

Postoperative Depression, Eating Behaviors, and Physical Activity as Indicators
of Weight Loss in Gastric Bypass Patients

by

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
of Philosophy in the Department of
Psychology & Neuroscience in the Graduate School
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ABSTRACT

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Abstract

Background: Bariatric surgery produces marked weight loss and improvement in comorbid health conditions among individuals with Class II or Class III obesity (Class I = $30.0 \leq \text{BMI} \leq 34.9 \text{ kg/m}^2$; Class II = $35.0 \leq \text{BMI} \leq 39.9 \text{ kg/m}^2$; Class III = $\text{BMI} \geq 40 \text{ kg/m}^2$). However, suboptimal weight outcomes occur in a significant minority of patients. Evidence suggests that psychological and behavioral factors might affect weight loss, but most of the literature has focused on preoperative factors, with mixed results. The current study tested the hypothesis that postoperative depressive symptoms, eating behaviors, and lower levels of physical activity would be associated with poorer weight loss outcomes. **Method:** Preoperative data were obtained from an extant clinical database, and postoperative data were collected via a mail or online questionnaire in a sample of 141 female Roux-en-y gastric bypass (RYGB) patients at an average of 16.80 (SD=2.20) months post-surgery. Self-report measures assessed cognitive-affective and somatic symptoms of depression; binge eating, grazing, night eating, distress about overeating or loss of control over eating; and physical activity. **Results:** Weight outcome measures were defined as percentage of excess BMI loss (%EBMIL) and successful weight loss ($\geq 50\%$ EBMIL). Higher distress was associated with poorer %EBMIL, and higher level of physical activity was associated with greater %EBMIL. Decreased cognitive-affective symptoms and increased somatic symptoms of depression were

associated with a higher probability of successful weight loss. Increased somatic complaints predicted greater %EBMIL unless those symptoms were associated with higher sedentary behavior. **Conclusions:** Consistent with hypotheses, preoperative depressive symptoms and binge eating disorder did not predict weight loss. Aspects of all three postoperative domains were associated with weight outcomes. Future research should explore the relations among these psychological and behavioral factors and weight loss over a longer follow-up period.

Dedication

Dedicated to my parents, Arturo Martinez and Janis Owens-Martinez.

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1. Introduction

1.1 Obesity: An Individual and National Health Concern

Obesity and overweight (Body Mass Index (BMI) $\geq 25\text{kg/m}^2$ and BMI $\geq 30\text{ kg/m}^2$, respectively) constitute a significant health and economic challenge. Over one-third of adults in the U.S. are obese (Ogden, Carroll, Kit, & Flegal, 2014), a condition that carries significant health risks and associated economic impacts (Dixon, 2010; Tsai, Williamson, & Glick, 2011). Mounting evidence indicates an increased risk of mortality of obesity compared with normal weight ($18.5 \leq \text{BMI} \leq 24.9$). Recent estimates suggest that obesity-related deaths may have been significantly underestimated due to age and cohort effects (Masters et al., 2013). Although the overall rate of obesity has slowed since the 1990s (Flegal, Carroll, Kit, & Ogden, 2012), there has been a rapid increase in the prevalence of obesity in recent birth cohorts as well as an associated increase in mortality among younger cohorts (Masters et al., 2013)

Even more concerning is the growing proportion of individuals in the U.S. population with Class III obesity (Class I = $30.0 \leq \text{BMI} \leq 34.9\text{kg/m}^2$; Class II = $35.0 \leq \text{BMI} \leq 39.9\text{kg/m}^2$; Class III = $\text{BMI} \geq 40\text{ kg/m}^2$; Sturm & Hattori, 2013). The prevalence of Class III obesity quadrupled between 1986 and 2000 (Sturm, 2003), and it continued to rise exponentially until 2005 (Sturm & Hattori, 2013). Although the growth rate of Class III obesity has slowed, the first decade of the 21st century saw a 70% increase in prevalence rates, from 2.1% in 2000 to 3.7% in 2010.

Compared with lower levels of obesity and overweight, Class II and Class III obesity (known together as clinically severe obesity) constitute an even greater public health challenge. Research has demonstrated increased risk of mortality associated with higher levels of obesity relative to normal weight (Adams, et al., 2007; Flegal, Kit, Orpana, & Graubard, 2013). In addition to increased mortality, Class III obesity is associated with a greater prevalence of chronic conditions such as diabetes, hypertension, and metabolic syndrome compared to lower levels of obesity (Nguyen, Magno, Lane, Hinojosa, & Lane, 2008). Taken together, the evidence strongly supports the contention that obesity is a significant health concern, and higher levels of obesity confer additional risk. The increased morbidity, mortality, and economic strain of severe obesity demonstrate the importance in identifying a successful treatment.

1.2 Non-Surgical Treatment of Severe Obesity

There is a large body of research on nonsurgical weight-loss interventions, but there are few well-designed studies specific to severe obesity. A handful of recent studies shed light on the effects of behavioral interventions on weight loss and health outcomes in this population.

Intensive lifestyle interventions for severe obesity have produced modest short-term weight loss (typically 7-10% of initial body weight), and improvements in cardiovascular and metabolic risk factors at 1 year (Goodpaster et al., 2010; Look AHEAD Research Group, 2006; Wing, et al., 2011). A 2-year randomized controlled trial

(RCT) of an intensive medical intervention (Ryan et al., 2010) for severe obesity consisted of behavioral and pharmacologic treatment and produced 13.1% weight loss and improvements in metabolic parameters at 1 year. However, regain of almost 25% of initial weight loss occurred by 2 years and most initial improvements in metabolic parameters were lost.

One RCT looked at long-term effects of a nonsurgical weight loss intervention. Look AHEAD (Action for Health in Diabetes), a large-scale, multicenter RCT of an intensive lifestyle intervention, examined the effects of weight loss on cardiovascular mortality and morbidity in overweight ($25 \leq \text{BMI} \leq 29.9$) and obese individuals with type 2 diabetes (Look AHEAD Research Group, 2006). Among those with severe obesity, mean weight loss was approximately 5% at 4 years, and 26% achieved weight loss of at least 10 percent (Unick et al., 2013). The intervention also produced 4-year improvements in cardiovascular risk factors, including HbA1c, LDL-cholesterol, and blood pressure, particularly among those with greater weight losses ($\geq 10\%$). The likelihood of meeting American Diabetic Association goals for HbA1c and blood pressure increased by 200% and 300%, respectively, in individuals with severe obesity who lost $\geq 10\%$ of initial weight. However, severe obesity was associated with smaller improvements in HDL-cholesterol and systolic blood pressure, compared with lower levels of obesity and overweight. Furthermore, the average weight regain was substantial. Those with severe obesity and class II obesity regained approximately 41%

and 48% of initial weight loss, respectively. Although Look AHEAD produced benefits, particularly in the earlier years, it was terminated prematurely after 11-year findings showed no reduction in the primary outcome measure, a composite of mortality from cardiovascular causes, for overweight or obese participants (Look AHEAD Research Group, 2013).

Taken together, the evidence suggests short-term benefits of intensive lifestyle interventions in severe obesity in terms of cardiometabolic risk factors, although longer-term cardiovascular mortality is not reduced. Weight loss is modest and recidivism is common (Wadden, Webb, Moran, Bailer, 2012). Lifestyle interventions are often time-intensive, involving years of treatment (Look AHEAD Research Group, 2013) or long residential treatment stays (Christiansen, et al., 2011).

1.3 Surgical Treatment of Severe Obesity

Bariatric surgery has become widely regarded as the most effective treatment for severe obesity (Elder & Wolfe, 2007), producing marked weight loss and improved weight maintenance compared to conventional behavioral and pharmacological interventions, as well as improvements in obesity-related comorbidities, including hyperlipidemia, hypertension, diabetes, and obstructive sleep apnea (Chang et al., 2013; Gloy et al., 2013; Maggard, Shugarman, & Suttorp, 2005; Picot, et al., 2009). A recent meta-analysis (Chang et al., 2013) reported the percentage of excess weight loss (%EWL= Weight Loss/ (Preoperative Weight – Ideal Body Weight) X 100) across procedures as 44-

48% at 1 year; 55-62% at 2 years; 65-68% at 3 years; and 66-83% at 5 years (Chang et al., 2013).

1.3.1 Surgical procedures and trends

Bariatric surgery was introduced in the 1950s (Elder & Wolfe, 2007). The early procedures were associated with high rates of peri- and postoperative complications and mortality, and, in some cases, poor initial weight loss or maintenance. It was not until 1991 that a National Institutes of Health (NIH) consensus panel endorsed newer procedures for a carefully selected subset of adults with class III obesity, or class II obesity with significant comorbidities, who failed multiple non-surgical treatments. In the late 1990s, the annual rate of bariatric surgery grew exponentially, increasing by 450% between 1998 and 2002 (Nguyen et al., 2005). The overall growth rate plateaued in 2003 (Livingston, 2010), but trends in bariatric procedures have changed in the interim.

Bariatric surgery comprises three functionally defined classes of operative procedures: restrictive, malabsorptive, and restrictive-malabsorptive (Elder & Wolfe, 2007). Restrictive procedures reduce the size of stomach, thereby creating a small pouch and a limited capacity for food intake. Primarily malabsorptive procedures entail diversions of intestinal continuity, but these procedures are rarely performed (Buchwald & Oien, 2009). Restrictive-malabsorptive procedures involve some combination of the two.

The most common bariatric procedure in the U.S. is Roux-en-Y gastric bypass (RYGB), a combined restrictive-malabsorptive procedure that is performed using laparoscopic or, far less frequently, open surgical technique (Buchwald, 2013; Nguyen, Nguyen, Gebhart, & Hohmann, 2013). Although RYGB remains dominant, the percentage of RYGB procedures decreased from 85% in 2003 to 47% in 2011, due in part to the emergence of sleeve gastrectomy (see below).

Laparoscopic sleeve gastrectomy (LSG) is a restrictive procedure that involves vertical transection of the stomach to create a narrow gastric tube (Roa et al., 2006). LSG was once a component of restrictive-malabsorptive procedures, but it recently gained recognition as a primary operation in 2010 by the American Society of Metabolic and Bariatric Surgery (ASMBS, 2012) and coverage by some third-party insurers (Nguyen et al., 2013). LSG grew from 0.9% of bariatric procedures in the last quarter of 2008 to approximately 36% in the third quarter of 2012 (Nguyen et al., 2013).

Laparoscopic adjustable gastric banding (LAGB) is a reversible restrictive procedure that involves the placement of an adjustable band of silicone tubing around the upper portion of the stomach to produce a gastric pouch, as well as the creation of an abdominal port through which saline can be injected or removed from the band (Elder & Wolfe, 2007). LAGB was introduced into the U.S. in 2001 and grew in popularity from the mid to late 2000s (Buchwald, 2013; Nguyen et al., 2013). However, the rate of LAGB

fell from approximately 24% in the last quarter of 2008 to 4% in the third quarter of 2012 (Nguyen et al., 2013).

These trends in the utilization of bariatric operative procedures are likely related to data regarding effectiveness and safety. Evidence indicates that RYGB produces greater 1-year (Padwal et al., 2011) and 5-year weight-loss than LAGB (Chang et al., 2013; Franco, Ruiz, Palermo, & Gagner, 2011). Preliminary evidence suggests similar short-term (Peterli et al., 2013) and mid-term weight loss and improvement of comorbidities for RYGB and LSG (Vidal et al., 2013), although additional research is needed. LSG has a lower overall rate of complications than RYGB, but higher than LAGB (Carlin et al., 2013).

1.3.2 Successful weight loss

Although the benefits of bariatric surgery in reducing obesity and related comorbidities are well documented (Buchwald, et al., 2009; Chang et al., 2013; Pontiroli & Morabito, 2011), a significant minority of patients experience weight regain or fail to lose the expected amount of weight. Estimates from recent investigations, including 10-year follow-up results from the prospective controlled Swedish Obesity Study, suggest that as many as 10-32% of bariatric surgery patients may have poor weight loss outcomes (Busseto et al., 2005; Christou et al., 2004; Karlsson et al., 2007; Melton, Steele, Schweitzer, Lidor, & Magnuson, 2008; Sjostrom et al., 2004).

The noteworthy proportion of patients with failed weight loss outcomes underscores the importance of examining potential predictors of surgical success and failure. Factors such as higher baseline BMI, older age, and anatomical factors (e.g., limb-length in RYGB, enlarged pouch, or presence of a gastric fistula) have been associated with lower weight loss or weight regain (Dykstra, Switzer, Sherman, Karmali, & Birch, 2014; Still et al., 2014). The field has also moved toward understanding psychological and behavioral factors that may have important implications for treatment selection, outcome, and intervention. To date, the literature has emphasized the association between preoperative psychological and behavioral factors and weight loss. However, a new line of research points to the role of postoperative psychiatric factors, including depression, eating pathology and physical activity in understanding individual differences in weight outcomes. The following section reviews several preoperative correlates of weight loss, highlighting the notable gaps and inconsistencies as they currently stand.

1.4 Preoperative Predictors of Weight Loss

The following sections provide a general overview of the research related to preoperative psychological and behavioral functioning, with a specific emphasis on depression and binge eating.

1.4.1 Preoperative depression

The following section examines the prevalence and severity of preoperative depression in bariatric surgery patients as well as a discussion of findings examining the association between preoperative depressive symptoms with weight loss outcomes.

1.4.1.1 Preoperative depression: Prevalence and severity

Findings suggest that current and lifetime affective disorders, particularly major depressive disorder (MDD), are among the most frequent Axis I psychiatric diagnoses in bariatric surgery candidates. This has been demonstrated using clinical interviews (Sarwer, Cohn, Gibbons, Magee, Crerand, et al., 2004) and retrospective chart reviews (Scholtz, Bidlake, Morgan, Fiennes, El-Etar, et al., 2007), and structured diagnostic interviews (Kalarchian, Marcus, Levine, Courcoulas, Pilkonis et al., 2007; Muhlans, Horbach, & de Zwaan, 2009).

Although estimates vary across studies, findings suggest that current and lifetime mood disorders affect at least a significant minority of bariatric candidates. Recent prevalence estimates for current diagnoses based on the gold-standard Structured Clinical Interview for DSM-IV (SCID) ranged from 6.7% to 31.5% for any mood disorder; 3.4% to 25.3% for MDD; and 1.1% to 6.2% for dysthymia. Prevalence rates for lifetime diagnoses ranged from 22.0% to 54.8% for any mood disorder; 14.9% to 50.7% for MDD; and 1.1% to 8.2% for dysthymia (Kalarchian et al., 2007; Mauri, Rucci, Calderone, Santini, Oppo et al., 2008; Muhlans et al., 2009; Rosenberger et al., 2006).

The potentially confounding effects of differences in sample sizes, demographics, and methodologies preclude direct comparison of estimates across studies (Muhlhans et al., 2009). However, as Muhlhans and colleagues (2009) noted in a review of these studies, three of the four (Kalarchian et al., 2007; Mauri et al., 2008; Muhlhans et al., 2009) reported elevated rates of mood disorders compared with the general population rates in their respective countries. In contrast, Rosenberger and colleagues (2006) did not find elevated prevalence rates compared with the general population.

A second line of inquiry has investigated the prevalence and severity of depressive symptoms—as opposed to formal diagnoses—using self-report measures, commonly the Beck Depression Inventory (BDI; Beck et al., 1961), the Beck Depression Inventory, Second Edition (BDI-2; Beck, Steer, & Brown, 1996), or the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). Studies that used the BDI or BDI-2 to assess depressive symptomology in bariatric candidates reported overall means in the mild range (Alger-Mayer, Rosati, Polimeni, & Malone, 2009; Colles, Dixon, & O'Brien, 2007; Colles, Dixon, & O'Brien, 2008c; Stout et al., 2007), and others reported means in the moderate range (Dixon, Dixon, & O'Brien, 2003; Schowalter, Benecke, Lager, Heimbucher, Bueter, et al., 2008). Similar findings were reported for depressive symptomology on the HADS (Thonney et al., 2010). Overall, estimates indicate that up to 30-40% of bariatric candidates may present with clinically significant depressive symptomology (Alger-Mayer et al., 2009; Burgmer et al., 2007; Schowalter et al., 2008).

Taken together, the evidence suggests that rates of depression and depressive symptoms are prevalent among bariatric surgery candidates. Research has also examined the effects of preoperative depression on weight loss.

1.4.1.2 Preoperative depression: Weight loss outcomes

A number of studies suggest that elevations in preoperative depressive symptoms do not adversely affect weight loss in the short-term. For instance, Dixon and colleagues (2001) concluded that significant preoperative depressive symptoms were not associated with weight loss 6 months after LAGB. In a subsequent study, preoperative BDI score did not predict %EWL one or two years post-surgery (Dixon, Dixon & O'Brien, 2003). Similarly, preoperative scores indicating mild or greater depression on the BDI (≥ 10) and the Center for Epidemiological Studies-Depression Scale (CES-D) did not predict %EWL at 1 year post-RYGB, controlling for age, gender, baseline weight, and medical co-morbidities (Ma, Pagoto, Olendzki, Hafner, Perugini et al., 2006). Preoperative HADS depression scores did not predict change in BMI or EWL at 1 or 2 years post-RYGB (Thonney et al., 2010). A study that used a standardized clinical interview found that neither lifetime nor current depression predicted weight outcomes at 1-year after restrictive bariatric surgery (Legenbauer, Petrak, de Zwaan, & Herpertz, 2011).

