129] (2002)	VBG	53	Range 22–56	73.6	53.8 (9.5)	12	33.5% BMI decrease	Psychiatric—other
Pekkarinen [56] (1994)	VBG	27	36	70.4	50	64.8	40.5	Preop BMI
Perugini [67] (2003)	Lap RYGB	188	44	83.5	53 (8)	12.5	61 (14)	Preop BMI
Pontiroli [58] (2002)	LAGB	143	42.9 (0.8)	81.1	44.9 (0.5)	36	17.6% BMI decrease	Preop BMI
Powers [54] (1997)	"Gastric restriction"	116	39.6 (9.3)	83	52.9	6	23.8% BMI decrease	Preop BMI
								Binge eating
								Other eating—night

Table 6 (continued)

Author (year)	Operation	# of patients	Mean age, years (SD)	% female	Baseline BMI (SD)	F/U (mo)	Weight loss (SD)	Weight loss predictors reported
								Personality d/o
								Psychiatric—other
Puzziferri [35] (2008)	Open and lap RYGB, LAGB	1,733	43.7 (10.5)	85.1	50.2 (10.3)	24	60.7	Preop BMI
Ray [80] (2003)	RYGB	149	39 (10)	81	52 (10)	12	56 (21) % EWL	Sexual abuse
								WL attempts
Riess [79] (2008)	Lap RYGB	353	42.9 (9.5)	83	48.5 (5.9)	12	72.3 (15) % EWL	Mandatory preop WL
Rowe [132] (2000)	VBG	35	41	91.4	46 (6.2)	6	26.1% BMI decrease	Personality d/o
Rowston [114] (1992)	BPD	16	Range 23–55	75	45.5 (7.4)	24	40.2% BMI decrease	Depression
								Sexual abuse
								Psychiatric—other
Ryden [103] (1996)	VBG	20	42 (9.9)	80	42.0 (9.9)	36	21.6% BMI decrease	Hunger
								Depression
								Personality d/o
Ryden [51] (2003)	RYGB, LAGB, VBG	2,231	47.5	71.5	41 (1.5)	24	21% TWL	Preop BMI
								Depression
								Anxiety
								Personality d/o
Sabbioni [88] (2002)	VBG	82	40.8	83	46.3	24	30.0% BMI decrease	Binge eating
								Psychiatric—other
Sallet [93] (2007)	RYGB	216	36.3 (9.6)	83	45.9 (6)	12	69.8 (21.1) % EBMIL	Binge eating
Sanchez-Cabezudo [61] (2002)	BPD	75	39	72%	53.2 (10)	12	63.7 (14.7) % EWL	Preop BMI
								Psychiatric—other
Silver [10] (2006)	RYGB	140	45.2 (9.9)	88.6	49.8 (7.9)	24	40.4% TWL	Preop BMI
								Depression
Still [68] (2007)	Open and lap RYGB	884	45 (10)	78	51.3 (8)	12	NR	Mandatory preop WL
Sugerman [20] (1989)	RYGB, VBG	222	NR	63.4	48.5 (8.5)	36	62% EWL	Preop BMI
Taylor [76] (1995)	VBG	76	33.9	88.2	45.6 (5.5)	12	31.2 (5.3) % EBMIL	Mandatory preop WL
Thalheimer [40] (2009)	LAGB	71	40	81.2	38	27	43	Preop BMI
Tichansky [38] (2005)	Lap RYGB	685	42.2 (10.8)	85.9	49.0 (5.2)	12	69.2 (15.8) % EWL	Preop BMI
Toouli [41] (2009)	LAGB	481	45.4 (10.3)	78.3	42.9 (4.1)	60	49.8 (27.6)	Preop BMI
Tsushima [62] (2004)	RYGB	52	44 (10)	75%	56 (11)	12	NR	Preop BMI
								Depression
								Self-esteem

Table 6 (continued)

Author (year)	Operation	# of patients	Mean age, years (SD)	% female	Baseline BMI (SD)	F/U (mo)	Weight loss (SD)	Weight loss predictors reported
								Personality d/o
Vallis [133] (2001)	VBG	89	NR	91	48.1 (6.8)	15	65% decrease excess BMI	Personality d/o
Van Gemert [127] (1998)	VBG	62	33.1 (9.4)	70.9	33.1 (9.4)	85.9	33.1% BMI decrease	Self-esteem
Vishne [44] (2004)	VBG	300	40.2 (10.6)	77	45 (7.8)	52.8 (27.6)	67.4 (33.0) % EWL	Preop BMI
White [84] (2006)	RYGB	139	42.4 (10.2)	89	51.7 (7.9)	12	35.6% BMI decrease	Binge eating
White [106] (2010)	LAGB	361	43.7 (10)	86	51.1 (8.3)	24	37% TWL	Other eating—loss of control
Wolfe [82] (2006)	RYGB	194	42.1 (10.4)	87.6	52.5 (10.1)	19.6	NR	Binge eating Depression Anxiety
Wolnerhanssen [92] (2008)	LAGB	380	40	78	44.3	60	NR	Binge eating
Yale [115] (1991)	VBG	200	37.1 (9.2)	76.9	46.1	12	53.7 (17.9) % EWL	Depression

BMI body mass index, *BPD* biliopancreatic diversion, *EWL* excess weight loss, *LAGB* laparoscopic gastric band, *Lap* laparoscopic, *NR* not recorded, *RYGB* Roux-en-Y gastric bypass, *VBG* vertical banded gastroplasty, *WL* weight loss

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