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Post-Operative Psychosocial Predictors of Outcome in Bariatric Surgery

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Abstract

Although there are several recent reviews of the pre-operative factors that influence treatment outcome for bariatric surgery, commensurate efforts to identify and review the predictive validity

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of post-operative variables are lacking. This review describes the post-operative psychosocial predictors of weight loss in bariatric surgery. Results suggest empirical support for post-operative binge eating, uncontrolled eating/grazing, and presence of a depressive disorder as negative predictors of weight loss outcomes; whereas, adherence to dietary and physical activity guidelines emerged as positive predictors of weight loss. With the exception of depression, psychological comorbidities were not consistently associated with weight loss outcomes. Results highlight the need for post-operative assessment of disordered eating and depressive disorder, further research on the predictive value of post-operative psychosocial factors, and development of targeted interventions.

Keywords

bariatric surgery; post-operative; psychopathology; psychosocial; weight loss

Introduction

Bariatric surgery is the frontline treatment for severe obesity. Whereas non-surgical interventions designed to treat severe obesity result in modest weight loss and frequent weight regain [1], bariatric surgery typically produces superior weight loss and maintenance along with resolution or improvements in medical morbidities [2-5]. Thus, bariatric surgery is recommended for adults with acceptable surgical risk and a body mass index (BMI) ≥40 or ≥35 with major obesity-related morbidities [6].

Gastric banding (GB), Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy, and biliopancreatic diversion with or without the duodenal switch are the most common bariatric procedures [7]. The definition of “successful” weight loss following these procedures varies, but reduction of at least 50% of the patient's excess weight (i.e., 50% excess weight loss; 50% EWL), is a commonly used metric [8]. Using this criterion, approximately 20-30% of patients experience either insufficient initial weight loss or weight loss followed by excessive regain [9-11].

In accordance with recommendations made by the National Institutes of Health [6], approximately 82-94% of U.S. bariatric programs and most major insurance companies require pre-operative psychological evaluations to identify factors that may significantly interfere with treatment outcome [12-15]. Researchers have conducted numerous studies to identify pre-operative prognostic factors associated with outcome from weight loss surgery [16-19], with the most recent comprehensive review published in 2012 by Livhits and colleagues [20]. Despite several decades of research in this area, few robust preoperative predictors of outcome have been identified. Comparatively, there is limited research examining how post-operative factors may influence weight loss and psychosocial outcomes. Prompt identification of post-operative psychosocial factors that negatively impact successful weight loss and for which there are evidence-based treatments, such as binge eating [21] and low motivation for behavior change [22], may help improve the overall efficacy of bariatric surgery. Although improving our understanding of these post-operative predictors has clear implications for improved patient care and outcomes, to our

knowledge, there are no recent comprehensive reviews since Herpertz et al. [17]. Therefore, the goal of this paper is to provide an updated narrative review of the literature on post-operative predictors of weight loss outcomes in bariatric surgery.

Method

Search Strategy and Inclusion Criteria

We identified articles published within the last decade (between 2003 and 2014) and conducted a literature search using the PubMed/Medline, Web of Knowledge, and PyscInfo databases. The authors generated a list of potentially relevant psychosocial predictors of outcome (e.g., “self-esteem,” “substance abuse,” “depression,” “anxiety,” “eating disorders,” “binge eating,” “disordered eating,” etc.) and conducted searches using these terms combined with “bariatric surgery,” “gastric band,” “sleeve gastrectomy,” “gastric bypass,” “Roux-en-Y,” “weight loss,” “post-operative,” “post-surgery,” and “predictors.” Additional articles were found by examining references within selected articles.

Original articles and review papers with a minimum of one-year post-operative follow-up period were included, with a few noted exceptions. We excluded non-English studies and those with adolescent samples. Articles were reviewed by a minimum of two authors to ensure they were appropriate for inclusion. Findings from the resulting 53 articles are presented in Tables 1-3 and reviewed below.

Results

Eating Behavior

We identified 21 studies that examined relationships between post-operative eating behavior and outcomes ranging from 1-10 years after surgery (see Table 1). The majority of these studies found that post-operative disordered eating behavior, including binge eating, grazing, sweet and stress eating, and nocturnal eating, predicted poorer weight loss one year or more after surgery.

Binge eating—Binge eating is defined as eating an objectively large amount of food combined with a sense of loss of control (LOC) over eating, although among bariatric surgery patients, binge eating is often classified by LOC rather than by amount. Of the 11 studies that evaluated the relationship between post-operative binge eating and weight loss, eight studies documented significant associations between poorer weight loss outcomes and binge eating [23-28], LOC, or uncontrolled eating [26, 29, 30]. Two studies reported non-significant relationships between binge eating and weight loss [31, 32]. One study was unable to evaluate for an association because binge eating was not endorsed by any patients after surgery [33]. In summary, the preponderance of evidence suggests that post-operative binge eating, LOC, or uncontrolled eating are associated with relatively poorer weight loss outcomes.

Binge eating disorder—Four studies reviewed how post-operative binge eating disorder (BED) is associated with weight loss outcomes, with mixed results. Three studies found that presence of post-operative BED significantly predicted poorer weight loss at one [30], two

[25], and five year follow-up [24]. However, one study found that BED was not associated with weight outcomes at one-year follow-up [34].