More support for the lack of an association between preoperative depression and weight loss comes from findings from studies with longer follow-up periods.

Preoperative HADS depression scores were not associated with BMI change or %EWL at 3 years post-RYGB or -LAGB (Buddeberg-Fischer et al., 2006). Another prospective study assessed weight every 3 months during the first postoperative year and annually thereafter for up to 6 years (Alger-Mayer et al., 2009). Weight outcomes did not differ between RYGB patients with significant preoperative depressive symptoms on the BDI (scores >13) and those with low BDI scores (≤ 13) at any point up to six years after surgery.

However, in contrast to findings suggesting a null association between preoperative depression and treatment outcome, other studies reported that preoperative depression was associated with poorer weight outcomes. A prospective study found that higher preoperative BDI scores were associated with less %EWL 1 year after LAGB (Colles, Dixon, & O'Brien, 2008b). In a study that assessed Axis I and II disorders with the SCID for DSM-IV, lifetime mood disorder was associated with smaller reductions in BMI at 6 months post-RYGB, controlling for baseline BMI, gender, age, and race (Kalarchian et al., 2008). However, current preoperative mood disorder did not predict weight loss. Analyses were not conducted for individual disorders, so it is not clear if these findings would generalize to MDD. A longer-term study (Legenbauer et al., 2011) found that baseline current and lifetime depression, assessed with a

standardized interview, predicted poorer weight outcomes 4 years after restrictive bariatric surgery.

A few studies reported that greater preoperative depressive symptoms were associated with better short-term weight outcomes. Individuals with more severe depression on the BDI tended to have greater %EWL at 1-year post-RYGB, controlling for the effects of BMI and age (Averbukh et al., 2003). Higher preoperative BDI scores were associated with lower risk of significant weight regain ($\geq 15\%$ increase from lowest postoperative weight) at a mean follow-up of 28.1(18.9) months post-RYGB (Odom et al., 2010).

Taken together, the conflicting evidence suggests that preoperative depressive symptoms are not a reliable predictor of weight outcomes. The few studies that have specifically examined depressive disorders did not find associations with weight loss in the short term, but there may be negative effects in the longer-term.

1.4.1.3 Preoperative depression: Summary

Overall, recent evidence suggests that current and past affective disorders, particularly lifetime MDD, occur in at least a significant minority of bariatric surgery candidates, with U.S. estimates ranging from approximately 3% to 10% in U.S. samples. Consistent with these findings, studies reported mean levels of depressive symptomology within the mild to moderate range for 30-40% of patients. The relation between preoperative depression and weight loss is inconclusive. A number of studies

reported that there was no association between preoperative depression and weight loss. However, other findings suggest an association—inverse in some studies and positive in others—between preoperative depression and weight loss.

1.4.2 Preoperative binge eating

The next section examines research pertaining to preoperative binge eating among bariatric surgery candidates. The prevalence of BED and binge eating are discussed, followed by an examination of the relation of these preoperative factors to weight outcomes.

1.4.2.1 Preoperative binge eating: Prevalence and severity

At the time of enrollment in the present study, BED was not a formal diagnostic category in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM IV-TR; APA, 2000). It appeared in the appendix as a provisional diagnostic category. Given that the studies in the literature review also used *DSM-IV-TR*, we will present those criteria here. The *DSM-IV-TR* defines binge eating in terms of overeating and loss of control, whether it occurs as a feature of bulimia nervosa or BED. In both bulimia nervosa and binge eating disorder, binge eating involves a sense of loss of control over eating behavior and consumption of “an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances” (APA, 2000). Criteria for BED stipulate that binge eating episodes be characterized by marked distress and must include one of the following: eating rapidly, eating until uncomfortably full, eating

without the presence of hunger, eating alone due to embarrassment, or feeling disgusted, depressed, or guilty after overeating.

BED and binge eating symptomology may be common among bariatric patients. In a long-term retrospective follow-up study, findings indicated that almost half of participants met criteria for lifetime BED before the surgery (Mitchell, Lancaster, Burgard, Howell, Krahn et al., 2001). The authors also reported separate percentages for each diagnostic criterion. A significant proportion of patients reported eating large amounts of food (74%), feeling out of control (61.5%), eating more rapidly than usual (65.4%); eating until uncomfortably full (73.1%); eating large amounts without feeling hungry (74.4%); eating alone due to embarrassment (33.3%); and feeling disgusted, depressed, or guilty after overeating (55.1%). The study employed a retrospective design to ascertain preoperative psychological status. This is an important methodological limitation, because patients were asked to recall eating behaviors and related cognitions that occurred 13-15 years earlier. Nevertheless, recent prospective evidence supports the overall findings (Muhlhans et al., 2009). Using the Eating Disorder Examination (EDE; Fairburn & Cooper, 1993), Muhlhans and colleagues reported that 50% of candidates met criteria for lifetime BED or presented with sufficient sub-syndromal symptoms to warrant a lifetime diagnosis of eating disorder not otherwise specified (EDNOS).

However, estimates vary significantly across studies, as confirmed by recent review (Niego, Kofman, Weiss, & Geliebter, 2007). Niego and colleagues found that

studies reported a wide range of prevalence estimates for preoperative binge eating, ranging from 2% to 49% for BED and 6% to 64% for binge eating of any kind. Recent prevalence estimates based on the same gold-standard measure—the SCID—have also produced a relatively wide range of rates, from 3.4 to 16.0% for current BED and 4.6 to 27.1% for lifetime BED (Kalarchian et al., 2007; Mauri et al., 2008; Rosenberger et al., 2006).

Given the inconsistent finding regarding the prevalence of preoperative BED and binge eating among bariatric surgery candidates, it not surprising that the evidence is also somewhat mixed with regard to the relationship of these factors and weight outcomes. A discussion of these findings follows in the next section.

1.4.2.2 Preoperative binge eating: Weight outcomes

Some findings suggest that preoperative BED and binge eating are not associated with weight outcomes, whereas other evidence indicates better or worse weight outcomes for patients with these forms of eating pathology.

A number of studies found that BED diagnosis, binge eating frequency and binge eating severity were not associated with weight outcomes in the short-term. For instance, baseline BED diagnosis was not associated with poorer percentage of weight lost (%WL) at 1-year post-LAGB (Colles, Dixon, & O'Brien, 2007) in a study that assessed with a semi-structured clinical interview, and analyses controlled for age, gender, baseline BMI and insulin resistance. Similarly, a study that assessed BED with a semi-

structured clinical interview and a modified version of the EDE found that there were no differences in BMIL or %EBMIL at 16 months post-RYGB between women with and without the disorder (Latner et al., 2004). In a study that assessed binge eating with the QEWP-R, preoperative binge eating at a rate of at least 1 binge per week was not associated with poorer %EWL 1 year post-RYGB compared with the weight loss outcome of patients with no binge eating or less than one episode per week (Bocchieri-Ricciardi et al., 2006), and comparable results were found for 1-year post LAGB patients (Burgmer, Grigutsch, Zipfel, Wolf, de Zwann et al., 2005).

Studies with longer follow-up periods also offer support for the lack of an association between preoperative BED weight outcomes. For instance, LAGB patients with preoperative BED did not differ from their counterparts without the disorder on %EWL at any point during the 5-year follow-up period (Busetto et al., 2005). At the 5-year evaluation, there were no statistically significant differences between those with and without preoperative BED in the proportion of patients who regained at least 20% of baseline EW, lost more than 50% of EW, or lost less than 20% of EW. Similarly, a retrospective chart analysis also found that individuals with and without preoperative BED did not differ in the proportion with successful or failed treatment outcomes at 5 years post-LAGB (Scholtz et al., 2007).

In addition to BED, preoperative binge eating severity also failed to predict treatment outcome in the longer-term. For instance, preoperative scores on BES did not

predict poor weight loss outcomes in a female sample up to six years after RYGB (Alger-Mayer et al., 2009). Analyses compared severe binge (BES score above 26) eaters with moderate binge eaters (BES score of 18 to 26) and non-binge eaters (BES score below 18). Annual assessment of weight loss outcomes—TBW loss, %TBW loss, and EWL—indicated that there were no statistically significant differences between severe binge eaters, moderate binge eaters and non-binge eaters. There were still no differences in weight loss outcomes when severe binge eaters were compared with the rest of the sample as a whole (i.e., moderate- and non-binge eaters combined).

In contrast with these findings, other evidence suggests that preoperative BED and frequent binge eating are associated with poorer short-term weight outcomes. Preoperative BED, assessed with the QEWP-R, was associated with lower %EWL six months after RYGB compared with %EWL in patients without BED (Dymek et al., 2001). In another study with a short follow-up period, patients with preoperative binge eating showed lower %EWL 6 months post-RYGB compared with their non-binge eating counterparts (Green, Dymek-Valentine, Pytluk, le Grange, & Averdy, 2007). In a study that categorized patients in terms of lifetime BED and binge eating frequency using the SCID, patients with preoperative BED (≥ 2 binge episodes/week) or subclinical binge eating (< 2 binge episodes/week) showed lower %EBL two years after RYGB compared with patients without preoperative binge eating (Sallet, Sallet, Dixon, Collis, Pisani et al.,

2007). However, one year after surgery, there was no difference in %EBL between patients with preoperative BED and those without preoperative binge eating.

In contrast, other evidence suggests that patients with frequent or severe preoperative binge eating or BED may have better weight loss outcomes than those without this behavior. For instance, patients with severe binge on the BES had greater %WL 6 months after RYGB. Similarly, Latner and colleagues (2004) found that frequent preoperative binge eating predicted *greater* BMI loss compared with non-binge eating at 16.4 months post-RYGB. Some have speculated that preoperative binge eating might function as a maintenance factor for obesity (Latner et al, 2004). Accordingly, if binge eating resolves after surgery, individuals may lose weight in a manner proportional to their preoperative rate of binge eating.

1.4.2.3 Preoperative binge eating: Summary

In summary, studies that examined the effects of preoperative binge eating on treatment outcome have produced inconsistent findings. A growing number of studies—with various study designs, assorted assessment methods and in a variety of populations—reached the conclusion that preoperative BED is not associated with weight outcomes. However, there is also evidence to suggest that BED is associated with poorer weight outcomes. Findings are also inconsistent regarding the effects of the severity or frequency of binge eating on weight loss outcomes. Some of the research suggests that preoperative binge eating severity and frequency are not associated with

weight outcomes, but other evidence points to a positive or inverse association between binge eating and weight loss.

1.4.3 Preoperative correlates of weight loss: Summary

The primary objective of surgical intervention is to decrease weight and related comorbidities. Notably, morbid obesity is associated with psychiatric symptoms and diagnosable psychopathology, with depression and binge eating being two of the most prevalent psychiatric comorbidities in the pre-operative bariatric surgery population. However, evidence to linking preoperative psychosocial factors to treatment outcomes is inconclusive, at best. There is emergent evidence suggesting that postoperative psychiatric factors, including depression and eating pathology, may be more useful than preoperative factors in understanding individual differences in weight outcomes. The next section details this literature.

1.5 Postoperative Correlates of Weight Loss

As a counterpart to the previous section, the following section provides an overview of the research related to postoperative psychological and behavioral functioning, with a specific emphasis on depression and eating pathology. Postoperative physical activity is discussed as an additional factor in optimal weight loss and successful weight maintenance.

1.5.1 Depression

Depression is another psychological factor that has emerged as a correlate of weight outcomes in bariatric surgery patients. However, in contrast to the research on postoperative eating pathology, the research on postoperative depression focuses on the association between weight outcomes and *changes* in depressive symptomology from pre- to post-surgery. This evidence indicates that greater improvement in baseline depression is associated with better weight outcomes in the short- and long-term. For instance, greater BMI loss was associated with greater decreases in depression at 1-year post-RYGB (Thonney et al., 2010). Similarly, those who lost a higher %EW at 1-year post-LAGB reported greater decreases in depression than those who lost less weight (Dixon, Dixon, & O'Brien, 2003).

Findings from the Swedish Obesity Study (SOS) offer additional insight into the relationship between weight loss and depression (Karlsson et al., 2007). When patients were divided by degree of weight loss, the 10-year change in depression was greatest among those who lost the most weight ($\geq 30\%$ Total Body Weight) versus those who lost less weight (10-29.9%TBW and 0-9.9%TBW). Distinct trends over the entire follow-up period emerged for patients whose 10-year weight loss was higher than 10% [higher weight loss group (HWL)] and those who lost less than 10% [lower weight loss group (LWL)]. Differences were apparent between the HWL and LWL groups as early as 1 year after surgery. At 1 year, the HWL patients lost significantly more weight (28%) than the

LWL patients (20%), and the divergence in weight loss increased each year thereafter. A similar pattern was observed for depression scores. At 1 year, the improvement in depression scores was greater among the HWL patients than the LWL patients, and the difference in improvement increased over most of the follow-up period.

Taken together, these findings suggest that the trajectory of depressive symptoms and weight are linked. The available evidence suggests that pre- to postoperative increases in depression are associated with less weight loss as early as one year after surgery. However, there is a dearth of research examining the association between weight and postoperative depression, as opposed to changes in pre- to postoperative depression.

1.5.2 Eating behaviors

The clinical presentation of eating disturbances in postoperative patients does not typically include the consumption of objectively large amounts of food, due to the surgical reduction of gastric capacity. However, a variety of eating patterns has been identified in postoperative patients, including variants of binge eating and binge eating disorder (BED), grazing, and night eating syndrome (NES). Evidence suggests that these behaviors and syndromes may be associated with poorer weight loss.

1.5.2.1 Binge eating and BED

Binge eating is defined terms of overeating and feeling a sense of loss of control of eating. According to this definition, binge eating involves a sense of loss of control

over eating behavior and consumption of “an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances” (APA, 2000). In order to meet criteria for BED, binge eating episodes must be characterized by marked distress and must include one of the following: eating rapidly, eating until uncomfortably full, eating without the presence of hunger, eating alone due to embarrassment, or feeling disgusted, depressed, or guilty after overeating.

The measurement of binge eating behavior is a notoriously complicated endeavor (Grilo, Masheb, & Wilson, 2001; Elder, Grilo, Masheb, Rothschild, Burke-Martindale et al., 2006), and this may be particularly true in postoperative patients (Elder et al., 2006). Due to the reduction in gastric pouch capacity, studies have begun to investigate the prevalence and effects of postoperative binge episodes and BED by omitting the *DSM-IV-TR* criterion of the consumption of objectively large amounts of food. Patients are able to consume more food than is optimal for a postoperative patient, but the manner in which they do it is not consistent with the objective size criterion. This behavior, and potential associations with poor weight outcomes, would not be captured by *DSM-IV-TR* binge eating criteria.

Whereas rates of *DSM-IV* defined BED and binge eating decline markedly after bariatric surgery (de Zwaan et al., 2010; Dymek et al., 2001; Latner et al., 2004), findings indicate that a significant minority of postoperative patients report binge eating that is not characterized by consumption of an objectively large amount of food. Instead, a

defining feature of postoperative binge eating appears to be perceived loss of control over small or subjectively large amounts of food (Colles, Dixon & O'Brien, 2008c; de Zwaan et al., 2010; Kalarchian et al., 2002; White, Kalarchian, Masheb, Marcus, & Grilo, 2010). Evidence indicates that almost half of postoperative patients reported episodes in which they could not control what or how much they ate (Kalarchian et al., 2002; Kofman, Lent, & Swencionis, 2009).

Findings suggest postoperative binge eating and modified BED are associated with poorer short- and long-term weight loss. For instance, patients who reported objective or subjective binge episodes (≥ 1 episode per week for the past 6 months) lost less weight compared to the rest of the sample 1 year after LAGB (Colles, Dixon, & O'Brien, 2008b). Similarly, the frequency of subjective binge eating was inversely associated with %BMIL in RYGB patients 18-35 months after surgery (de Zwaan et al., 2010). Individuals who reported at least one subjective binge episode per week in the past six months achieved a significant amount of weight loss (29%BMIL), but it was significantly lower compared with the average of 37%BMIL among those who engaged in the behavior less than once a week or not at all. A longer-term study found that the frequency of subjective binge eating was associated with poorer %EWL three to ten years after RYGB (Kofman, Lent, & Swencionis, 2010).

Evidence also indicates that postoperative binge eating is associated with weight regain. Two to seven years after RYGB, patients with subjective or objective binge eating

(≥ 1 episode per week for 4 weeks) regained more weight than those without binge eating (Kalarchian et al., 2002). Patients with binge eating experienced a mean increase in BMI of 5.2(4.4) from their lowest postoperative BMI, compared with a lesser increase of 2.5(2.8) for those without binge eating. Binge eating was also associated with weight gain in the past three months, whereas non-binge eating was associated with weight loss in the same period (Kalarchian et al., 2002). At the mean follow-up of 4.2 years after RYGB, subjective binge eating frequency was positively associated with weight regain (Kofman, Lent, & Swencionis, 2010).

Similar findings have been reported in patients who met modified criteria for BED (i.e., without the DSM-IV size criterion) after surgery. Three to 10 years (mean=4.2) after RYGB, patients with modified BED regained more weight and had poorer EWL than those without the disorder (Kofman, Lent, & Swencionis, 2010). Thirteen to fifteen years after RYGB, patients with both preoperative *and* postoperative BED regained more weight than those with preoperative BED alone or those without preoperative BED (Mitchell et al., 2001).

Taken together, these findings suggest that patients who experience subjective binge eating or meet criteria for modified BED after bariatric surgery may be at risk for poorer weight outcomes than those without these behaviors.

In addition to BED and binge eating, an emergent literature has examined other forms of postoperative eating behavior that do not entail the consumption of objectively

large amounts of food within a short period of time. These include grazing and night eating syndrome (NES).

1.5.2.2 Grazing

Grazing may be broadly defined as the continuous consumption of small to average amounts of food over the course of an extended period of time (Saunders, 2004). Recent studies with follow-up periods ranging from one to ten years found that approximately one-third of postoperative patients reported frequent grazing (Colles, Dixon, & O'Brien, 2008a; Kofman, Lent, & Swencionis, 2010).

Postoperative grazing may be associated with less weight loss and more weight regain. Patients with postoperative grazing had poorer %WL (17.3 +/- 7.6% vs. 22.9 +/- 8.4%) and %EWL (40.9 +/- 18.6% vs. 55.6 +/- 20.0%) compared with patients who did not report grazing 1 year after LAGB (Colles, Dixon, & O'Brien, 2008a). Postoperative grazing predicted %WL, controlling for baseline BMI, gender, and insulin resistance. A longer-term follow-up study found that higher frequency of grazing was associated with more weight regain and poorer %EWL among post-LAGB patients at the mean follow-up of 4.2 years (Kofman, Lent, & Swencionis, 2010). Greater weight regain and less EWL was observed in patients who reported grazing at least 2 days per week on average for 6 months compared with those who grazed less frequently. Patients who regained more than 10% of their EWL—approximately 47% of the sample—reported more frequent grazing than those who regained less than 10% of their EWL.

1.5.2.3 Night eating syndrome

Night Eating Syndrome (NES) is characterized by a disturbance in the circadian rhythms of food intake involving evening hyperphagia (eating an increased proportion of daily energy intake at night, usually demarcated as occurring after dinner) and/or nocturnal ingestions (awakening followed by ingestion of food) (Allison et al., 2006; Allison et al., 2010). Depending on the strictness of criteria, prevalence estimates range from 2% to 9% at 1-year post-surgery (Colles, Dixon, & O'Brien, 2008a; Latner et al. 2004).

Findings regarding the association between NES or night eating behaviors and weight outcomes are inconsistent. Some evidence suggests that NES and related symptoms are associated with higher BMI. Latner and colleagues (2004) found a positive correlation between the frequency of postsurgical night eating episodes and BMI. However, Colles and colleagues (2008a) reported no statistically significant differences in %WL between postoperative LAGB patients with and without NES. This is a nascent area of inquiry, and further research is needed to elucidate whether there is an association between postoperative NES and weight loss.

Taken together, these emergent findings suggest that grazing and night eating may be associated with poorer weight outcomes and, as such, these forms of eating behavior warrant further investigation.

1.5.3 Physical activity

Physical activity has long been a cornerstone of conventional weight loss interventions, but its role in facilitating weight loss after surgical intervention is less well understood. Although it is not the primary mechanism of weight reduction in bariatric surgery, postoperative physical activity is thought to facilitate and maintain weight loss and sedentary behavior is thought to impede weight loss.

A small but growing body of research suggests a positive association between postoperative physical activity and greater weight loss (Livhits, Mercado, Yermilov, Parikh, Dutson Mehran et al., 2010). For instance, one year after bariatric surgery, patients who became physically active or continued to be physically active lost more weight than those who were inactive (Bond, Phelan, Wolfe, Evans, Meador, et al. 2009). Several studies have reported that greater intensity or volume of physical activity was associated with more short-term weight loss. Patients who participated in a minimum of 150min/wk of at least moderate intensity physical activity after surgery demonstrated greater weight loss at 6 and 12 months compared with those who did not meet this activity threshold (Evans, Bond, Wolfe, Meador, Herrick, et al., 2007). Other recent studies support these findings. For instance, Rosenberger and colleagues (2010) found that higher intensity physical activity was associated with better weight outcomes 1 year after RYGB. Another study demonstrated that higher levels of leisure time physical activity independently predicted greater weight loss 1 year after LAGB, above and

beyond the contribution of baseline BMI, subjective hunger and physical function (Colles, Dixon, & O'Brien, 2008b).

Based on this observational data, the causal association between postoperative physical activity and weight loss is uncertain. Physical activity may facilitate initial weight loss by contributing to the surgically induced caloric imbalance, and it may help to offset the gradual increases in caloric intake that occur over time. Alternately, surgically induced weight loss may promote physical activity, perhaps due to resultant increases in mobility and physical function (Josbeno, Jakicic, Hergenroeder, & Eid, 2010).

In addition to the association with weight outcomes, recent research has found that postoperative physical activity is associated with better psychosocial outcomes. Rosenberger and colleagues (2010) reported that patients who reported greater intensity and frequency of physical had lower levels of depression 1 year after RYGB.

Given the established relationship between physical activity and weight loss in the broader obesity treatment literature, postoperative exercise prescriptions are commonplace (Elkins, Whitfield, Marcus, Symmonds, Rodriguez, & Cook, 2005). Nevertheless, there is a lack of consensus in clinical practice and the research regarding the amount and type(s) of physical activity that should be recommended to facilitate optimal weight outcomes.

1.6 Subgroup Vulnerability: Gender Considerations

There is a lack of consensus in the literature regarding the potential for increased

risk of psychopathology among obese individuals in the general population. As a result, Friedman and Brownell (1995) contended that future investigations should adopt a risk factor approach that takes into account the heterogeneity within the obese population in terms of psychological vulnerability. Heeding this advice, the next generation of research has taken a more nuanced approach to this line of inquiry by focusing on subgroups within the obese population (Markowitz, Friedman, & Arent, 2008). Emerging from this body of work is the important role gender plays in identifying subgroups of obese individuals with increased psychiatric morbidity, particularly with regard to expression depression symptomology.

1.6.1 Gender and depression

Perhaps the most notable evidence of a gender disparity in the prevalence of psychopathology among the obese population concerns depressive disorders and symptomology. Epidemiologic studies in the U.S. have identified gender differences in the prevalence of depression in the obese population that parallels the pattern in the general population, in which rates are approximately twice as high among women (Hasin, Goodwin, Stinson, & Grant, 2005; Kessler, McGonagle, Swartz, Blazer, & Nelson, 1993; Kuehner, 2003). Moreover, findings from several studies suggest that the direction of the association between obesity and depression may differ for men and women. For example, in a study analyzing data from 40,086 adults nationwide, Carpenter and colleagues (2000) found that obese women had a 37% increase in the probability of being

diagnosed with major depression and reported significantly more suicidal ideation and attempts when compared to normal weight women. By contrast, obesity was associated with significant *decreases* in the probability of being diagnosed with major depression for men, whereas being underweight was associated with the highest risk among men (Carpenter, Hasin, Allison, & Faith, 2000). Further evidence of this gender difference was demonstrated in a recent longitudinal study. Controlling for income and stability of depression over time, women who were obese at age 27 were at an increased risk for experiencing a major depressive episode at age 30, whereas men who were obese at age 27 were at a decreased risk three years later (McCarty et al., 2009). Although it is difficult to tease apart the direction of the association between depression and obesity, these findings indicate that obese women represent a subgroup within the obese population particularly vulnerable to increased psychological distress.

2. Specific Aims

The primary objective of surgical intervention is to decrease weight and related comorbidities. Given that Class III obesity is associated with psychiatric symptoms, especially depression and binge eating, there is an interest in the surgical literature regarding the effects of psychosocial factors on weight outcomes, but findings are inconclusive. It is important to identify predictors of treatment outcome because up to one-third of patients fail to achieve or maintain significant long-term weight loss (Karlsson et al., 2007). Yet, studies reported that preoperative depression and binge eating were not reliably associated with weight outcomes and in some cases were associated with more positive outcomes.

The preponderance of extant data addresses the relation between preoperative psychological status on weight outcomes, but the association between concurrent postoperative psychopathology and treatment outcome is less well-studied. Emergent research suggests that postoperative psychological and behavioral factors may be more consistent predictors of weight loss. To this end, the current study examined the association between weight loss and postoperative eating pathology, depression and physical activity in women approximately 12-18 months after RYGB .

In terms of eating pathology, previous research has focused on DSM-IV defined binge eating, which involves the consumption of a large amount of food in one sitting. Rates of DSM-IV defined binge eating and BED drop precipitously after bariatric

surgery, which is logical given that the procedure mechanically restricts the ability to consume large amounts of food. However, recent findings suggest that other forms of eating pathology persist or emerge after bariatric surgery. For instance, some investigators have omitted the size criterion in order to capture postoperative binge eating that is characterized by loss of control. Studies using modified criteria have found that postoperative binge eating is associated with less weight loss. Therefore, the present study will use modified criteria to determine BED status. Two other forms of eating behavior—grazing and night eating—will also be assessed at follow-up.

In terms of depression, there is a dearth of research on the association between postoperative depression and weight loss. Extant research has focused on *changes* in depressive symptoms from pre- to post-surgery as they relate to weight loss. This methodology does not address the unique contribution of postoperative depression to the variance in weight loss. The current study aims to test the hypothesis that postoperative depression is independently associated with poorer weight loss. A secondary aim of the study is to test the hypothesis that physical activity partially mediates the relationship between postoperative depression and weight loss. Depressed patients may engage in less physical activity than those without significant symptoms of depression. If physical activity facilitates weight loss, depressed patients may lose less weight than non-depressed patients due to in part to lower levels of physical activity. Evidence to support this hypothesis comes from longitudinal studies in other

populations that suggest that baseline depression is associated with subsequent decreases in physical activity and increases in sedentary behavior (Roshanaei-Moghaddam, Katon, & Russo, 2009).

The current study examined the association between weight loss and postoperative depressive symptoms, eating behaviors, and levels of physical activity in female RYGBP patients approximately 12-18 months after surgery. The primary and secondary hypotheses are listed below.

2.1 Hypotheses

Postoperative psychological and behavioral factors (binge eating, grazing, night eating, depression and physical activity) will predict weight loss above and beyond preoperative psychological and demographic factors (preoperative binge eating, preoperative depression, initial BMI, ethnicity, age). Specifically, postoperative binge eating, grazing, night eating, depression and lower levels of physical activity will be associated with poorer weight loss. The secondary hypothesis is that postoperative physical activity will mediate the association between depression and weight loss.

3. Method

3.1 Research Design Overview

The study employed a retrospective cohort design to examine the relationship between %EBMIL and depressive symptoms, disordered eating behaviors, and physical activity. Preoperative data were obtained from an extant database of questionnaire and interview data collected as part of the routine preoperative clinical evaluation at the Duke Center for Weight Loss and Metabolic Surgery. Original postoperative data were collected via a mail or online questionnaire for the purposes of the present study.

3.1.1 Surgical candidacy

As part of routine care, surgical candidates were required to attend an evaluation at the surgical center in order to obtain approval for weight loss surgery. Candidates underwent a comprehensive battery of medical tests as well as a psychological evaluation in order to receive approval for surgery. The psychological included self-report measures and a semi-structured psychiatric interview in order to assess for eating pathology, significant untreated psychopathology, and cognitive function. In terms of weight-related eligibility, candidates met criteria for either Class II obesity (BMI >35 kg/m² with co-morbidities) or Class III obesity (BMI >40 kg/m²).

3.1.2 Eligibility for the current study

The recruitment for the present study was limited to RYGB patients. Several factors informed this criterion. The Duke University Center for Weight Loss and

Metabolic Surgery Center performs various types of bariatric surgery, but RYGB constituted the majority of procedures at time of enrollment. LAGB constituted only a small minority of surgeries, estimated at 3%, so analyses would likely have lacked sufficient power to detect significant effects. Second, LAGB is a primarily restrictive (vs. restrictive-malabsorptive) in terms of the mechanism, and it is associated with a different rate of weight loss. Specifically, RYGB produces significantly greater initial weight loss compared with LAGB (Tice, et al., 2008).

Sample recruitment included female patients only, who comprised approximately 85% of the clinic's patients at the time of enrollment. Indeed, women constitute the preponderance of bariatric surgery patients, and the clinic's composition was consistent with reported population rates (Martin, Beekley, Kjorstad, & Sebesta, 2010). Furthermore, the primary research questions informed the decision to restrict the sample to female participants. Epidemiologic studies in the U.S. have identified gender differences in the prevalence of depression in the obese population that parallels the pattern in the general population, in which rates are approximately twice as high among women (Hasin, Goodwin, Stinson, & Grant, 2005; Kessler, McGonagle, Swartz, Blazer, & Nelson, 1993; Kuehner, 2003), and evidence suggests that female bariatric surgery patients report more depressive symptomology than their male counterparts (Dixon, Dixon, & O'Brien, 2003; Mahony, 2008; Mazzeo, Saunders, & Mitchell, 2006).

3.1.3 Recruitment procedures

The study materials and procedures were approved by the Duke University Health Care System Institutional Review Board. The patient pool for recruitment consisted of over 400 female patients of the Duke Center for Metabolic and Weight Loss Surgery who had undergone RYGBP approximately 12-18 months prior to enrollment in the study.

At the beginning of enrollment, staff psychologists provided a flyer to patients who expressed interest in the study during postoperative support groups. Those who wished to receive more information about the study were invited to provide their contact information for a brief follow-up phone call with the co-principal investigator. This recruitment method proved too slow for the study timeline, with 11 participants enrolled after 3 months.

In order to improve the enrollment rate, subsequent recruitment was conducted via invitation letters, followed by a phone call. Invitation letters were mailed to the available pool of 436 patients. The co-principal investigator then phoned prospective participants to follow up on the letter. She introduced herself as a student of the patient's providers, the staff psychologists, and she invited the patient to learn more about a research study on women's health behaviors, mood, and weight loss. Those who declined over the phone were thanked for their time and were not contacted again. Those who expressed interest in hearing more about the study were provided with a

verbal summary the consent form. Prospective participants who indicated an interest in participating in the study were given the option of receiving a mail or electronic version of the survey. This two-pronged approach was intended to increase accessibility to the clinic's diverse patient population and proved to be an effective strategy in this regard, as almost 70% of the participants of color (N=56) opted to complete the mail version of the survey.

In accordance with patient preference, the survey packet or email invitation was sent on the next business day, followed by a reminder call or email three weeks later. The survey packet contained an invitation letter, consent form, questionnaire, and pre-paid return envelope. One hundred and twelve surveys were mailed after the initial phone call; eighty-four (75%) of these were completed and returned. The online survey was administered with Qualtrics, the platform for electronic data collection that is approved by the Duke University Medical Center IRB. Prospective participants received an email invitation via Qualtrics with a unique link to the consent form and questionnaire. The consent form appeared first, and prospective participants used a radio button to indicate consent (n=57) or lack thereof (n=2), the latter selection automatically routing to them to the end of the survey. All participants received \$30 in reimbursement for completion of an online or mail survey.

3.2 Participants Overview

One hundred forty-one women who were less than 24 months (mean= 16.80, SD=2.20) post RYGB participated in the current study. Participants ranged in age from 21 to 61 years old (mean = 45.78, SD = 10.96). The sample's ethnic and racial composition (57% European American, 38% African American, 3% Hispanic, 1% American Indian/Alaska Native, 1% other) is representative of the clinic as a whole, as well as the geographic region. Educational background ranged from GED to graduate/professional degree, with 70% of the sample completing some education beyond high school (2% GED, 27% high school, 22% partial college education, 28% college education, 5% graduate education, 16% professional degree).

3.3 Measures

Preoperative and postoperative measures of depression, eating behaviors, physical activity and weight loss will be described in detail in the following sections. Please recall that preoperative measures were obtained from an extant database of questionnaire and interview data collected as part of the routine preoperative clinical evaluation, whereas postoperative data were collected via a mail or online questionnaire for the purposes of the present study. All measures are included in Appendix A.

3.3.1 Depression

3.3.1.1 Beck Depression Inventory (BDI)

The Beck Depression Inventory (BDI) is a widely used 21-item self-report inventory of depressive symptoms (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Items are scored on a 4-point scale and summed to form a composite score reflecting severity of past-week depressive symptoms, where higher scores indicate increasing severity of depressive symptoms. The measure has well-established psychometric properties (Beck, Steer, & Garbin, 1988), and it has demonstrated sound internal consistency (Cronbach's alpha= 0.87 and 0.88) and factor structure in bariatric surgery patients. Research in bariatric surgery candidates has found that the BDI is a suitable screening measure for depressive symptoms, whether or not somatic items are included (Krukowski, Friedman, & Applegate, 2010).

3.3.1.2 Preoperative depression

The BDI was administered to surgical candidates during the preoperative clinical evaluation. Only the total score across the 21 items was available in the preoperative dataset, limiting an examination of reliability. The current study uses this composite measure as an index of preoperative depression.

3.3.1.3 Postoperative depression

In order to assess postoperative depression, participants in the current study completed the BDI as part of a battery of self-report measures. A composite score across the 21 items yielded high internal consistency (Cronbach's $\alpha = .80$).