Grazing, snacking, and non-hungry eating—Five studies identified a significant relationship between poorer weight loss and post-operative grazing [26, 30], snacking [28, 35], and non-hungry eating [36], whereas only one study failed to find a significant association between post-operative snacking and EWL [37]. In one study, snack-eating was associated with the poorest weight loss, highest caloric intake, and highest number of daily meals as compared to sweet-eating or normal eating [35]. Another found that the combination of uncontrolled eating and grazing significantly predicted poorer weight loss and these behaviors showed significant overlap, as 20% of participants endorsed both eating patterns post-operatively [30]. Additionally, approximately 76% of the participants who reported post-operative grazing and uncontrolled eating reported a high level of emotional distress associated with the loss of control.

Other eating behaviors—We identified 11 studies that examined whether other post-operative eating behaviors were predictive of weight loss. Four studies suggested that nocturnal eating episodes [33], stress eating [38], emotional eating [28], and a composite measure of aberrant eating behaviors [39] were associated with poorer weight loss. Conversely, five studies found non-significant associations between weight loss and post-operative night eating syndrome [40], vomiting frequency [41], eating rate [41], number of daily meals [42], and changes in emotional and external eating [43, 44]. Finally, four studies found that post-operative eating behaviors such as lower post-operative disinhibition [45], subjective hunger [45], fewer cravings for sweets [45], increases in restrained eating [44], higher ratings of eating self-efficacy [46], and vomiting [38] were associated with greater weight loss.

Adherence

Another area of interest is post-operative adherence to professional recommendations regarding diet, physical activity, medical care, and support group attendance. Several studies have found that missed appointments and patient noncompliance with diet and exercise are common pre-operatively [47] and are even more prevalent after surgery [47, 48]. Several studies suggest that better patient adherence to post-surgical recommendations predicts greater weight loss [49-51]. We review findings from a total of 27 studies on adherence with diet and exercise recommendations, as well as medical care and support group attendance, below and in Table 2.

Diet—Four studies reported that adherence to prescribed food intake guidelines is associated with greater weight loss. Self-reported adherence to the post-operative dietary guidelines predicted greater weight loss [49] [52]. Similarly, failure to change eating habits increased the risk two-fold of losing <50 EWL% two years post-operatively [8]. Lower dietary intake, calculated from patient food diaries at 8 years after surgery, was associated with >50 EWL% [53].

Physical activity—A recent meta-analysis of 14 studies [54] and literature review [55] of 19 studies concluded that post-operative physical activity was significantly associated with greater post-surgery weight loss. Nineteen additional studies were identified in the current review that examined post-operative exercise and weight loss outcomes [5, 8, 31, 33, 36-38, 50-53, 56-63], and all but three [31, 53, 58] found that patient-reported post-surgery exercise frequency was significantly associated with weight loss outcome.

Medical visits and care—Three prospective studies [52, 64, 65] and one retrospective study [66] were identified that found that higher adherence to post-surgery physician visits predicts greater weight loss outcomes in RYGB [66] and GB surgery [52, 64, 65]. Three studies were identified that examined the relationship between medication adherence and outcomes, two of which [47, 60] found no significant association between post-operative medication noncompliance and weight loss outcomes at one-year follow-up in RYGB patients, whereas one study demonstrated a significant negative association with medication noncompliance and EWL at two-year follow-up [47].

Support groups—Three studies were identified that examined the impact of support group attendance on weight loss outcomes and all found a positive relationship between the frequency of support group attendance and the percentage EWL [67-69].

Psychological Disorders

A small but growing body of literature examines the impact of psychological disorders on weight-loss outcomes. We review findings from 12 studies (see Table 3) investigating how post-operative psychological disorders influence weight loss.

Anxiety and depressive disorders—Nine studies examined whether other post-operative Axis I psychological disorders, besides BED, predicted EWL. Five of these studies reported a non-significant relationship between weight loss and post-operative anxiety and depressive symptoms [27], Axis I psychological disorders [33] – including anxiety disorder [70], Medical Outcomes Study Short Form-36 [71] mental health scores [72]. Those with and without a post-operative Axis I disorder do not differ in EWL two-years post-operatively [73]. Conversely, two studies suggest that the presence of a post-operative depressive disorder was associated with poorer weight loss outcomes two-, three- [70], and five-year follow-up [24]. Two studies reported that successful weight loss was associated with significantly greater improvements in pre- to post-operative depression scores [4, 53].

Substance use—Finally, three studies examined post-operative substance use and weight loss, two of which failed to find a significant independent relationship between either post-operative alcohol use disorders [74] or opioid use disorders [75] and initial weight loss. The third study [76] documented a significantly increased risk for weight regain following RYGB among patients for whom someone had expressed concern regarding their post-operative drug or alcohol use.

Overall psychological functioning—Other studies have examined the relationship between post-operative changes in psychological functioning and weight loss, with several

documenting positive associations between psychosocial improvements and successful weight loss 3-10 years following surgery. Specifically, successful weight loss has been associated with significantly greater post-operative quality of life scores on self-esteem, physical activity, social relationships, sexuality, and eating pattern in females [77].

Discussion

The purpose of this review was to summarize the literature on post-operative psychosocial predictors of weight loss among bariatric surgery patients. Consistent with previous post-operative reviews [17], the most robust predictors of weight loss were post-operative eating behavior, and adherence to dietary and physical activity recommendations.