Postoperatively, it was possible to examine somatic symptoms of depression and cognitive-affective symptoms in order to obtain a more nuanced picture of the relationship with weight loss. Items on the BDI were separated into two validated subscales in accordance with previous research (Munoz, Chen, Fischer, Roehrig, Sanchez-Johnson, et al., 2007). The cognitive-affective subscale yielded high internal consistency (Cronbach's $\alpha = .84$) and contains 14 items : sadness, hopelessness, past failures, loss of pleasure, guilty feelings, punishment feelings, self-dislike, self-criticalness, suicidal thoughts or wishes, crying, irritability, loss of interest, indecisiveness, unattractiveness. The somatic complaints subscale had adequate internal consistency (Cronbach's $\alpha = .58$) and consists of the remaining 7 items: work ability, change in sleep patterns, tiredness and/or fatigue, appetite loss, weight loss, health concerns, and loss of interest in sex.

Finally, it should be noted that that no participant completing the BDI in the current study endorsed the responses "I have definite plans about committing suicide," or "I would kill myself if I could" on the suicidal thoughts and wishes item, thereby not

requiring the use of the crisis management plan outlined in the IRB protocol for high-risk participants.

3.3.2 Eating behaviors

3.3.2.1 Preoperative eating behavior

Preoperative Binge Eating Disorder (BED), in accordance with the criteria outlined in the appendix of DSM-IV-TR (2000), was diagnosed with a semi-structured clinical interview conducted by clinic psychologists as part of the preoperative evaluation.

3.3.2.2 Postoperative binge eating, grazing, and related distress

Participants in the current study completed a modified version of the Questionnaire on Eating and Weight Patterns Revised (QEWP-R). The QEWP-R (Yanovski, 1993) is a self-report measure of Binge Eating Disorder (BED) based upon criteria as specified in the appendix of DSM-IV-TR and binge eating frequency over the past 6 months. The version used in the present study contains an additional seven questions that were modified by researchers Susan Colles, Ph.D. and Ronna Saunders, LCSW to assess grazing and binge eating without the DSM-IV-TR size criterion (Colles Dixon, & O'Brien, 2008a; Saunders, 2004) after weight loss surgery. Postoperative BED was defined by the following criteria from the QEWP-R: eating an unusually large amount of food (given bariatric surgery) in a two-hour period; sense of loss of control of eating during these episodes; frequency of at two or more days per week; three of five

associated symptoms (eating more rapidly than usual; eating until uncomfortably full; eating when not hungry; eating alone due to embarrassment; feeling disgusted, depressed, or very guilty after overeating). The following items from the modified QEWP-R were used to operationalize grazing: “eating smaller amounts of food continuously over an extended period of time, more than you think is best for you.”

Two additional questions from the QEWP-R were examined in the current study to assess general distress related to binge eating behaviors during the past 6 months. Specifically, participants rated on a 5-point likert scale (1 = not at all to 5= extremely) the following items: “How upset were you by overeating (eating more than you think is best for you?” and “How upset were you by feeling that you could not stop eating or could not control what or how much you were eating?”, with higher scores indicating increased distress.

3.3.2.3 Postoperative night eating

The Night Eating Questionnaire (NEQ) (Allison, Stunkard, & Their, 2004) is a 15-item measure that assesses the severity of behavioral and psychological symptoms of Night Eating Syndrome (NES). The NEQ has demonstrated acceptable reliability ($\alpha = .70$); convergent validity with measures of night eating, disordered eating, depressive symptoms, and stress; and discriminant validity in bariatric surgery patients with and without NES (Allison, Lundgren, O’Reardon, Martino, Sarwer, et al., 2008). Items are

rated on a 4-point Likert scale. Thirteen of the 15 items are summed for a global score ranging from 0-52, with higher scores indicating greater night eating symptoms.

The present study used the global score for inferential analyses. The global score yielded a slightly lower reliability α score (Cronbach's $\alpha = .51$) than previously reported (Allison, Lundgren, O'Reardon, Martino, Sarwer, et al., 2008). Participants were also screened for NES using a clinical cut-off of 25 (Allisson et al., 2008) as well as using criteria based on endorsement of evening hyperphagia (consuming at least 25% of daily food intake at night), or nocturnal eating (snacking upon awakening at least half of the time and being at least somewhat aware of eating, the latter to exclude parasomnia) (Mitchell, King, Courcoulas, et al., 2014).

3.3.3 Physical activity

3.3.3.1 Preoperative physical activity

The existing preoperative database did not contain an adequate measure of physical activity collected prior to weight loss surgery.

3.3.3.2 Postoperative physical activity and sedentary behavior

The International Physical Activity Questionnaire (IPAQ) (Craig, Marshall, Sjostrom, Bauman, Booth, et al., 2003) is a self-administered 7-day recall measure of physical activity. The IPAQ is widely used in epidemiological and primary care settings, and it has been used in weight loss surgery patients (Bond et al., 2009; Evans et al., 2007). The IPAQ has demonstrated acceptable test-retest reliability, and criterion validity of the

IPAQ against accelerometer data was fair to moderate for estimated physical activity and sedentary behavior (Booth et al., 2003).

Participants were asked to recall the amount of varying levels of activity performed for greater than 10 minutes at a time during the previous week for walking, moderate-intensity and vigorous-intensity activity within each of four physical activity domains: work, transportation, domestic/garden, and leisure-time activities. Participants completed the full 27-item measure. The current analyses focused on the subset of questions on the IPAQ pertaining to walking, moderate and vigorous activity performed during leisure-time (i.e. "physical activities that you did in the last 7 days solely for recreation, sport, exercise or leisure"). These questions correspond to the IPAQ short form and reflect general patterns of activity that are purposefully undertaken in one's free-time. Table 1 summarizes the IPAQ algorithm used to categorize participants as having low, moderate and high activity levels. Given the small sample size, scoring followed the IPAQ committee guidelines to truncate all time variables (total minutes of activity) at 180 minutes, permitting a maximum of 21 hours of activity per week to be reported for each category

Table 1. IPAQ Algorithm for Categorization of Level of Physical Activity

Low-Intensity Activity Level	Moderate-Intensity Activity Level	High-Intensity Activity Level
<p>1. Zero days of walking, moderate- or vigorous-intensity activity</p> <p>OR</p> <p>2. Did not meet moderate- or vigorous-intensity activity level as defined in column 2 and 3.</p>	<p>1. Three or more days of vigorous-intensity activity of at least 20 minutes per day</p> <p>OR</p> <p>2. Five or more days of moderate-intensity activity and/or walking of at least 30 minutes per day</p> <p>OR</p> <p>3. Five or more days of any combination of walking, moderate- or vigorous-intensity activities achieving a minimum total physical activity of at least 600 MET-minutes/week.</p>	<p>1. Vigorous-intensity activity on at least 3 days achieving a minimum total physical activity of at least 1500 MET-minutes/week</p> <p>OR</p> <p>2. Seven or more days of any combination of walking, moderate- or vigorous-intensity activities achieving a total physical activity of at least 3000 MET-minutes/week.</p>

Note: MET=Metabolic equivalent.

In addition to the physical activity categories, analyses included a proxy for sedentary behavior, an IPAQ item that asks participants to report amount of time (in hours and minutes) spent sitting during the weekend. Weekend sitting, as opposed to weekday or total sitting, was selected for analyses as a plausible counterpart to physical activity reported during leisure time.

3.3.4 Weight

3.3.4.1 Preoperative and postoperative weight assessment

Preoperative BMI was calculated using weight and height data collected by clinic medical staff. Due to logistical constraints, postoperative BMI was calculated using self-reported weight. Although different methods were used in the current study to assess pre- and post-surgery weight, recent findings suggest that post-operative self-reported weight is suitable when measured weight is unavailable (Christian, King, Yanovski, Courcoulas, & Belle, 2011).

3.3.4.1.1 Validity of self-reported weight

In a study of female bariatric surgery candidates, findings indicated overall accuracy in self-reported BMI (White et al., 2010). Actual BMI did not impact the accuracy of self-reported BMI. However, accuracy was differentially associated with race, such that black women were more likely to underestimate BMI compared with white women.

Another group (Christian et al., 2011) directly examined the validity of using self-reported weight in post-operative bariatric surgery patients in the Longitudinal Assessment of Bariatric Surgery (LABS) study. The findings of the large-scale cohort (n=900) study found only small differences between measured and self-reported weight leading the authors to conclude that post-operative self-reported weight is suitable when measured weight is unavailable, as it is in the current study of postoperative bariatric surgery patients.

3.3.4.2 Operationalization of weight loss and surgical success

3.3.4.2.1 Percentage of excess BMI loss

In accordance with recommendations for the standardization of the reporting of bariatric surgery weight outcomes (Deitel et. al, 2007; Dixon McPhail, & O'Brien, 2005; Herman, Carver, Christou, & Andersen, et al., 2014), analyses were conducted using %EBMIL as the primary weight outcome measure (Deitel & Greenstein, 2003; Dixon McPhail, & O'Brien, 2005). The previously described formula appears below for ease of reference:

$$\%EBMIL = ((\text{BMI loss}/(\text{Baseline BMI} - 25)) \times 100$$

3.3.4.2.2 Percentage of excess weight loss

Percentage of excess weight loss (%EWL) is a weight outcome that has been used frequently in the bariatric surgery literature, particularly in earlier studies.

Recommendations from some of the major journals in the field (e.g., *Obesity Surgery*)

indicate that it may be reported for purposes of comparison with these earlier studies. Accordingly, we report %EWL in this context. This measure of weight loss requires calculation of Ideal Body Weight. In the literature ideal body weight is typically based on Metropolitan Life Insurance Tables (1983), which provide ideal weight by body frame, sex, and height. In accordance with standard practice (Deitel et al., 2007), ideal body weight was determined for each participant based on a reference weight of 119lbs for a medium frame woman of 5'0", adding 3lbs for each additional inch. Percentage EWL was calculated using the previously described formula (Deitel et al., 2007), which appears below for ease of reference:

$$\% \text{ EWL} = ((\text{Weight Loss}) / (\text{Preoperative Weight} - \text{Ideal Body Weight})) \times 100$$

3.3.4.2.3 *Successful weight loss*

Lastly, successful weight loss was defined as EBMIL \geq 50%, in accordance with previous studies (Robinson, Adler, Stevens, Darcy, Morton, & Safer, 2014; Kofman, Lent, & Swencionis, 2010). The same cut-off was used to categorize success as defined by %EWL, which was again was only used for purposes of comparison with previous studies.

4. Results

4.1 Data Cleaning

Although 141 participants enrolled in the study, a total of 11 cases were excluded from analyses. Procedural errors required that 10 cases be dropped from analyses. Specifically, three cases were excluded due to unavailability of critical preoperative data such as BMI, and six cases were excluded due to an initial error in the online survey that resulted in a lack of data on postoperative weight, the primary outcome measure. Lastly, missing data due to participant non-response on the post-operative weight item required an additional case to be excluded. Together these exclusions resulted in a total sample of 130 used in all descriptive and inferential analyses.

4.2 Treatment of Missing Data

Missing data due to participant non-response on individual survey items ranged from 0.8% to 3.8%. Overall, only 1.31% of values were missing due to non-response. Research suggests that multiple imputation (Rubin, 1987) is the most effective of the common imputation methods (Nakai, Chen, Nishimura, & Miyamoto, 2014). Multiple imputation was conducted using SPSS 22.0 (IBM, 2013), which uses the fully conditional specification (FCS) strategy. FCS has been shown to be a robust and efficient approach (Van Buuren, Brands, Groothuis-Oudshoorn, & Rubin, 2006).

4.3 Descriptive Statistics

Descriptive statistics are presented for demographics, preoperative covariates, and postoperative predictors of weight outcomes. Table 2 provides descriptive information on all continuous measures, including mean, standard deviation, and range. Table 3 provides descriptive information on all categorical measures, including percentages.

4.3.1 Demographics

Demographics for the reduced sample were almost identical to the overall sample. Participants ranged in age from 21 to 69 years old (mean = 45.78, SD = 10.96). Thirty-seven percent of the sample completed the online version of the survey. Educational background ranged from GED to graduate/professional degree, with 70% of the sample completing some education beyond high school (2% GED, 28% high school, 22% partial college education, 28% college education, 6% graduate education, 15% professional degree). The sample's ethnic and racial composition of the reduced sample revealed that the majority of the participants identified as white (57%) followed by identification as black or African-American (39%). One participant identified as American Indian, 4 identified as Hispanic, and 1 as multi-ethnic. Given the small number of the other racial/ethnic groups, ethnicity was coded into three categories (White, Black, Other) and dummy coded in analyses, where the White category served as the reference group.

4.3.2 Preoperative covariates

The next subsections provide descriptive statistics for 1) two domains of preoperative functioning: depression and eating behaviors; and 2) preoperative BMI.

4.3.2.1 Depression

Prior to surgery, the average total score on the BDI was 9.66 (SD=7.28), which falls within the category of minimal or no depressive symptoms and on the cusp of the lower cutoff (10-18) for mild depressive symptoms. Over 90% of participants reported mild to no symptoms. The sample reported less symptomatology compared with much of the literature on preoperative patients (e.g., Colles, Dixon, & O'Brian, 2007; Colles, Dixon, & O'Brian, 2008c; Dixon, Dixon, & O'Brien, 2003; Schowalter, Benecke, Lager, Heimbucher, Bueter, et al., 2008), indicating a relatively well-adjusted sample from the outset.

4.3.2.2 Eating behavior

Approximately 17% of participants (n=22) received a preoperative diagnosis of BED, based upon the aforementioned semi-structured clinical interview. This prevalence rate is comparable to the upper end of the range of findings from studies using structured clinical interviews, which often yield more conservative rates (e.g., Mitchell et al., 2012) when compared with other methodologies (Kalarchian, Wilson, Brolin, & Bradley, 2000; Mitchell, King, Courcoulas, et al., 2014).

4.3.2.3 BMI

Preoperative BMI ranged from 36-72, with a mean of 48.09 (SD=7.74). Ten percent of the sample (n = 13) met criteria for Class II obesity, and 90% (n=117) met criteria for Class III obesity.

4.3.3 Postoperative predictors

The next subsections provide descriptive statistics for 1) three domains of postoperative functioning: depression, eating behaviors, physical activity, and 2) weight outcomes. Comparison to preoperative data is reported when applicable.

4.3.3.1 Depression

The average total score on the BDI after surgery was 4.75 (SD=5.23). This indicates that approximately 96% of participants fell within the range of minimal or no depressive symptoms (total score= 0-9). Despite low preoperative depression scores, this represented a significant mean decrease of 4.91 (SD=6.68, $t=8.35$, $p<.01$) from pre- to post-surgery. This suggests the sample was a well-adjusted group that, on the whole, exhibited minimal depressive symptoms.

In terms of the type of depressive symptomology, participants reported fewer cognitive-affective symptoms compared to somatic symptoms of depression ($t=8.35$, $p<.01$; $M= 1.73$ vs. 3.03 , respectively). These subscales were used in analyses as the two measures of depressive symptomology given they provide additional information about symptomology and together fully capture responses included in the total score.

4.3.3.2 Eating behaviors

4.3.3.2.1 Binge eating

BED diagnoses as defined by *DSM-IV-TR* criteria dropped dramatically from pre- to post-surgery. The McNemar chi-square test revealed a significant difference between the proportion of preoperative (4.5%) to postoperative BED diagnoses (0.8%; $p < .0001$). Specifically, of the 22 participants who carried a BED diagnosis prior to surgery, only one screened positive after surgery. This participant met *DSM-IV-TR* (APA, 2000) criteria for binge eating, which required endorsement of eating an amount of food that others would agree is “unusually large” on the two unmodified QEWP-R items that screen for *DSM-IV-TR* criteria.

Approximately 4% of participants ($n=5$) screened positive for a BED diagnosis based on the modified QEWP-R criteria, which defined binges in the context of bariatric surgery. One of the five participants retained her preoperative BED diagnosis, whereas the other four screened positive for emergent BED after surgery.

In terms of overeating behavior as a whole, regardless of diagnostic status, 8.5% of the sample ($n=11$) reported binge eating (overeating with loss of control), and 16% ($n=21$) reported overeating without loss of control. Given the low number of participants who endorsed binge eating, the two groups were combined for analyses to capture a broader subset of the sample (25%; $n = 32$) with potentially problematic eating behaviors.

4.3.3.2.2 *Grazing*

Approximately 11% (n = 14) of participants reported postoperative grazing, defined as “eating smaller amounts of food continuously over an extended period of time, eating more than you think is best for you,” with loss of control. Twenty-seven percent of the sample (n = 35) reported grazing without loss of control. Parallel to the measure of overeating behavior (see subsection 4.3.2.1 above), these two groups were combined for analyses in order to capture a broader subset of the sample (38%, n = 49) that endorsed grazing behavior.

4.3.3.2.3 *Distress related to overeating or loss of control*

Distress regarding overeating and feeling a sense of loss of control of eating over the last 6 months was assessed using two items on the QWEP-R. The mean level of distress regarding overeating was 2.20 (SD=1.14) on a Likert scale ranging from 1-5. Comparatively, the mean level of distress regarding the loss of control of overeating (M(SD)=1.90(1.08) was slightly lower ($t=4.32$, $p<.0001$).

4.3.3.2.4 *Night eating*

The average total score on the NEQ after surgery was 12.17 (SD=5.02). In terms of NES, only 1.5% of the sample reached a clinical cutoff (25 or above) proposed by Allison and colleagues (2008). Approximately 14.6% of participants screened positive for NES using evening hyperphagia or nocturnal eating as alternative screening criteria (Mitchell, King, Courcoulas, et al., 2014). Six percent of the sample reported consuming 25% of daily intake after dinner, and 8.5% of participants reported snacking at least half

the time upon awakening at night. Again, low endorsement of this type of behavior overall led to the decision to use the NEQ total score in analyses, in order to best capture these behaviors.

4.3.3.3 Physical Activity

Sixty-three percent of the sample reported engaging in walking activity for at least 10 minutes over the past 7 days in their leisure time, with an average of 2.28 walking-days/week and 40 walking-minutes/day. Thirty percent of the sample reported engaging in moderate or vigorous activity for at least 10 minutes during leisure time over the past 7 days. Eighty-two percent of the sample was categorized as engaging in low levels of activity. Participants reported sitting for almost 5 hours per weekend day on average.

4.3.3.4 Weight

Postoperative BMI ranged from 20-50, with a mean of 31.75 (SD=6.75). As would be expected, this represented a significant mean decrease of 16.34 (SD=5.22, $t = -35.71$, $p < .0001$) from pre- to post-surgery.

The mean amount of excess BMI loss was 75% with the upper range being 148%. Similarly, the average excess weight loss was 67%. Given these means, it is not surprising that 87% of the sample was categorized as having a successful weight loss surgery based on the 50% or greater %BMIL cut-off. Likewise, 84% of the sample was considered a surgical success using this cut-off for %EWL. Taken together, the current

sample demonstrates an extremely high success rate in terms of weight loss and excess weight loss.

Table 2. Descriptive Statistics: Mean, Standard Deviation, and Range for Continuous Measures

	Mean	SD	Min	Max
Demographics				
Age	45.78	10.96	21.00	69.00
Preoperative Covariates				
BDI Total	9.66	7.28	0.00	40.00
BMI	48.08	7.74	36.00	72.00
Postoperative Depression				
BDI Total	4.75	5.23	0.00	19.00
Cognitive-Affective Subscale	1.73	3.15	0.00	19.00
Somatic Subscale	3.03	2.91	0.00	17.00
Postoperative Eating Behaviors				
Distress: Overeating	2.20	1.14	1.00	5.00
Distress: Loss of Control	1.90	1.08	1.00	5.00
NEQ Total	12.17	5.02	3.00	30.00
Postoperative Physical Activity				
Weekend Sitting	284.30	170.48	30.00	1080.00
Postoperative Weight				
BMI	31.75	6.75	19.74	49.69
% EBMIL	75.22	23.98	16.42	147.82
% EWL	66.82	18.63	24.48	121.05

Table 3. Descriptive Statistics: Frequencies and Percentages for Categorical Measures

	N	Percent
Demographics		
Race		
<i>Black</i>	50	38.5
<i>White</i>	74	56.9
<i>Other</i>	6	4.6
Education		
<i>GED</i>	2	1.5
<i>High School</i>	34	26.2
<i>Partial College</i>	26	20.0
<i>College</i>	34	26.2
<i>Graduate</i>	7	5.4
<i>Professional</i>	18	13.8
Preoperative Covariates		
Survey Format		
<i>Online</i>	48	63.1
<i>Mail</i>	48	36.9
Preoperative BED Diagnosis	22	83.1
Postoperative Eating Behaviors		
BED Diagnosis	1	0.8
BED Diagnosis (Modified)	5	3.8
Overeating (Modified)	21	16.2
Binge Eating (Modified)	11	8.5
Grazing	35	26.9
Grazing with LOC	14	10.8
NEQ >25	2	1.5
Evening Hyperphagia	8	6.2
Nocturnal Ingestion	11	8.5
Postoperative Physical Activity Level		
Low	107	82.3
Moderate	8	6.2
High	15	11.5
Postoperative Surgical Success		
% EBMI > 50	113	86.9
% EWL >50	109	83.8

4.4 Reduction of Measures for Analyses

Redundant measures within each construct were removed in order to include the most pertinent analyses in order to streamline the measures used in the analyses.

Analyses used the following demographics that are known to be associated with weight loss outcomes in bariatric surgery: age, race, education, and preoperative BMI.

Additional covariates included survey format (mail vs. online), preoperative BDI total score, and preoperative BED diagnosis. Nine postoperative predictors were included in analyses involving three domains of postoperative adjustment: 1) depression (cognitive-affective and somatic symptoms subscales of the BDI); 2) eating behaviors (overeating, grazing, night eating questionnaire total score, and two indices of distress about overeating and grazing, and 3) physical activity (categorical physical activity level and time spent sitting on weekends). The primary outcome measures are %EBMIL and surgical success (%EBMIL > 50); however, parallel outcome measures using %EWL calculation are reported in tables for purposes of comparison with earlier studies.

4.5 Interrelations among variables

4.5.1 Correlations

The next set of analyses examined bivariate correlations among demographic variables, preoperative measures, postoperative measures, and weight outcomes. The Pearson correlation matrix appears in Table 4, and only significant associations will be discussed in the text.

Table 4. Bivariate Correlations among Demographics, Preoperative Covariates, Postoperative Depression, Postoperative Eating Behavior, Postoperative Physical Activity and Weight Loss Outcomes

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1. Black	--																					
2. Other race	-.17*	--																				
3. Education	-.08	-.02	--																			
4. Age	.01	-.17*	-.12	--																		
5. Survey	-.05	-.17	.20*	.08	--																	
6. Preop BMI	.19*	-.04	-.22	-.03	-.19*	--																
7. Preop BDI	-.14	-.12	-.18	.13	-.05	.07	--															
8. Preop BED	-.19*	.10	-.21*	.19*	-.09	-.03	.36**	--														
9. Cog/Affect	-.13	-.07	-.16	.07	.07	.06	.42**	.17†	--													
10. Somatic	.02	-.05	-.18	.05	.08	.21*	.36**	.32**	.50**	--												
11. Distress-OE	.01	-.07	-.13	.11	-.11	.14	.18†	-.03	.38**	.17†	--											
12. Distress-LOC	.06	-.18*	-.05	.05	-.13	.20*	.27**	.04	.39**	.16†	.75**	--										
13. Overeating	.14	-.05	-.09	.16†	-.00	.05	.11	-.01	.21**	.12	.31**	.40**	--									
14. Grazing	.03	-.10	.18†	.00	-.05	.10	.05	-.03	.20**	-.01	.44**	.36**	.37**	--								
15. Night Eating	.04	-.11	.03	-.08	.03	.13	.17†	.15†	.45**	.28**	.24**	.26**	.34**	.27**	--							
16. Phy Activity	.06	.23**	-.01	-.08	-.03	-.02	.03	-.08	-.12	-.14	.02	-.03	-.11	-.02	-.14	--						
17. Sitting	-.03	.11	-.22*	.14	-.15	.20*	.13	.12	.23*	.29**	.18†	.14	.08	.10	.07	-.14	--					
18. %EBMIL	.37**	.04	.20*	-.14	.22*	-.56**	.04	.09	-.07	-.03	-.26**	-.34**	-.07	-.21*	-.18*	.13	-.23**	--				
19. %EWL	.38**	.03	.20*	-.13	.22*	-.52**	.05	.09	-.06	-.02	-.24**	-.34**	-.09	-.19*	-.17†	.13	-.24**	.98**	--			
20. %EBMIL >50	.21*	.09	.21*	.36**	.11	-.28**	-.03	-.07	-.18*	.02	-.29**	-.26**	-.12	-.21*	-.13	.10	-.16†	.63**	.64**	--		
21. %EWL >50	.25**	.10	.22*	.33**	.16†	-.27**	.01	-.03	.10	.22*	-.33**	.16†	.27**	.01	-.03	.06	-.16†	.65**	.69**	.83**	--	

Note. * $p < .05$, ** $p < .01$, † $p \leq .01$

4.5.1.1 Demographics

Black women had a higher preoperative BMI, lower rate of preoperative BED diagnoses, lower %EBMIL, lower %EWL, and lower likelihood of surgical success (%EBMIL and %EWL). Participants of other races and ethnicities (i.e., Hispanic, American Indian, other) reported lower distress about loss of control of eating and reported higher levels of physical activity.

Higher level of educational attainment was significantly associated with selection of the online survey format, lower rate of preoperative BED diagnoses, increased weekend sitting, higher rate of preoperative BED, greater %EBMIL, greater %EWL, successful %EBMIL, and successful %EWL.

4.5.1.2 Preoperative covariates

Preoperative BED diagnosis was significantly associated with higher preoperative BDI, and higher postoperative somatic symptoms on the BDI. Preoperative BED diagnosis approached significance with higher night eating symptoms and higher BDI cognitive-affective symptoms.

As would be expected, preoperative BDI was associated positively with postoperative cognitive-affective and somatic symptoms of depression. Preoperative BDI was associated with higher levels distress related to loss of control of overeating. Higher preoperative BMI was significantly associated with higher distress over loss of control of eating, higher BDI somatic symptoms, increased weekend sitting, greater

%EBMIL, greater %EWL, successful %EBMIL, and successful %EWL. Lastly, survey format (1= online version) was significantly associated with higher education levels, lower preoperative BMI and greater weight loss using both %EBMIL, and %EWL calculations.

4.5.1.3 Postoperative predictors

Overeating (yes=1, no=0) was positively associated with grazing and was associated with higher distress about overeating, higher distress about loss of control of eating, higher night eating symptoms, and higher BDI cognitive-affective symptoms.

Grazing (yes=1, no=0) was positively associated with overeating and was associated with higher night eating symptoms, higher BDI cognitive-affective symptoms, lower %EBMIL, lower %EWL, and less surgical success (%EBMIL<50).

Higher distress about loss of control of eating was significantly associated with higher night eating symptoms, lower %EBMIL, lower %EWL, less surgical success (%EBMIL and %EWL < 50). Higher distress about overeating was associated with lower %EBMIL, lower %EWL and less surgical success (%EBMIL and %EWL <50). Higher night eating symptoms were significantly associated with lower %EBMIL. Level of physical activity was not associated with other measures; however, increased weekend sitting was associated with lower %EBMIL, and lower %EWL.

4.5.1.4 Weight outcomes

All four of the weight outcomes--%EBMIL, %EWL, successful %EBMIL, and successful %EWL—were positively associated with one another, with correlations ranging from $r=.63$ to $r=.98$.

4.6 Overview of Regression Analyses

The next set of analyses was conducted in order to test the primary hypothesis that post-operative psychological and behavioral factors would predict weight loss and surgical success. Specifically, regressions were conducted to examine post-operative depression, physical activity, and eating behaviors as predictors of weight loss and surgical success, above and beyond demographics and preoperative depression and BED diagnostic status. Weight loss was defined both continuously, with a measure of %EBMIL or %EWL, and categorically, with surgical success defined as losing 50% or more of excess BMI or weight post-surgery. A series of hierarchical multiple regression analyses predicted to continuous weight loss outcomes, and a series of hierarchical logistical regressions predicted to categorical surgical success.

All regression analyses were first run separately for each of three postoperative domains: depression, physical activity and eating behaviors. In each regression analysis, the following covariates were entered in the first step: race, survey format, education, age, preoperative BMI, preoperative depression, and preoperative BED diagnostic status. Race was grouped into three categories and was dummy coded such that black

and other racial/ethnic groups were compared the white participants, who served as the reference group in analyses. Survey format was coded as mail= 0 and online= 1.

Education was entered as an ordinal variable.

Measures within each of the three postoperative domains were then entered simultaneously in the second step of the regression. Across analyses, depression consisted of the two-factor BDI: 1) cognitive-affective symptoms and 2) somatic symptoms. Across analyses, the physical activity domain consisted of two indices: 1) physical activity level (low, moderate, high) and 2) time spent sitting on the weekend (minutes). Across analyses, eating behaviors consisted of 1) overeating (yes= endorsed overeating with or without loss of control, no= no overeating); 2) grazing (yes= endorsed grazing with or without loss of control; no= no grazing); 3) distress about overeating (Likert 1-5); distress about loss of control (Likert 1-5); and night eating symptoms (NEQ total). In total, there were 9 predictors across all three domains of postoperative adjustment.

Following the domain-specific regression analyses, covariates and predictors that reached ($p < .05$) or approached significance ($p < 0.1$) across domains were entered into a full model to examine their relative contributions. Discussion of the results of linear hierarchical regressions is followed by results of logistic regressions.

4.6.1 Hierarchical linear regressions

Three separate regression analyses were conducted to examine post-operative depression, post-operative physical activity, and eating behaviors as predictors of %EBMIL. Analyses were repeated to examine the prediction to %EWL. Given that the pattern of findings was nearly identical both cases, discussion of findings in the text will be limited to %EBMIL; however, Table 6 presents findings for %EWL for comparison, as is recommended in the field.

4.6.1.1 Covariates

Given that all analyses included the same covariates, the results are summarized once in Table 5. Overall, the covariates explained 43.3% of the variance in %EBMIL. Age, race, and preoperative BMI were significant predictors of %EBMIL. Specifically, older participants, those with a higher preoperative BMI, and black participants lost less excess BMI than younger participants, those with a lower preoperative BMI, and white participants, respectively.

4.6.1.2 Depression

The overall model predicting %EBMIL from postoperative depression was statistically significant [$F(10, 119) = 9.95, p < .001$] and accounted for 45.5% of the variance in %EBMIL. The two-factors of the BDI were entered at Step 2 and approached significance in overall prediction of %EBMIL ($F\Delta = 2.43, p = .098$), adding an additional 2.2% of the variance to the 43.3% accounted for by covariates. An examination of the

individual coefficients revealed only cognitive-affective symptoms approached significance as a predictor of %EBMIL ($B = -1.30, t = -1.98, p = .049$), such that higher cognitive-affective symptoms were associated with poorer %EBMIL. Somatic symptoms did not significantly predict %EBMIL.

4.6.1.3 Eating behaviors

The overall model predicting %EBMIL from postoperative eating behaviors was statistically significant ($F(13, 116) = 9.61, p < .001$) and accounted for 51.9% of the variance in %EBMIL. Eating behaviors variables were entered at Step 2 and reached significance in the overall prediction of %EBMIL ($F\Delta = 4.12, p < .001$) adding an additional 8.5% of the variance to the 43.3% accounted for by covariates. An examination of the individual coefficients revealed that distress over loss of control independently predicted %EBMIL, such that higher distress was associated with poorer %EBMIL ($B = -6.75, t = -2.86, p < .01$). Night eating symptoms approached significance in the prediction of %EBMIL, such that higher night eating symptoms were associated with poorer %EBMIL ($B = -.66, t = -1.86, p = .063$). Grazing (with and without loss of control), overeating (with or without loss and control), and distress about overeating did not significantly predict %EBMIL.

4.6.1.4 Physical activity

The overall model predicting %EBMIL from postoperative physical activity was statistically significant ($F(10, 119) = 10.19, p < .001$) and accounted for 46.2% of the

variance in %EBMIL. The physical activity variables were entered at Step 2 and approached significance in the overall prediction of % EBMIL ($F\Delta = 3.12, p = .049$) adding an additional 2.8% of the variance to the 43.3% accounted for by covariates. An examination of the individual coefficients revealed that both physical activity variables independently predicted %EBMIL. Higher level of physical activity was associated with greater %EBMIL ($B = 4.88, t = 1.89, p < .05$), and increased time spent sitting on weekends was associated with poorer %EBMIL ($B = -.013, t = -1.23, p < .05$).

4.6.1.5 Full linear model

The full linear model included covariates and individual predictors that reached or approached significance in the domain-specific models. Covariates entered in step 1 were race, age, preoperative BMI, and survey format. Individual predictors entered at step 2 consisted of cognitive-affective symptoms of depression; level of physical activity; time spent sitting on weekends; night eating symptoms; and distress over loss of control of eating.

The overall model was statistically significant ($F(5, 124) = 18.31, p < .0001$) and accounted for 46.5% of the variance in %EBMIL. All covariates entered at Step 1 reached or approached significance (see Table 5). Predictor variables entered in Step 2 reached significance in the overall prediction of % EBMIL ($F\Delta = 3.96, p = .003$) adding an additional 8.2% of the variance to the 42.4% accounted for by covariates. Two predictors entered at Step 2 reached or approached statistical significance in the prediction of

%EBMIL. Higher distress was associated with poorer %EBMIL ($B = -5.02, t = -3.00, p = .003$). Higher level of physical activity approached significance in the prediction of %EBMIL, such that high level of physical activity was associated with greater %EBMIL ($B = 4.81, t = 1.95, p = .051$). Cognitive-affective symptoms of depression, time spent sitting on weekends, and night eating symptoms were non-significant.