Post-operative disordered eating behavior (i.e., binge or LOC eating, grazing, sweet eating, emotional eating, and nocturnal eating) predicted poorer weight loss outcomes. Of these behaviors, the association between binge/LOC eating (but not necessarily a threshold diagnosis of BED) and poorer weight loss has the most empirical support. Post-operative eating disturbances like LOC eating or binge eating are also concerning among post-surgical patients because these behaviors are associated with higher ratings of psychological distress [30, 78]. These findings suggest the need for post-surgical interventions to address aberrant eating behaviors. Notably, vomiting was associated with higher weight loss; however, this behavior is clearly not recommended as it is associated with negative physiological sequelae (e.g., electrolyte imbalances, tooth decay [79] and may represent a serious eating disorder or medical/surgical problem like dumping syndrome. Regardless of whether vomiting is intentional (i.e., a compensatory behavior) or unintentional (i.e., failure to follow dietary guidelines in GB or RYGB surgery) it is a concerning behavior and an important target for intervention.

Attendance and adherence to treatment recommendations were associated with weight loss. Overall, patients who follow medical, dietary, and physical activity recommendations after surgery experience greater weight loss [49-51]. The preponderance of these studies supports the importance of frequent physical activity. Moreover, we were unable to identify any studies in which noncompliance with dietary suggestions resulted in superior weight outcomes. There is relatively less literature examining how follow-up medical care or support group attendance influences weight and results of these studies are somewhat mixed. Thus at this time, there is no clear indication as to whether medical or support group attendance noncompliance is a negative prognostic indicator. However, the few studies available [67-69] suggest that patient outcomes may be improved with support group attendance.

There is consistent support in the extant literature for an association between post-operative depressive disorders and poorer weight loss over follow-up; however the directionality of this relationship remains unknown. In contrast, post-surgery anxiety or other Axis I disorders do not seem to interfere with weight loss. Although there is growing research interest in the emergence of substance use problems after bariatric surgery, the studies reviewed here do not consistently support that substance use is associated with poorer weight loss outcomes. In fact, weight loss due to bariatric surgery generally improves

psychological functioning (i.e., reduced depressive symptoms, increased quality of life and self-esteem) in most individuals and pre-surgery psychological symptoms appear to improve significantly or remit following bariatric surgery [80]. One caveat to these findings is that without a thorough pre-operative evaluation of psychological symptoms, it is unclear whether such symptoms arise post-operatively or if they are merely a continuation of pre-operative mood. The same is true for disordered eating symptoms. It is possible that some individuals may deliberate minimize psychological or eating disorders symptoms pre-operatively for fear of being declined for surgery. Thus, mood or eating disorders may be more likely to be identified post-operatively and it may not always be clear whether they were present pre-operatively. Future research is needed to determine whether the distinction between pre- and post-operative symptoms is important, or whether the presence of eating/psychological symptoms or disorders at any timepoint negatively impacts weight loss outcomes.

In general, our review suggests that the literature on psychosocial predictors of weight loss continues to be marked by considerable variability across studies in measurement of independent and dependent variables, thereby limiting the conclusions that can be drawn from the larger body of evidence. Given this variability, we believe that caution is warranted in interpreting and implementing conclusions from this literature, particularly with regard to Axis I disorders (outside of eating pathology).

Our review highlights several limitations of the extant literature on psychosocial predictors of weight loss. Much of the adherence data reviewed were collected via self-report; thus, patients may have reported adherence in a manner perceived as socially desirable. Furthermore, such data represent a self-selected sample of individuals who came to follow-up appointments. Some studies [8] used one-item to measure adherence rather than relying on behavioral indicators like patient food logs or attendance at appointments. Similar limitations, including reliance on self-report, also apply to the literature examining post-surgery physical activity. Thus, it is difficult to accurately quantify physical activity and understand how it changes over the post-operative period. Findings with regards to adherence should be interpreted in light of these limitations.

Another limitation to consider is that several constructs of interest within the obesity field were excluded from the current review yet may represent important areas for continued research. For instance, although there is literature suggesting that emotional eating negatively affects weight loss after bariatric surgery, the majority of these studies had small sample sizes and insufficient follow-up to be included in the current review. In addition, there may be other variables that have predictive utility in bariatric surgery outcomes; however, these variables are not currently measured in the research literature and thus could not be included in this review. Future studies that are sufficiently powered with longer follow-up periods (greater than 2 years) are needed to clarify the potential consequences of post-operative emotional eating on weight loss outcomes. In general, the lack of studies with longer follow-up periods is concerning and a limitation of this review. Follow-up periods of at least 5 years are optimal to accurately assess weight loss. However, the shorter-term outcomes reviewed here, which allow earlier identification and intervention of concerning behaviors or high risk patients, are also important to consider.

This review provides the most empirical support for post-operative binge/LOC eating, uncontrolled eating/grazing, and presence of a depressive disorder as negative predictors of weight loss outcomes, while adherence to dietary and physical activity guidelines emerged as positive predictors of weight loss. The limited number of robust predictors found in this and previous reviews suggests the need for three shifts in the field, namely: (1) focusing research and clinical attention on the value of post-operative psychosocial factors and interventions, such as motivational interviewing to promote behavioral change (e.g. increase physical activity) and evidence-based psychological interventions for disordered eating/ eating disorders and depression (e.g., cognitive-behavioral or dialectical behavioral), (2) addressing transportation challenges for follow up appointments (e.g., telemedicine for those that live farther away), and (3)continuing to move away from a dichotomous inclusion or exclusion approach for surgery candidacy towards a model that supports enhancing outcomes for all surgery patients.