Table 5. Full Hierarchical Regression Model Predicting %EBMIL from Postoperative Depression, Physical Activity, and Eating Behaviors

	Adjusted R ²	R ² Δ	F Δ	F Δ p value	B	SE	t	t p value
Step 1	0.40	0.43	18.31	p<.0001				
Race								
<i>Black vs. White</i>					-13.62	3.46	-3.93	p=.000
<i>Other vs. White</i>					-3.62	8.12	-0.45	p=.655
Age					-0.37	0.15	-2.42	p=.015
Preoperative BMI					-1.51	0.22	-6.91	p=.000
Survey format								
<i>Mail vs. Online</i>					5.95	3.50	1.70	p=.089
Step 2	0.47	0.08	3.96	p<.01				
Cognitive-Affective					0.60	0.63	0.96	p=0.34
Physical Activity					4.81	2.46	1.95	p=0.051
Sedentary Behavior					-0.10	0.01	-0.95	p=0.344
Distress-Loss of Control					-5.02	1.67	-3.00	p=.003
Night Eating					-0.46	0.36	-1.25	p=.210

Table 6. Full Hierarchical Regression Model Predicting %EWL from Postoperative Depression, Physical Activity, and Eating Behaviors

	Adjusted R²	R² Δ	F Δ	F Δ p value	B	SE	t	t p value
Step 1	0.36	0.39	15.75	p=.000				
Race								
<i>Black vs. White</i>					-11.15	2.78	-4.02	p=.000
<i>Other vs. White</i>					-4.10	6.51	-0.63	p=.529
Age					-0.27	0.12	-2.25	p=.025
Preoperative BMI					-1.07	0.18	-6.12	p=.000
Survey format								
<i>Mail vs. Online</i>					4.72	2.80	1.69	p=.092
Step 2	0.44	0.09	4.22	p=.002				
Cognitive-Affective					0.59	0.50	1.17	p=.243
Physical Activity					3.78	1.97	1.92	p=.055
Sedentary Behavior					-0.01	0.01	-1.22	p=.225
Distress-Loss of Control					-4.21	1.35	-3.12	p=.002
Night Eating					-0.35	0.29	-1.19	p=.223

4.6.2 Logistic regressions

Three separate logistic regression analyses were conducted to examine post-operative depression, post-operative physical activity, and disordered eating as predictors of successful weight loss, defined as greater than 50% EBMIL. Analyses were repeated to examine the prediction to EWL. As in the case of the linear regressions, that the pattern of findings was similar in both cases, so discussion of findings will be limited to EBMIL; Table 8 includes EWL, per reporting standards.

The set of covariates used in domain-specific linear regression was entered into Block 1 of each logistic regression. Race and ethnicity were collapsed into two groups and dummy coded, such that black = 1 and other = 0. Several covariates were found to predict the likelihood of successful EBMIL. Higher age and higher preoperative BMI were associated with a lower probability of successful weight loss. Race approached significance, such that identifying as black or African-American was associated with lower probability of successful weight loss compared with other ethnic and racial groups (collapsed into one). Results for covariates are summarized in Table 7.

Domain specific findings are discussed below.

4.6.2.1 Depression

In order to assess the prediction of depression to successful weight loss, cognitive-affective symptoms and somatic symptoms were entered into Block 2 (See Table 7). The addition of postoperative depression variables was statistically significant

($\chi^2=9.82$, $df = 2$, $p < .001$), indicating that the combined effect of these variables contributes to the prediction of successful EBMIL. Examination of individual coefficients revealed that lower cognitive-affective symptoms were associated with a higher probability of successful %EBMIL (Wald= 6.21, $B= -.434$, $p < .05$). In contrast, higher somatic symptoms of depression were associated with a higher probability of successful EBMIL ($B = .460$, Wald = 4.42, $p < .05$). Results from this regression are summarized in Table 7, because the two depression subscales were the significant predictors out of the 9 postoperative IVs, the remainder of which are discussed below, to reach significance. Therefore, a full logistic model was not conducted

4.6.2.2 Eating behaviors

In order to examine the prediction of postoperative eating behaviors to successful EBMIL, overeating (with and without loss of control), grazing (with and without loss of control), distress about overeating, distress about loss of control, and night eating symptoms were entered into Block 2. The addition of eating behaviors variables approached significance, indicating that the combined effect of these variables contributes to the estimation of successful EBMIL ($\chi^2 = 10.33$, $df = 5$, $p = .069$).

Examination of individual coefficients indicated that all were non-significant.

4.6.2.3 Physical activity

In order to examine the prediction of postoperative physical activity to successful %EBMIL, level of physical activity and time spent sitting were entered into Block 2. The

addition of physical activity variables was non-significant, indicating that the combination of these variables did not contribute to the estimation of successful EBMIL ($\chi^2= 0.52, df= 1, p = .784$).

Table 7. Logistic Regression Predicting Successful EBMI from Depression

	Model χ^2	χ^2 df	χ^2 p value	B	SE	Wald	Wald p value	OR
Step 1	40.59	7	p<.0001					
Race				-1.53	0.77	3.99	p=.05	0.24
Education Level				0.20	0.25	0.94	p=.42	1.25
Age				-0.19	0.05	13.79	p<.0001	0.86
Preoperative BMI				-0.14	0.06	6.57	p=.01	0.91
Preoperative BDI				0.04	0.05	0.57	p=.421	1.05
Preoperative BED Diagnosis				-0.56	0.92	0.36	p=.482	0.90
Survey Format				0.53	0.77	0.56	p=.493	2.79
Step 2	9.82	2	p=.008					
Cognitive-Affective				-0.43	0.18	6.21	p=.02	0.77
Somatic				0.46	0.22	4.42	p=.034	1.35

Table 8. Logistic Regression Predicting Successful EWL from Depression

	Model χ^2	χ^2 df	χ^2 p value	B	SE	Wald	Wald p value	OR
Step 1	39.26	7	p<.0001					
Race				-1.45	0.67	4.68	p=.031	0.24
Education Level				0.22	0.23	1.42	p=.333	1.25
Age				-0.15	0.04	13.63	p<.0001	0.86
Preoperative BMI				-0.10	0.05	5.13	p=.027	0.91
Preoperative BDI				-0.05	0.05	0.94	p=.341	1.05
Preoperative BED Diagnosis				-0.10	0.84	0.02	p=.898	0.90
Survey Format				1.03	0.71	2.09	p=.151	2.79
Step 2	6.00	2	p=.053					
Cognitive-Affective				-0.27	0.13	4.52	p=.042	0.77
Somatic				0.30	0.16	3.61	p=.064	1.35

4.7 Mediation Analyses

The next set of analyses was conducted to examine the hypothesized role of physical activity as a mediator of the relationship between postoperative depression and weight loss. Mediation analyses were conducted in SPSS using the macro INDIRECT, which employs the bootstrapping method described by Preacher and Hayes (2008). Bootstrapping is recommended over the Barron and Kinney method (Hayes, 2009) for a number of reasons, including increased power, reduction of type I error, and the ability to detect significant indirect effects without a requisite significant association between the IV and DV (i.e., X and Y) (Rucker, Preacher, Tormala, & Petty, 2011). Please see Figure 1 for a graphic representation of the model.

In the current analysis (see Figure 2 and Table 9), preoperative BMI and race were entered as covariates due to their bivariate association with %EBMIL; the BDI somatic factor was entered as the independent variable (X); level of physical activity and sedentary behavior (total time spent sitting on the weekend) were entered as proposed mediators; and %EBMIL was entered as the dependent variable (Y).

Results showed a significant partial effect of the control variables, race (-14.93, SE= 3.44, $p < .001$) and preoperative BMI (-1.58, SE= .221, $p < .001$), on %EBMIL. The mediation analysis revealed that the total effect of somatic symptoms of depression on %EBMIL was non-significant, with an estimate of .0827 (SE = .57, $p = .16$). However, there was a significant direct effect of somatic symptoms of depression on %EBMIL when the

physical activity variables were included, with an estimate of 1.308 (SE= .58, $p < .05$). The specific indirect effects of the proposed mediators clarify this finding. Level of physical activity was non-significant. The indirect effect of time spent sitting, with an estimate of -0.33 and a BCaCI of -1.31 to -.01 was significant and opposite in sign to the direct effect of somatic symptoms on %EBMIL. This suggests a suppression effect (MacKinnon et al., 2000; Rucker, Preacher, Tormala, & Petty, 2011), such that that sedentary behavior obscured the total effect of somatic symptoms on %EBMIL. Therefore, increased somatic symptoms of depression may be associated with greater %EBMIL unless those symptoms are associated with higher sedentary behavior. This finding should be interpreted with caution, given the wide confidence interval for the indirect effect of sedentary behavior.

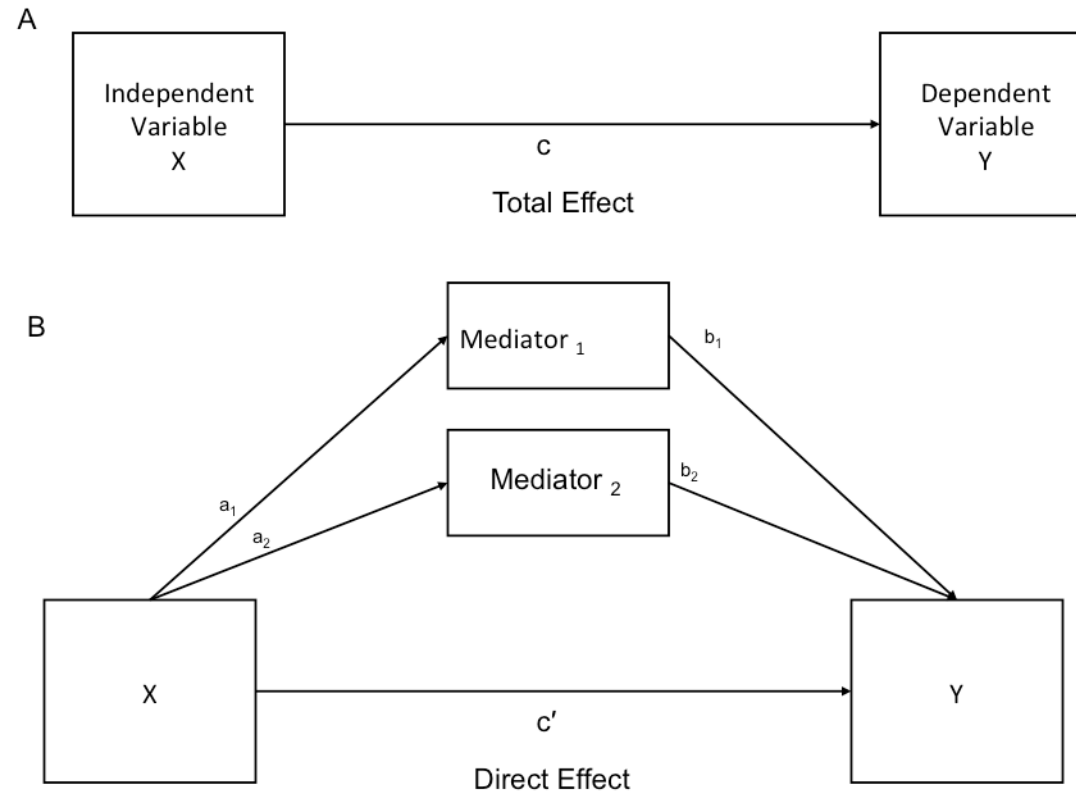


Figure 1. Indirect Effects Mediation Model. Adapted from Preacher and Hayes (2008).

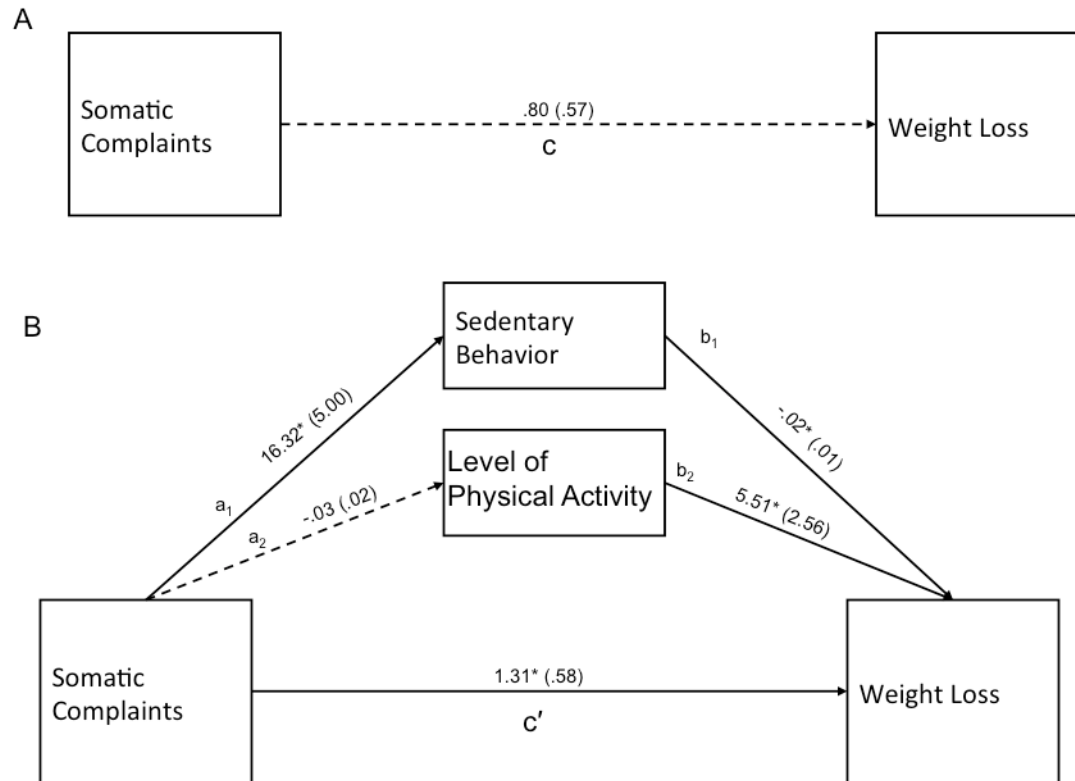


Figure 2. Indirect Effects of Somatic Symptoms of Depression on %EBMIL.

Table 9. Indirect Effects of Somatic Symptoms of Depression on %EBMIL through Physical Activity and Sedentary Behavior

	Coefficient	Bootstrapping		95% Confidence Interval	
		Bootstrap	SE	Lower	Upper
Level of physical activity	- 0.16	- 0.17	0.14	- 0.60	0.00
Weekend time spent sitting	- 0.34	- 0.33	0.27	- 1.31	- 0.01
Total effect	-0.51	- 0.50	0.29	- 1.39	- .08

5. Discussion

The following subsections examine the findings of the study in a variety of contexts. The sample itself is considered in terms of its representativeness of other bariatric surgery populations. The predictors are examined in terms of time (pre and post), as well as domain (depression, eating behaviors, and physical activity). The study is evaluated in terms of strengths and contributions, as well as limitations. Finally, future directions are presented in terms of phenotypes, assessment, and outcomes.

5.1 Characterization of the Sample: Findings and Relations to the Literature

Demographic characteristics of the current sample were generally consistent with previous studies. Baseline BMI [48(7.74)], (Mitchell, King, Courcoulas, et al., 2014; Kalarchian et al., 2007; Rosenberger et al., 2010), age [46(11)] (Kalarchian et al., 2007; Mitchell et al., 2012; Rosenberger et al., 2006) and level of education (Kalarchian et al., 2007; Mitchell, King, Courcoulas, et al., 2014; Rosenberger et al., 2006) were comparable to other bariatric surgery samples.

A notable exception to this pattern of similarity, and a strength of the present study, was the greater proportion of Black patients (38%) compared with national bariatric samples. Two large-scale studies illustrate this point. In the multi-center Longitudinal Assessment of Bariatric Surgery (LABS-1) study, only 10% of patients were black (LABS Writing Group, 2008). A recent large-scale study (Sudan, Winegar, Thomas,

& Morton, 2014) reported a racial and ethnic composition of 79% White, 12% Black, and 9% Hispanic in a sample of 108,333 RYBG patients in the database of the American Society of Bariatric and Metabolic Surgery (ASMBS) Bariatric Surgery Center of Excellence (BSCOE) program, which consisted of data from 1029 surgeons and 709 hospitals across the country. The proportion of black participants in the current study was representative of census data on the racial composition of the city (41%) and surrounding area (29%) during the period of enrollment.

In terms of baseline psychological status, 54% percent of participants reported minimal preoperative depressive symptomology, and 46% reported at least mild depressive symptomology. This falls within the range of prevalence estimates in studies that used the BDI, some of which were higher (e.g., Dixon, Dixon, & O'Brien, 2003; Hayden, Dixon, Dixon, & O'Brien, 2011) or lower (Belle et al., 2013) compared with the current sample. Similarly, the 17% prevalence rate of baseline BED fell within the mid-range of estimates (e.g., 4-27%) reported by studies that used structured or semi-structured interviews (Allison, Wadden, Fabricatore, Crerand, Gibbons, et al., 2006; Marek, Ben-Porath, Ashton, & Heinberg, 2014).

In terms of postoperative psychological adjustment, there was a significant decrease in the prevalence of clinically significant depressive symptoms (total BDI score > 10), consistent with previous research (Mitchell, King, Chen, et al., 2014). However the prevalence of postoperative depressive symptoms was quite low, with

approximately 96% of participants reporting minimal or no depressive symptoms at follow-up. This suggests an exceptionally healthy sample in comparison with other studies. A prospective study (de Zwaan, 2011) that used structured interviews, which typically produce more conservative estimates, found a point prevalence of 16.5% and 14.3% at 6-12 months and 24-36 months post-surgery, respectively. The apparent well-being of the present sample could be a function of self-selection, such that patients who were less depressed may have been more likely to participate in the study than those with more depressive symptomology.

Similar to the course of depressive symptoms, postoperative binge eating decreased dramatically after surgery. Indeed, only 1 of 22 patients with preoperative BED still screened positive for *DSM-IV-TR* BED after surgery. This finding is unsurprising, given the mechanical restrictions that preclude objective binge eating episodes. Using modified BED criteria that specified binge eating in the context of bariatric surgery, 4% of participants (n=5) screened positive for BED. These findings are consistent with previous research. For instance, two years after surgery, no patients met full criteria for *DSM-IV-TR* BED, and approximately 3% met the modified criteria for BED (de Zwaan et al., 2010).

Regarding postoperative binge eating, only 8.5% of the sample (n=11) reported overeating with loss of control (i.e., subjective binge episodes in the context of bariatric surgery). In contrast, prior research found that 25% of postoperative patients reported subjective binge episodes, and among these patients, half reported at least one subjective binge episode per

week in the past 6 months (de Zwaan et al., 2010). Other evidence suggests even higher rates of subjective binge eating, with point prevalence rates of 36% and 39% at 12 and 24 months post-surgery, respectively (White et al., 2010). In the present study, however, it appears that grazing captured the pattern of overeating behavior that was most salient for participants.

Grazing was the most prevalent eating behavior after surgery. Thirty-eight percent of participants (n=49) reported “eating smaller amounts of food continuously over an extended period of time, eating more than you think is best for you.” This is comparable with previous findings postoperative LAGB patients, 38% of whom reported grazing at 12-months post-surgery (Colles, Dixon, & O’Brien, 2008a).

5.2 Prediction of Weight Loss and Surgical Success

The goals of the current study were to examine psychological and behavioral predictors of weight loss and surgical success in a sample of female RYGB patients who were approximately 16 months post-surgery. Findings offered partial support for the primary hypothesis that concurrent postoperative depressive symptoms, eating behavior, and physical activity would predict weight loss above and beyond preoperative psychological and demographic factors. The following subsections examine the preoperative and postoperative domains of functioning in relation to study hypotheses.

5.2.1 Demographics and baseline BMI in the prediction of weight outcomes

Age, race, and baseline BMI were associated with weight outcomes and accounted for a significant proportion of the variance in all models. Older age predicted poorer %EBMIL and a lower likelihood of attaining successful %EBMIL, consistent with recent findings (Contreras, Santander, Court, & Bravo, 2013; Still et al., 2014). Black participants had less %EBMIL than White participants and were less likely to attain successful %EBMIL, compared with the rest of the sample. Previous research has produced mixed findings in this area, but a recent large-scale study found that Black patients lose a large amount of weight, but, controlling for baseline characteristics, it tends to be lower in comparison to White patients (Sudan et al., 2014).

5.2.2 Preoperative depression and BED in the prediction of weight outcomes

Preoperative depressive symptoms and BED diagnosis were not associated with weight outcomes in the multivariate models, consistent with hypotheses. This finding might be viewed in the context of recent research that suggests a delayed effect of preoperative depression and eating behavior on weight outcomes (Legenbaur, Petrak, de Zwaan, & Herpertz, 2011). The short-term follow-up period in the present study would not have captured these longer-term effects.

5.2.3 Postoperative psychological and behavioral factors in the prediction of weight outcomes

5.2.3.1 Depression

Higher cognitive-affective symptoms of depression predicted poorer %EBMIL after controlling for demographics and preoperative covariates. Somatic symptoms of depression did not predict %EBMIL. These findings, in isolation, might suggest that negative affect and negative/self-critical cognitions, but not somatic complaints, drive the relationship between depression and poorer %EBMIL. Mediation analyses, to be discussed in a later subsection, tell a different story. In terms of surgical success, cognitive-affective symptoms predicted a lower likelihood of achieving greater than 50% EBMIL, while somatic symptoms predicted a greater likelihood of achieving greater than 50% EBMIL.

5.2.3.2 Eating behaviors

In terms of eating behaviors, findings were mixed. Overeating and grazing were not significant predictors of %EBMIL. Night eating approached significance, with increased symptoms associated with poorer %EBMIL. Higher distress about loss of control of eating was significantly associated with poorer EBMIL, whereas distress about overeating was not associated with %EBMIL. Distress about loss of control of eating has been associated with poorer weight outcome in previous research (Colles, Dixon, & O'Brien, 2008c). However, it is interesting that distress about loss of control of eating drove the association between eating behaviors and %EBMIL. In contrast with previous

research (Colles, Dixon, & O'Brien, 2008a), simply engaging in grazing was not associated with weight outcome. Overeating, or even experiencing distress about overeating, was not associated with %EBMIL. It may be that distress about loss of control is a more reliable and specific indicator of overeating than the overt self-reported behaviors. Support for this interpretation comes from evidence that non-bariatric obese individuals with BED may use psychological distress and loss of control, rather than quantity, as the primary criteria in defining binge episodes (Telch & Agras, 1996; Telch, Pratt, & Niego, 1998).

5.2.3.3 Physical activity

Level of physical activity and weekend sitting were associated with %EBMIL after controlling for demographics and preoperative covariates. Consistent with hypotheses and previous research (e.g., Bond et al., 2008; Evans et al., 2007; Rosenberger et al., 2010; for a review, see Livhits et al., 2010), higher level of physical activity was associated with greater %EBMIL, and increased weekend sitting was associated with poorer %EBMIL. However, level of activity, but not weekend sitting, predicted %EBMIL after controlling for the effects of the eating behavior and depression.

5.2.3.4 Summary of postoperative domains

When the significant predictors from all three postoperative domains—depression, eating behavior, and physical activity—were entered simultaneously into the linear regression model, only two predictors remained significant. Higher distress

about loss of control of eating was associated with poorer %EBMIL, and higher level of physical activity was associated with greater %EBMIL.

Taken together, these findings do not fully support the primary hypothesis that all three postoperative domains would be associated with %EBMIL. It appears that distress about loss of control, rather than the behavioral aspects of eating behavior, is a robust predictor of %EBMIL. It remains significant in the full model, contributing to the variance in %EBMIL after controlling for demographic factors and preoperative covariates. Level of physical activity also contributed unique variance to the full model, but the effect of weekend sitting was washed out in the presence of the other predictors. The association between cognitive-affective symptoms of depression also dropped out of the full model.

5.3 Relationship between Depression and Physical Activity

Mediation analyses revealed a more nuanced, albeit unexpected, picture of the association between depression and %EBMIL. In contrast with the hypothesis that physical activity would mediate the relationship between depression and %EBMIL, the findings revealed a suppression effect. Specifically, somatic symptoms of depression were associated with %EBMIL through the indirect effects of level of physical activity and weekend sitting. The direct effect was not in the predicted direction, as increased somatic symptoms of depression were associated with greater %EBMIL. However, the indirect effect indicated that somatic symptoms were associated with poorer %EBMIL in

the context of increased weekend sitting. Again, we emphasize that these results should be interpreted with caution due to the wide confidence interval. Future research might tease apart these somatic complaints to identify possible subgroups of the population that might account for the indirect effect.

One plausible speculative explanation of these findings is that there may be different subgroups of patients who endorse somatic symptoms. For instance, previous research in bariatric surgery candidates indicated that those with chronic pain, compared to those without chronic pain, scored higher on both BDI factors, and they were more likely to endorse the following somatic items: motivation to work, changes in sleep, tiredness, and worry about health (Krukowski, Friedman, & Applegate, 2008). Perhaps the association between somatic symptoms and increased sitting is explained by chronic pain or other medical conditions, whereby increased pain leads to more sitting and less %EBMIL. This is consistent with previous findings that less preoperative pain predicts more physical activity after surgery (King et al., 2012). In contrast, those whose somatic complaints are related to a primary medical condition such as GERD might attain greater %EBMIL through another mechanism, e.g., dieting.

5.4 Strengths and Contributions of the Present Study

Among the strengths of the present study is the proportion of black participants compared with most bariatric research samples. Prevalence rates may vary among studies with different ethnic/racial compositions. For instance, consistent with our

findings, white female bariatric surgery patients reported more binge eating symptomology than black women (Azarbad et al., 2010). Therefore, the current findings may be more generalizable to black women than findings of studies with a small number of black participants. Another strength of the study is the inclusion of measures of maladaptive eating behaviors appropriate for the bariatric surgery population.

The present study represents a novel contribution to the literature in several ways. To our knowledge, the independent associations of the 2-factor BDI with weight outcomes have not been examined in postoperative patients. Also unique is the suppression effect in which somatic symptoms were associated with %EBMIL via the indirect effect of weekend sitting. Regarding eating behavior, this study highlighted the role of distress about loss of control of eating as a predictor of poorer %EBMIL, whereas previous research has focused on the association between the behavioral aspects of eating and weight outcomes.

5.5 Limitations

The following section addresses limitations of the study and implications for generalizability.

5.5.1 Sample biases

The present sample may have been biased in several ways. As is common in the literature, preoperative data were gathered as part of the evaluative process. Bariatric surgery candidates may be reluctant to disclose the full extent of their eating behaviors

for fear of being disqualified for surgery or losing insurance coverage (de Zwaan et al., 2003; Latner et al., 2004). Prospective research that is conducted independently of the surgical evaluation process could address this particular source of bias (e.g., Kalarchian et al., 2007; Mulhans, Horbach, & de Zwaan, 2009). Further support for the use of research-based assessments comes from preliminary evidence suggesting poor concordance in current diagnoses between research assessments compared with routine clinical evaluations in bariatric surgery candidates (Mitchell et al., 2010).

The postoperative patients who chose to participate in the study may have differed in meaningful ways from those who declined or did not respond to the invitation. For instance, it is plausible that respondents were less depressed than non-respondents, given the sample's remarkably low rate of postoperative depressive symptoms.

5.5.2 Self-report measures

5.5.2.1 Self-reported weight

As previously mentioned, the present study used self-reported postoperative weight. Although self-reported weight has been shown to be reasonably accurate in postoperative bariatric surgery patients (Christian et al., 2011), research suggests that accuracy varies between black women and white women, in part due to differences in weight cycling history (White et al., 2007). White and colleagues found that black women were more likely to underreport their weight and have fewer lifetime episodes

of weight cycling than their white counterparts. In-person anthropometric data collection would address the effects of such individual differences and allow for standardization of various factors known to impact the measurement of weight, such as type of clothing and time of day. Objective measurement would also allow for the collection of other anthropometric data, such as waist circumference. Therefore, objective measures are preferable to self-reported weight and should be used when possible.

5.5.2.2 Self-report questionnaires

The present study used self-report questionnaires to assess the domains of interest, aside from preoperative binge eating disorder, which was assessed with a semi-structured clinical interview. As previously discussed, self-report measures have produced higher prevalence estimates than investigator-based interviews in the bariatric surgery literature (e.g., Kalarchian, Wilson, Brolin, & Bradley, 2000).

In terms of eating behavior, structured diagnostic interviews are preferable to self-report measures of binge eating and night eating (Parker, O'Brien, & Brennan, 2014). However, there were no measures of grazing, self-report or interview, which had been psychometrically evaluated in bariatric surgery patients at the time of data collection. There are a few other survey options for grazing at present, although there remains much work to be done in this area (please see section 5.6.3).

In terms of the depression, a structured diagnostic interview would be preferable to the self-report measure for diagnostic purposes. However, the BDI-I was suitable for the present study, given our interest in symptomology as opposed to dichotomous diagnoses.

In terms of physical activity, overreporting is inherent in self-report measures. Objective measures of physical activity and sedentary behavior are more accurate than retrospective recall (see section 5.6.2). Therefore, the findings of the present study may overestimate the degree of physical activity in postoperative bariatric patients.

5.5.3 Concurrent assessment

The current study involved concurrent assessment of postoperative predictors and weight. Therefore, causality cannot be inferred from the findings. Future research with multiple postoperative time points would provide prospective data for the prediction of weight outcomes from depression, eating behaviors, and physical activity.

5.5.4 Length of postoperative follow-up

Research suggests that the trajectory of weight loss varies with time since surgery. In RYGB, the weight-loss nadir typically occurs between 12-18 months, and weight regain begins around 24 months (Courcoulas et al., 2013; Magro et al., 2007). The length of follow-up in the current study was less than 24 months, with an average of approximately 16 months. This window was well within the nadir period and prior to

the point at which weight regain is more common. A longer follow-up period would likely yield more variability in weight outcomes.

5.5.5 Generalizability

The current study included women and individuals between 21-69, so findings may not be generalizable to men, adolescents, or older patients. In terms of race and ethnicity, the sample consisted primarily of white and black participants, with few Hispanic/Latino or American Indian/ Pacific Islander participants, and no Asian participants, so findings may not be generalizable to these populations.

5.6 Directions for Future Research

The following subsections offer directions for future research on the psychological and behavioral aspects of bariatric surgery. This area of the literature has grown rapidly in the past decade, and there are many exciting facets on which to build.

5.6.1 Subtypes of depression

A promising avenue of future research is the role of atypical depression in the prediction of weight outcomes in bariatric surgery. In *DSM-IV-TR* and *DSM 5*, the terms “atypical” and “melancholic” are diagnostic specifiers used to characterize major depressive episodes (MDE). In this context, depression with atypical features, or atypical depression, requires the presence of MDE, mood reactivity, and two of four associated symptoms: leaden paralysis, interpersonal rejection sensitivity, hyperphagia or weight gain, and hypersomnia. Depression with melancholic features, or melancholic

depression, requires the presence of MDE, pervasive anhedonia or mood nonreactivity, and three of six associated symptoms: distinct quality of depressed mood, significant early morning awakening, excessive or inappropriate guilt, significant anorexia or weight loss, morning worsening of depressed mood, and marked psychomotor agitation or retardation.

The reverse vegetative symptoms (hyperphagia and hypersomnia) of atypical depression may be particularly relevant to weight changes. For instance, an epidemiologic study found that persons with vegetative symptoms of atypical depression were twice as likely to be obese compared with population controls and those with classic depression (Levitan, Davis, Kaplan, Arenovich, Phillips, Ravindran, 2011). The heterogeneity of appetitive characteristics of depression (Privitera, Misenheimer, & Doraiswamy, 2013) is a factor that may explain the inconsistent findings regarding the association between depression and weight outcomes in the bariatric literature. Bariatric surgery patients with atypical depression, particularly as compared to those with classic depression, may be at increased for weight regain or lower weight loss due to the reverse vegetative symptoms associated with this subtype.

5.6.2 Technology in the assessment of eating behaviors and physical activity

Self-report and interview-based methods rely on patients' recollection of various aspects of behaviors. Research in cognitive psychology indicates that retrospective recall is subject to random error and systematic biases (Bradburn, Rips, & Chevell, 1987;

Shiffman, Stone, & Hufford, 2008). Technological tools could increase the accuracy of assessment of eating and exercise behaviors among bariatric surgery patients (Thomas, Bond, Sarwer, & Wing, 2011), given the evidence that self-report measures underestimate caloric intake (Schoeller, 1995) and overestimate physical activity in obese persons (Jakicic, Polley, & Wing, 1998; Lichtman et al., 1992). Interestingly, snack foods may be particularly subject to underreporting among obese persons (Heitmann & Lissner, 1995), a finding with potential implications for grazing. In terms of physical activity, research in postoperative patients found a significant discrepancy between self-report and objective measures of physical activity (Bond, Jakicic, Unick, Roye, Ryder, Sax, & Wing, 2010).

5.6.2.1 Ecological Momentary Assessment

Ecological momentary assessment (EMA) addresses the limitations of retrospective recall by allowing “real-time” reporting of behaviors, emotions, and cognitions through repeated daily or hourly assessments (Shiffman, Stone, & Hufford, 2008; Stone & Shiffman, 1994). This could be a fruitful assessment strategy in bariatric surgery patients. For instance, EMA has been used in the assessment of binge eating in obese persons with BED (Wonderlich, Gordon, Mitchell, Crosby, & Engel, 2009). This methodology could be used to monitor subjective binge eating, grazing, and night eating in bariatric surgery patients. Along these lines, an observational study used EMA to

assess adherence to postoperative dietary and exercise prescriptions in bariatric surgery patients (Thomas, Bond, Ryder, Leahey, Vithiananthan, Roye, & Wing, 2011).

5.6.2.2 Accelerometry in the assessment physical activity

Objective monitoring of physical activity among bariatric surgery patients is a growing area of inquiry. Accelerometer-based methods allow for direct assessment of frequency, duration, and intensity of habitual physical activity (Plasqui & Westerterp, 2007) as well as sedentary behavior (Unick et al., 2012). One such monitor, the Intelligent Device of Energy Expenditure and Activity (IDEEA; Zhang, Pi-Sunyer, & Boozer, 2004; Zhang, Werner, Sun, Pi-Sunyer, & Boozer, 2003), has been validated for the assessment of physical activity and sedentary behavior in obese women with Class III obesity (Kwon, Jamal, Zamba, Stumbo, & Samuel, 2010). There is still a need for psychometric evaluation of other monitors that are being used in the bariatric surgery population (Unick et al., 2012; King et al., 2008).