We recommend that pre-operative preparation of patients for surgery should include: (1) identifying patient strengths (e.g., regular physical activity) and weaknesses (e.g., LOC/ binge eating), (2) offering specific recommendations to address any areas of concern, (3) educating patients more thoroughly about necessary post-operative dietary and physical activity changes, and (4) providing coaching on lifestyle change strategies. There is a need to offer continuous care throughout both the pre-and post-operative periods: The research on post-operative predictors highlights the importance of performing ongoing screening for aberrant eating behaviors (i.e., binge and uncontrolled eating), depressive symptoms, and administering interventions to address emotional and psychological issues, teach behavioral modification strategies, increase compliance, and provide support. As experts in behavior change, mental health professions can contribute significantly to the bariatric practice's team and help improve outcomes even for patients without clear psychological issues.

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Table 1

Studies Examining Post-Operative Eating Behavior (n=21)

Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Predictors
Batsis et al. 2009	(A) RYGBP (B) Non-operative patients	(A) 148(268); M_{age}=46±11, dor=45% (B) 88(273); M_{age}=44±13, dor=68%	(A) 4.0±2.5 yrs. (B) 3.8±2.8 yrs.	Medical records, standardized questionnaires	%WL= (A) 31±11 (B) -0.2±23%EWL= (A) 59±21 (B) -2±57	Eating self-efficacy post-operatively was associated with greater weight loss.
Beck et al. 2012	RYGBP	45(67); 37 women, 8 men, M_{age}=43.6±9.16, dor=67%	23.2±4.4 mos.	Standardized questionnaires, self-made questionnaires, self-reported weight	%EBMIL=35.43±10.69	Binge eating predicted poorer weight loss outcomes.
Bueter et al. 2007	LAGB	71(85); 69 women, 16 men, M_{age}=40, dor=16%	27 mos.	Interview, standardized questionnaire	%EWL=43.2	Change in eating behaviors post-surgery predicted increased weight loss.
Burgmer et al. 2005	VBG and LAGB	118(149); 102 women, 47 men, M_{age}=38.8±10.3, dor=21%	14±1.5 mos.	Standardized questionnaires, weight measurement	BMIL=12.8	Lower post-operative ratings of disinhibited eating and hunger were associated with greater weight loss. Weight loss did not differ between those with and without binge episodes
Colles et al. 2008	LAGB	129(173); 103 women, 26 men, M_{age} =45.2±11.5, dor=25%	12 mos.	Semistructured clinical interviews, standardized questionnaires, self-made questionnaire	%WL=20.8±8.5, %EWL=50.0±20.7	Uncontrolled eating and grazing predicted poorer weight loss 12-mos. post-surgery. Pre-surgery BED subjects were more likely to graze post-surgery.

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Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Predictors
de Man Lapidoth et al. 2011	RYGBP, LAGB, VBG, and BPDS	130(173); 102 women, 28 men, M_{age}=40.6±9.2, dor=25%	3 yrs.	Standardized questionnaires, weight measurements	NR	Pre- and post-operative binge eating was not associated with weight loss.
de Zwaan et al. 2010	RYGBP	59(119); 50 women, 9 men, M_{age}=44.59±9.9, dor=50%	1.9±4 yrs.	Structured interviews, height & weight measurements	%BMIL=36.3±8.4, %EBMIL=73.9±19.3	Subjective binge episodes were significantly associated with pre-operative BED and with less weight loss.
Faria et al. 2009	RYGBP	75; 60 women, 15 men, M_{age}=36.8±10.7	23±10.3 mos.	4-day food intake record	%EWL=67.5±18.8	Snack eating pattern associated with significantly worse weight loss outcome than normal eating.
Kinzl et al. 2006	LAGB	140(220); 140 women, M_{age}=44, dor=37%	50 mos.	Semistructured interview, standardized questionnaires	BMIL=14.6	Patients with no eating disordered behavior pre-operatively had the lowest BMI loss.
Kofman et al. 2010	RYGBP	497(695); 475 women, 22 men, M_{age}=43.2±8.4, dor=28%	4.2 yrs.	Modified standardized questionnaires, self-reported weight	%EWL=70	Frequency of binge-eating, loss of control when eating and grazing were significantly correlated with greater weight regain 3-10 years after surgery and lesser long-term EWL.

Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Predictors
Lanyon et al. 2009	RYGBP	79(243); M_{age}=NR, dor=67%	3.2 yrs.	Interview, standardized questionnaires, self-made questionnaires	BMIL=0.15±3.68	Dysfunctional eating behaviors 1 year post-operatively associated with poorer weight loss at 3 years post-operatively.
Larsen et al. 2004	LAGB	250; 221 women, 29 men, M_{age}=39.6	16 and 42 mos.	Standardized questionnaires, self-reported weight	NR	Binge eating, fat intake, and external eating all decreased significantly post-operatively. Restrained eating and eating self-efficacy were significantly higher post-operatively. Post-operative binge eaters demonstrated poorer weight loss outcomes, consumed more fat, endorsed more external eating, emotional eating, and had lower eating self-efficacy.
Latner et al. 2004	LAGB	65(150); 65 women, M_{age}=39.5, dor=57%	16.4 mos.	Semistructured clinical interview, telephone follow-up interviews, standardized questionnaires	%EBMIL=71	BED did not predict weight loss outcome.

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Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Predictors
Laurenius et al. 2012	RYGBP	43; 31 women, 12 men, M_{age}=42.6±9.7	12 mos.	Standardized questionnaires, self-made questionnaire	NR	Emotional and uncontrolled eating were significantly decreased post-operatively.
Scholtz et al. 2007	LAGB	29(37); 28 women, 1 man, M_{age}=39±9, dor=22%	5 yrs.	Standardized questionnaires	%EWL<40%=24 (65%) patients	Post-operative BED and predicted poorer weight outcome but pre-surgical BED did not.
Silver et al. 2006	RYGBP	140(212); 124 women, 16 men, M_{age} =45.2±9.9, dor=44%	24.2±7.9 mos.	Self-made questionnaire, weight measurements	%WL=55.8±15.2	Neither number of meals and snacks nor number of food groups avoided predicted weight loss.
Sioka et al. 2013	LSG	94(110); (A) 10; 7 women, 3 men, M_{age}=38.2 ± 10.76 (B) 11; 11 women M_{age}=38 ± 9.96 (C) 11; 7 women, 4 men, M_{age}=42.1 ± 10.9 (D) 39; 31 women, 8 men, M_{age}=39.56 ± 9.15 (E) 23; 19 women, 4 men, M_{age}=40.39 ± 9.68 dor=15%	(A) <3 mos. (B) 3-6 mos. (C) 6-12 mos. (D) 12-24 mos. (E) 24-36 mos.	Standardized questionnaires	%EWL= (A) 31.7 ± 12.01 (B) 41.97 ± 8.97 (C) 59.43 ± 15.51 (D) 68.81 ± 19.3 (E) 62.73 ± 21.22	Post-operative eating pattern was significantly correlated with %EWL. Binge eating and emotional eating associated with lowest EWL, normal eating and snacking associated with highest EWL.
van Hout et al. 2007	VBG	91; 80 women, 11 men, M_{age}=38.6±8.3	12 mos.	Semi-structured interview, standardized questionnaires, self-made questionnaires	%EWL=61.5±27.5	Changes in restrained eating accounted for largest proportion of variance in predicting EWL. Less restrained

Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Predictors
						eating associated with superior weig eating associated with superior weig eating associated with superior weig eating associated with superior weig eating associated with superior weig eating associated with superior weig eating associated with superior weig
Wadden et al. 2011	RYGBP and LAGB	(A) Surgery-BED: 36(51); 26 women, 10 men, M_{age}=47.0±1.6, dor=41% (B) Surgery-nonBED: 59(80); 49 women, 10 men, M_{age}=43.8±1.3, dor=36% (C) Non-surgery-BED: 49(51); 39 women, 10 men, M_{age}=43.8±1.4, dor=18%	12 mos.	Semistructured interview, standardized questionnaires, weight measurements	%WL= (A) 22.1±1.7 (B) 24.2±1.3 (C) 10.3±1.5	Pre-operative BED did not affect weight loss outcomes at 1 year. Presence of subjective binge eating did not impact weight loss at any timepoint.
White et al. 2010	RYGBP	361; 311 women, 50 men, M_{age}=43.7±10.0	12 and 24 mos.	Standardized questionnaires, self-reported weight	NR	Pre-operative loss of control (LOC) eating did not predict postsurgical outcomes. Post-operatively, patients with LOC lost significantly less weight at 12 and 24 mo. follow-up.
Wolfe et al. 2006	RYGBP	93(194); 170 women, 24 men, M_{age}=42.1±10.4, dor=52%	78.4±35.7 weeks	Self-made questionnaire, weight measurements	NR	Planning and self-monitoring of food intake was not related to BMI lost.

[1] LAGB=laparoscopic adjustable gastric banding, RYGBP=Roux-en-Y gastric bypass, LSG=laparoscopic sleeve gastrectomy, VBG=vertical banded gastroplasty, BPDS=biliopancreatic diversion with duodenal switch.

[2] Sample presented as: post-operative *N* (pre-operative *N*, if relevant). DOR=percent lost to post-operative follow-up (if relevant). BED=binge eating disorder.

[3] NR=not reported. All weight loss (WL) values in kilograms (kg). (%) EWL=(percent) excess weight lost. (%) EMBIL=(percent) excess body mass index lost. (%) BMIL=(percent) body mass index lost.

Table 2

Studies Examining Post-Operative Adherence to Recommended Diet, Physical Activity, Medical Visits, and Support Groups (n=27)

Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/ methods	Weight loss at follow-up[3]	Predictors
Bond et al. 2004	LAGB	1585; 1309 women, 276 men, M_{age}=40.4±10	24 mos.	Self-made questionnaires	%EWL=Physical activity: 68.2±17.4 No physical activity: 63.9±19.5	Self-reported physical activity was associated with greater %EWL at 2 years post-surgery.
Bond et al. 2009	RYGBP	199(293); M_{age}=43.8±11, dor=32%	12 mos.	Standardized questionnaires	Inactive/active: WL=52.5 %EWL=71.5 Active/active: WL=50.8 %EWL=69.8 Inactive/inactive: WL=46.4 %EWL=63.1	Patients who changed from inactive to active (>=200min/week) from pre- to 1 yr post-surgery had greatest weight loss. Those who changed had equal weight loss to those who had been active prior to and after surgery.
Bueter et al. 2007	RYGBP, LAGB	71(85); 69 women, 16 men, M_{age}=40, dor=16%	27 mos.	Clinical interview, self-made questionnaire	%EWL=43.2 Success (EWL> 50% and no band removal)= 37%	Post-operative physical activity and absence of sweet eating and stress eating was correlated with successful weight loss (%EWL >50 with no band removal).
Chevallier et al. 2007	LAGB	942(1236); M_{age}=NR, dor=24%	24 mos.	Retrospective chart review, standardized questionnaires	%EWL <50%=606 patients %EWL>50%=336 patients	Not changing eating behavior associated with 2.2× higher risk of losing <50% vs>50% EWL 2 years post-surgery.
Coleman et al. 2010	RYGBP	110(172); 95 women, 15 men, M_{age}=44.4±10.6, dor=36%	32±12 mos.	Clinical interview, standardized questionnaires, height and weight measurement	≥70% EWL=75 patients ≥50% EWL=103 patients	Post-operative medication and dietary noncompliance were not associated with weight loss outcomes. Depending on the measure, unsuccessful weight loss was associated with missed appointments and dumping syndrome 6 months post-op and exercise noncompliance 2 years post-op.
Colles et al. 2008	LAGB	129(173); 103 women, 26 men, M_{age}=45.2±11.5, dor=25%	12 mos.	Semistructured clinical interview, standardized questionnaires, self-made questionnaire	%WL=20.8±8.5 %EWL=50.0±20.7	Uncontrolled eating and grazing predicted poorer weight loss post-operatively.
Dixon et al. 2008	(A) LAGB (B) Conventional therapy	55(60); (A) 30; 15 women, 15 men, M_{age}=46.6±7.4, dor=3% (B) 30; 17 women, 13 men, M_{age}=47.1±8.7, dor=13%	24 mos.	Medical assessments	WL=Physically active: 13.9±10.9 Not physically active: 7.8±12.3	Participants who reported more than 3 periods of physical activity>30 minutes/wk had higher mean weight loss.
Dixon et al. 2009	LAGB	204(227); 177 women, 50 men, M_{age}=42.9±10.4, dor=10%	24 mos.	Standardized questionnaire, self-made questionnaire	WL=27.9±16.6 %WL=22.1±11.1, %EWL=52.7±27.6	Poor attendance at follow-up visits associated with less weight loss 2 years post-surgery.
Elakkary et al. 2006	(A) LAGB without support group (B) LAGB support group attenders	38; (A) 28; 26 women, 2 men, M_{age}=43.1±12.4 (B) 10; 10 women, M_{age}=45.5±15.1	12 mos.	Retrospective chart review	BMIL= (A) 8.1±2.1 (B) 9.7±1.9	Patients who attended support groups had greater weight loss/BMIL that those who did not attend support groups.
Evans et al. 2007	LAGB comparison of subjects at 3 (A), 6 (B), and 12 (C) mo. follow-up	515; 422 women, 93 men (A) 178; M_{age}=42.3±10, (B) 128; M_{age}=43.5±10.9, (C) 209; M_{age}=43.1±10.9	24 mos.	Standard questionnaires	6-mos. %EWL=Physical activity: 56±11.5 No physical activity: 50.5±11.612 mos. %EWL=Physical activity: 67.4±14.3 No physical activity: 61.7±17.0	Patients who engaged in 105 minutes/wkof physical activity showed significantly greater weight loss at 6 and 12 months post-operatively, but not at 3 months.

Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/ methods	Weight loss at follow-up[3]	Predictors
Forbush et al. 2011	RYGBP	265(805); 229 women, 36 men, M_{age}=48.2±10.25, dor=67%	5 yrs.	Standardized questionnaires, weight measurements	%EWL=81.24±24.76	Patients with more energy expended and more hours in activity had better %EWL; increasing hours in activity improved %EWL maintenance. Self-reported energy consumption was not associated with %EWL or %EWL maintenance.
Gould et al. 2007	LAGB	85(130); 71 women, 14 men, dor=35% (A) M_{age}=47±10 (B) M_{age}=43±10 (C) M_{age}=40±7	36-48 mos.	Clinical interview	%EWL= (A) 74±16 (B) 61±15 (C) 56±26	LAGB patients who attend all scheduled follow-up appointments show increased long-term (2-4 year) weight loss.
Josbeno et al. 2011	RYGBP	42(48); 38 women, 4 men, M_{age}=50.6±9.8, dor=12%	2-5 yrs.	Standardized questionnaires, weight measurements, accelerometer arm band	%EWL=62.7 ± 19.7%EWL= (A) ≥150 min physical activity/wk: 68.2 ± 19 (B) <150 min physical activity/wk: 52.5 ± 17.4	Overall, moderate-to-vigorous physical activity (MVPA) predicted %EWL. Those with ≥150 min/wk of MVPA (A) had greater %EWL than those with <150min/wk (B).
Kaiser et al. 2011	LAGB	102; 89 women, 13 men, M_{age}=45.6±11.3	12 mos.	Retrospective chart review	NR	Support group meeting attendance significantly predicted %EWL, controlling for age and baseline BMI.
Kruseman et al. 2010	RYGBP	80(141); 80 women, M_{age}=40±10, dor=41%	8 ±1.2 yrs.	Semi-structured interview, standardized questionnaires, food diary, pedometer, BIA measurements	WL=30.7±13.8	Energy intake (kcal) at 8-year follow-up (but not at 1-year follow-up) was associated with successful weight loss. Patients reporting total daily steps in the upper quartile were four times more likely to achieve 50% EWL. Macronutrient intake and mean number of steps per day were not associated with successful WL.
Larsen et al. 2006	LAGB	157(196); 144 women, 13 men, M_{age}=40.0±7.9, dor=20%	33.9±15.1 mos.	Standardized questionnaires, self-reported weight	Mean Post-Operative BMI: 35.3±6.9 (Mean Pre-operative: 45.5±5.7)	Physical activity was not strongly associated with weight loss at 34 months post-surgery.
Latner et al. 2004	LAGB	65(150); 65 women, M_{age}=39.5, dor=57%	16.4 mos.	Semistructured clinical interview, telephone follow-up interviews, standardized questionnaires	%EBMIL=71	Post-operative exercise predicted greater BMI loss.
Metcalf et al. 2005	DS	100; 86 women, 14 men, M_{age}=NR	18 mos.	Height, weight and BIA measurements	%WL= Exercisers: 51 Non-exercisers: 54	Exercise does not affect total percentage of body weight loss, but positively affected body composition post-operatively.
Orth et al. 2008	(A) RYGBP, LAGB, and VBG without support group (B) RYGBP, LAGB, and VBG support group attenders	46; M_{age}=NR (A) 28 (B) 18	12 mos.	Self-made questionnaires	%BMIL= (A) 32 (B) 42	For RYGBP patients, support groups attenders had greater %BMIL than non-attenders.
Pontiroli et al. 2007	LAGB	162(172); 138 women, 34 men, M_{age}=40.7±0.81, dor=6%	12, 24, 36, and 48 mos.	Interview	BMIL=93.3±0.81	Greater compliance and % attendance at scheduled visits positively associated with weight loss at 12, 24 and 36 months post-surgery. % attendance at scheduled visits predicted weight-loss at 48 months.

Study	Bariatric procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/ methods	Weight loss at follow-up[3]	Predictors
Rosenberger et al. 2011	RYGBP	131; 116 women, 15 men, M_{age}=42.9±10.3	12 mos.	Standardized questionnaires, weight measurements	%BMIL=71.3±18.1	Frequency of moderate/strenuous activity correlated with %BMIL. Intensity of activity significantly associated with greater %BMIL.
Sarwer et al. 2008	RYGBP	112(200); 164 women, 36 men, M_{age}=43.2±9.8, dor=44%	20, 40, 66, and 92 wks.	Standardized questionnaires, self-made questionnaires	%EWL=39.4	Greater self-reported adherence to post-20 week diet associated more weight loss at post-92 weeks.
Shen et al. 2004	(A) LAGB (B) RYGBP	311(355); (A) 130 women, 56 men, M_{age}=40.4, dor=14%, (B) 92 women, 33 men, M_{age}=41.3, dor=17%	12 mos.	Medical follow-up assessments, weight measurements, self-reported weight	%EWL= (A) 44.5±1.4 (B) 66.3±1.9	Significant difference in %EWL in LAGB patients who attended <=6 times/year vs 6+ times/year, with greater weight loss for the regular attenders.
Silver et al. 2006	RYGBP	140(212); 124 women, 16 men, M_{age}=45.2±9.9, dor=44%	24.2±7.9 mos.	Self-made questionnaire, weight measurements	WL=55.8±15.2	Physical activity but not number of meals and snacks and number of food groups avoided did not predict weight loss.
Toussi et al. 2009	RYGBP	112(172); 95 women, 17 men, M_{age}=44.5±10.9, dor=35%	24 mos.	Structured and semistructured interview, standardized questionnaires, measured height and weight	%EWL=70±17	Post-operative medication noncompliance was not associated with weight loss outcomes at one year but it was associated with less EWL at 2 years. Adherence to appointment attendance, and diet and exercise plans was not associated with EWL.
Welch et al. 2008	RYGBP	200(201); 169 women, 31 men, M_{age}=44.9±9.7, dor=0.5%	14.5±13.9 mos.	Self-made questionnaires, self-reported weight	WL=108.9±68.1	Post-surgery weight loss associated with adherence to activity regime.
Wolfe et al. 2006	RYGBP	93(194); 170 women, 24 men, M_{age}=42.1±10.4, dor=52%	78.4±35.7 wks.	Self-made questionnaire, weight measurements	NR	BMI lost did not differ between exercisers and non-exercisers. Planning and self-monitoring of food intake was not associated with BMI lost.

[1] LAGB=laparoscopic adjustable gastric banding, RYGBP=Roux-en-Y gastric bypass, DS=duodenal switch, VBG= vertical banded gastroplasty.

[2] Sample presented as: post-operative *N* (pre-operative *N*, if relevant). DOR=percent lost to post-operative follow-up (if relevant).

[3] NR=not reported. All weight loss (WL) values in kilograms (kg). (%) EWL=(percent) excess weight lost. (%) EMBIL=(percent) excess body mass index lost. (%) BMIL=(percent) body mass index lost.

Table 3

Studies Examining Post-Operative Psychological Disorders (n = 12)

Study	Bariatric Procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Outcomes
Beck et al. 2012	RYGBP	45(67); 37 women, 8 men, M_{age}=43.6±9.16, dor=33%	23.2±4.35 mos.	Standardized questionnaires, self-made questionnaires, self-reported weight	%EBMIL=35.43±10.69	Symptoms of ineffectiveness predicted poorer weight loss. Depression and anxiety were not significantly associated with weight loss.
de Zwaan et al. 2011	RYGBP and LAGB	84(107); 75 women, 32 men, M_{age}=37.5±9.7, dor=21%	9 and 30 mos.	Standardized interview, self-reported weight	EBMIL=54.4±23.4	Post-operative anxiety disorder was not associated with EWL at any follow-up time-point; however post-operative depressive disorder was negatively associated with EWL on long-term follow-up (24-36 mos.).
Hayden et al. 2014	LAGB	150(204); 122 women, 28 men, M_{age}=48.32 ± 11.27, dor=26%	101.18 ± 13.20 wks.	Standardized interview, measured weight	%EWL=44.80±21.01	Prevalence of any Axis I disorder decreased from 39.7% pre-operatively to 20% post-operatively. No differences in %EWL at 2 years for those with or without post-operative Axis I disorder
Karlsson et al. 2007	RYGBP, VBG, and fixed or variable gastric banding	655(851); M_{age}=47±5.7, dor=23%	(A) 5, (B) 12, (C) 24, (D) 36, (E) 48, (F) 70, (G) 96, (H) 120, (I) 180, and (J) 240 mos.	Standardized questionnaires	%WL= (B) 25.3±9.7 (F) 16.9±11.6 (H) 16±12.1	Health-related quality of life during the 10-year observation period largely followed phases of weight loss, weight regain and weight stability. Greater weight loss was associated with greater reduction of

Study	Bariatric Procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Outcomes
						depression symptoms. depression symptoms.
King et al. 2012	RYGBP, LAGB, and BPD	1945(2458); 1533 women, 412 men, M_{age}=47, dor=21%	12 and 24 mos.	Standardized questionnaires, self-made questionnaires	NR	No relationship between post-operative substance use disorders and weight loss. Alcohol use disorders (AUDs) higher in 2nd post-operative year and more common in RYGBP. Half of those with AUD in 2nd year did not report AUD pre-operatively.
Kinzl et al. 2007	LAGB	176(300); 110 women, 66 men, M_{age}=NR, dor=41%	50 mos.	Structured and semi-structured clinical interview, standardized questionnaires	BMIL= Women: 14.77 Men: 14.67	Successful weight loss associated with significantly greater post-operative quality of life, self-esteem, and social relationships in women.
Kruseman et al. 2010	RYGBP	80(141); 80 women, M_{age}=40±10, dor=43%	(A) 12 mos. (B) 96±14 mos.	Structured clinical interview, standardized questionnaires, food diaries	%EWL=56±22.6	Patients with >50% EWL after 8 years had significantly improved depression while baseline depression, anxiety, and quality of life scores were similar between successful and unsuccessful patients.
Latner et al. 2004	LAGB	65(150); 65 women, M_{age}=39.5, dor=57%	16.4 mos.	Semistructured clinical interview, telephone follow-up interviews, standardized questionnaires	%EBMIL=71	Post-operative BED and psychiatric disorders did not predict weight loss outcome.
Odom et al. 2010	RYGBP	203(1117); 147 women, 56 men, M_{age}=50.6±9.8, dor=75%	28.1±18.9 mos.	Self-made questionnaires, medical chart review, standardized questionnaires	79% weight regain, with 30 (15%) regaining ≥15% of total WL	Significantly increased risk for weight regain following RYGBP among patients for whom someone had expressed concern regarding their

Study	Bariatric Procedure[1]	Sample[2]	Mean follow-up period	Assessment measures/methods	Weight loss at follow-up[3]	Outcomes
						post-operative drug or alcohol use. post-operative drug or alcohol use.
Raebel et al. 2013	RYGBP, LSG, and LAGB	11,719; M_{age}=NR	12 mos.	Pharmacy dispensing records	NR	No significant relationship found between opiate use and ≤ or ≥ 50% EWL post-operatively.
Scholtz et al. 2007	LAGB	29(31); 28 women, 1 man, M_{age}=39±9, dor=7%	60 mos.	Structured clinical interview, review of case notes	>40%EWL=17 (60%) patients	Only post-operative, not pre-operative, development of psychiatric disorder (depression, BED) predicted poorer weight outcome.
Shiri et al. 2007	LAGB	57(31); 25 women, 6 men, M_{age}=40±9.7, dor=46%	12 mos.	Standardized questionnaires, measured weight	BMIL=11.8±5.1	Positive impact included: greater appreciation of life, increased sense of personal strength and improvement in relating to others.

[1] LAGB=laparoscopic adjustable gastric banding, RYGBP=Roux-en-Y gastric bypass, LSG=laparoscopic sleeve gastrectomy, VBG=vertical banded gastroplasty, BPD=biliopancreatic diversion.

[2] Sample presented as: post-operative *N* (pre-operative *N*, if relevant). DOR=percent lost to post-operative follow-up (if relevant).

[3] NR=not reported. All weight loss (WL) values in kilograms (kg). (%) EWL=(percent) excess weight lost. BMIL=body mass index lost. (%) EMBIL=(percent) excess body mass index lost.