5.6.3 Standardization of grazing

The literature lacks a standardized definition of grazing, variously defined as “the consumption of smaller amounts of food continuously over an extended period of time, more than the subject considers best for them” (Colles, Dixon, & O’Brien, 2008, p. 616), “uncontrolled, repetitive eating of small amounts of food” (Lane & Szabo, 2013, p. 57), “nibbling” with loss of control (Kofman, Lent, & Swencionis, 2010), or “permanent

eating” (Burgmer et al., 2005). Inconsistencies include the definition of repetitive eating and the use of loss of control as a criterion.

A recent study (Conceicao et al., 2014) attempted to address these inconsistencies by identifying the most frequently used criteria for grazing and surveying 24 experts in the field regarding which of these criteria should define grazing. The proposed standardized definition is “...an eating behavior characterized by the repetitive eating of small/modest amounts of food in an unplanned manner and/or not in response to hunger/satiety sensations.”¹ Repetitive eating was characterized in terms of frequency and time delineation, such that two or more episodes of eating must occur with a gap of less than 1 hour. This conceptualization of grazing also included two proposed subtypes of grazing, defined in terms of loss of control (compulsive subtype) or distracted eating (non-compulsive subtype).

There is a clear need for a validated measure of grazing in order to make accurate cross-study comparisons (Conceicao et al., 2014). Research is beginning to make strides in this direction. One group developed the Grazing Questionnaire (Lane & Szabo, 2013), but initial psychometric testing was conducted in college students. The measure will need to be validated in bariatric populations for it to have any utility in this area of research. A more promising measure is the Disordered Eating after Bariatric

¹ The accepted manuscript was available online in advance of publication; therefore, final page numbers were not available at the time of this writing.

Surgery (DEBS), a brief self-report questionnaire that was developed and validated in postoperative bariatric surgery patients and has shown acceptable psychometric properties (Weineland, Alfonsson, Dahl, & Ghaderi, 2012).

The development of empirically validated measures is an important direction for future research because it would also help to clarify whether grazing is a distinct clinical entity, particularly as compared with subjective binge eating. Qualitative evidence suggests that postoperative patients may perceive grazing as binge eating (Saunders, 2004). A recent study reported a significant degree of overlap between postoperative grazing and binge eating (> 1 objective or subjective binge episode per week for the past 6 months) (Colles, Dixon, & O'Brien, 2008), with 20.2% of the sample meeting criteria for both grazing and binge eating at 12 months post-LAGB. More than half of postoperative patients with grazing also reported binge eating, and 78.8% those with binge eating also reported grazing. Other qualitative research points to patients' varied interpretations of the term "grazing." Some postoperative bariatric surgery patients perceived grazing as a healthy behavior entailing eating small amounts throughout the day in a planned manner, whereas others may view it as unhealthy behavior involving eating continuously in an unplanned manner (Zunker, Karr, Saunders, & Mitchell, 2010). An understanding of patients' perceptions of the term is important for developing psychometrically sound measures.

5.6.4 Beyond the scale

The current study examined surgical success in terms of weight loss (<50% EBMI), in accordance with previous research. However, future studies should investigate other outcomes, such as changes in various indices of health status and quality of life. Although weight loss is an important aspect of bariatric surgery, it is not the only purpose or benefit (Neff et al., 2014).

5.7 Conclusions

Weight loss is of great interest to bariatric surgeons and patients alike. The high prevalence of psychiatric disorders among bariatric candidates has led to a proliferation of research on psychological and behavioral predictors of weight loss. Initial studies examined preoperative predictors of weight outcomes, with mixed findings. The current investigation focused on postoperative depression, eating behaviors, and physical activity as predictors of weight outcomes.

In terms of depression, higher postoperative cognitive-affective symptoms were associated with a lower likelihood of surgical success (<50% EBMI), consistent with predictions. Regarding eating behavior, findings suggested that distress about eating behavior might be a more important predictor of weight loss than endorsement of the behavior itself. Specifically, distress about loss of control of eating, but not distress about overeating, predicted poorer weight loss. Previous research has cited the subjective sense of losing control over one's eating as a more salient factor in

postoperative binge eating than the perception of having overeaten. It could be the case that distress is a proxy for higher actual caloric intake. This seems a reasonable speculation, given that self-report measures are not ideal for capturing eating behavior, not to mention the lack of a validated measure of binge eating or grazing.

Analyses also revealed a complex relationship between depression, sedentary behavior, and weight loss. Tentative findings suggested that somatic symptoms of depression might be associated with greater weight loss, unless there is associated sedentary behavior. This relationship might be clarified with a measure specific to the vegetative symptoms of depression.

The results of the current investigation provide directions for future research into postoperative behaviors and potential targets of intervention.

Appendix A

Survey Measures

Demographics

1. Date of birth

Month (mm) Day (dd) Year (yyyy)

2. Race/ethnicity

Please select all that apply.

- Hispanic or Latino
- American Indian/Alaska Native
- Asian
- Native Hawaiian or Other Pacific Islander
- Black or African American
- White

3. Have you given birth since you had your weight loss surgery?

- Yes
- No

4. How tall are you?

Feet Inches

Beck Depression Inventory (BDI-I)

This questionnaire consists of 21 groups of statements. After reading each group of statements carefully, fill in the circle next to the statement in each group which best describes the way you have been feeling **the past week including today**. If several statements within a group seem to apply equally well, fill in the circle next to each one. Be sure to read all the statements in each group before making your choice.

1. I do not feel sad
 I feel blue or sad
 I am blue or sad all the time and I can't snap out of it
 I am so sad or unhappy that it is very painful
 I am so sad or unhappy that I can't stand it

2. I am not particularly pessimistic or discouraged about the future
 I feel discouraged about the future
 I feel I have nothing to look forward to
 I feel that I won't ever get over my troubles
 I feel that the future is hopeless and that things cannot improve

3. I do not feel like a failure
 I feel I have failed more than the average person
 I feel I have accomplished very little that is worthwhile or that means anything
 As I look back on my life all I can see is a lot of failures
 I feel I am a complete failure as a person (parent, husband, wife)

4. I am not particularly dissatisfied
 I feel bored most of the time
 I don't enjoy things the way I used to
 I don't get satisfaction out of anything any more
 I am dissatisfied with everything

5. I don't feel particularly guilty
 I feel bad or unworthy a good part of the time
 I feel quite guilty
 I feel bad or unworthy practically all the time now
 I feel as though I am very bad or worthless

6. I don't feel I am being punished
 I have a feeling that something bad may happen to me

- o I feel I am being punished or will be punished
 - o I feel I deserve to be punished
 - o I want to be punished
- 7.
- o I don't feel disappointed in myself
 - o I am disappointed in myself
 - o I don't like myself
 - o I am disgusted with myself
 - o I hate myself
- 8.
- o I don't feel I am any worse than anybody else
 - o I am very critical of myself for weaknesses or mistakes
 - o I blame myself for everything that goes wrong
 - o I feel I have many bad faults
- 9.
- o I don't have any thoughts of harming myself
 - o I have thoughts of harming myself but I would not carry them out
 - o I feel I would be better off dead
 - o I have definite plans about committing suicide
 - o I feel my family would be better off if I were dead
 - o I would kill myself if I could
- 10.
- o I don't cry any more than usual
 - o I cry more now than I used to
 - o I cry all the time now. I can't stop it
 - o I used to be able to cry but now I can't cry at all even though I want to
- 11.
- o I am no more irritated now than I ever am
 - o I get annoyed or irritated more easily than I used to
 - o I feel irritated all the time
 - o I don't get irritated at all at the things that used to irritate me
- 12.
- o I have not lost interest in other people
 - o I am less interested in other people now than I used to be
 - o I have lost most of my interest in other people and have little feeling for them
 - o I have lost all my interest in other people and don't care about them at all
- 13.
- o I make decisions about as well as ever
 - o I am less sure of myself now and try to put off making decisions
 - o I can't make decisions any more without help
 - o I can't make any decisions at all any more

14.
 - I don't feel I look any worse than I used to
 - I am worried that I am looking old or unattractive
 - I feel that there are permanent changes in my appearance and they make me look unattractive
 - I feel that I am ugly or repulsive looking

15.
 - I can work about as well as before
 - It takes extra effort to get started at doing something
 - I don't work as well as I used to
 - I have to push myself very hard to do anything
 - I can't do any work at all

16.
 - I sleep as well as usual
 - I wake up more tired in the morning than I used to
 - I wake up 1-2 hours earlier than usual and find it hard to get back to sleep
 - I wake up early every day and can't get more than 5 hours sleep

17.
 - I don't get any more tired than usual
 - I get tired more easily than I used to
 - I get tired from doing anything
 - I get too tired to do anything

18.
 - My appetite is no worse than usual
 - My appetite is not as good as it used to be
 - My appetite is much worse now
 - I have no appetite at all any more

19.
 - I haven't lost much weight, if any, lately
 - I have lost more than 5 pounds
 - I have lost more than 10 pounds
 - I have lost more than 15 pounds

20.
 - I am no more concerned about my health than usual
 - I am concerned about aches and pains or upset stomach or constipation or other unpleasant feelings in my body
 - I am so concerned with how I feel or what I feel that it's hard to think of much else
 - I am completely absorbed in what I feel

21.
 - I have not noticed any recent change in my interest in sex
 - I am less interested in sex than I used to be
 - I am much less interested in sex now
 - I have lost interest in sex completely

International Physical Activity Questionnaire (IPAQ)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

Yes

No →

Skip to PART 2: TRANSPORTATION

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

_____ **days per week**

No vigorous job-related physical activity

→ ***Skip to question 4***

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____ **days per week**

No moderate job-related physical activity **➔ Skip to question 6**

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

_____ **days per week**

No job-related walking **➔ Skip to PART 2: TRANSPORTATION**

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____ **hours per day**
_____ **minutes per day**

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ **days per week**

No traveling in a motor vehicle



Skip to question 10

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____ **hours per day**

_____ **minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

No bicycling from place to place



Skip to question 12

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

_____ **hours per day**

_____ **minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

No walking from place to place



*Skip to PART 3:
HOUSEWORK, HOUSE
MAINTENANCE, AND
CARING FOR FAMILY*

13. How much time did you usually spend on one of those days **walking** from place to place?

_____ **hours per day**
_____ **minutes per day**

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

_____ **days per week**

No vigorous activity in garden or yard



Skip to question 16

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____ **days per week**

No moderate activity in garden or yard



Skip to question 18

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days per week**

No moderate activity inside home



***Skip to PART 4:
RECREATION, SPORT
AND LEISURE-TIME
PHYSICAL ACTIVITY***

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____ **hours per day**

_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

No walking in leisure time



Skip to question 22

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**

_____ **minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days per week**

No vigorous activity in leisure time → **Skip to question 24**

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____ **days per week**

No moderate activity in leisure time → **Skip to PART 5: TIME SPENT SITTING**

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**
_____ **minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**
_____ **minutes per day**

Questionnaire on Weight and Eating Patterns-Revised with Supplementary Modified Questions

- 1) During the **past 6 months**, did you often eat an unusually large amount of food within a 2-hour period (an amount that most people would agree is unusually large)?

Circle one: Yes No

- 1a) During the times when you ate an unusually large amount of food, did you often feel you could not stop eating or control what or how much you were eating?

Circle one: Yes No

- 2) During the **past 6 months**, did you often eat within any two-hour period what **you** regard as an unusually large amount of food for the circumstances (given that you have had gastric bypass/weight loss surgery)?

Circle one: Yes No

- 2a) During the times when you ate this way, did you often feel you couldn't stop eating or control what you were eating?

Circle one: Yes No

- 3) During the **past 6 months**, how often, on average, did you have times when you ate unusually large amounts of food and felt that your eating was out of control? (There may have been some weeks when it was not present—just average those in.)

- A. Less than one day a week
- B. One day a week
- C. Two or three days a week
- D. Four or five days a week
- E. Nearly every day

- 4) Did you *usually* have any of the following experiences during those occasions? Please complete each item.

- | | | |
|---|-----|----|
| A. Eating much more rapidly than usual? | Yes | No |
| B. Eating until you felt uncomfortably full? | Yes | No |
| C. Eating large amounts of food when you didn't feel physically hungry? | Yes | No |

- D. Eating alone because you were embarrassed by how much you were eating? Yes No
- E. Feeling disgusted with yourself, depressed, or feeling very guilty after overeating? Yes No
- F. Eating large amounts of food throughout the day with no planned mealtimes? Yes No

5) Think about a typical time when you ate this way (that is, large amounts of food **and** feeling that your eating was out of control). What time of day did the episode start?

- A. Morning (8 A.M. to 12 Noon)
- B. Early afternoon (12 Noon to 4 P.M.)
- C. Late afternoon (4 P.M. to 7 P.M.)
- D. Evening (7 P.M. to 10 P.M.)
- E. Night (After 10 P.M.)

6) Approximately how long did this episode of eating last, from the time you started to eat until when you stopped and did not eat again for *at least* 2 hours?
 ____ hours ____ minutes

7) As best you can remember, please list *everything* you might have *eaten* or *drunk* during that episode. If you ate for more than 2 hours, describe the food eaten and liquids drunk that you ate the most. Be specific—include amounts and brand names (when possible). Estimate as best you can estimate.

For example: 7 ounces Ruffles potato chips; 1 cup Breyer’s chocolate ice cream with 2 teaspoons of hot fudge; 2 8-ounce glasses of Coca-Cola; and 1 ½ ham and cheese sandwiches with mustard.

Food	Amount	Brand (if possible)

8) At the time this episode started, how long had it been since you had previously finished eating a meal or snack?

_____ hours _____ minutes

- 9) During the **past 6 months**, did you often eat smaller amounts of food continuously over an extended period of time, eating more than you think is best for you?

Circle one: Yes No

- 10) Is this a pattern of eating that you also followed before your surgery?

Circle one: Yes No

- 11) During the times when you ate this way (since your surgery), did you often feel you couldn't stop eating or control what you were eating?

Circle one: Yes No

- 12) During the **past 6 months** how often, on average, did you have times when you ate in this way--that is, eating smaller amounts of food continuously over an extended period of time, plus the feeling that your eating was out of control? (There may have been some weeks when it was not present-- just average those in.)

- A. Less than one day a week
- B. One day a week
- C. Two or three days a week
- D. Four or five days a week
- E. Nearly every day

- 13) Did you usually have any of the following experiences during these occasions? Please complete each item.

- | | | |
|---|-----|----|
| A. Eating much more rapidly than usual? | Yes | No |
| B. Eating until you felt uncomfortably full? | Yes | No |
| C. Eating food when you didn't feel physically hungry? | Yes | No |
| D. Eating alone because you were embarrassed by how much you were eating? | Yes | No |
| E. Feeling disgusted with yourself, depressed, or feeling very guilty after overeating? | Yes | No |

- 14) Think about a *typical time* when you ate this way--that is, eating smaller amounts of food continuously over an extended period of time--plus the feeling that your eating was out of control.
- a) What time of day did the episode start?
- A. Morning (8am to noon)
 - B. Early afternoon (noon to 4pm)
 - C. Late afternoon (4pm to 7pm)
 - D. Evening (7pm to 10pm)
 - E. Night (After 10pm)
- b) Approximately how long did the eating last, from the time you started to eat to when you stopped and didn't eat again for at least two hours?
- _____ hours
 _____ minutes
- c) Which statement best describes these eating behaviors?
- A. I have always eaten like this, including before my surgery
 - B. I have always eaten like this, but it is not so bad after surgery
 - C. I eat like this more often now that I have had surgery
 - D. I never ate like this before surgery. This pattern is new for me.
- d) Are there any situations where, or reasons why you are more likely to eat this way? You may circle more than one option.
- A. When I feel anxious
 - B. When I feel tired
 - C. When I feel bored
 - D. When I feel stressed
 - E. When I feel angry
 - F. When I feel depressed/upset
 - G. Out of habit
 - H. When socializing
- 15) In general, during the **past 6 months**, how upset were you by overeating (eating more than you think is best for you)?
- A. Not at all
 - B. Slightly
 - C. Moderately
 - D. Greatly
 - E. Extremely

16) In general, during **the past 6 months**, how upset were you by feeling that you could not stop eating or could not control what or how you were eating?

- A. Not at all
- B. Slightly
- C. Moderately
- D. Greatly
- E. Extremely

17) In general, during **the past 6 months**, how important has your weight or shape been in how you feel about or evaluate yourself as a person—compared to other aspects of your life (i.e. how you do at work, as a parent, or how you get along with other people)?

Weight and shape...

- A. were not very important.
- B. played a part in how I felt about myself.
- C. were among the main things that affected how I felt about myself.
- D. were the most important things that affected how I felt about myself.

18) During the past 3 months, did you ever make yourself vomit in order to avoid gaining weight after binge eating?

Circle one: Yes No

If yes: How often, on average, was that?

- A. Less than once a week
- B. Once a week
- C. Two or three times a week
- D. Four or five times a week
- E. More than five times a week
- F.

19) During the past 3 months, did you ever take more than twice the recommended dose of laxatives in order to avoid gaining weight after binge eating?

Circle one: Yes No

If yes: How often, on average, was that?

- A. Less than once a week
- B. Once a week

- C. Two or three times a week
- D. Four or five times a week
- E. More than five times a week

20) During the past 3 months, did you ever take more than twice the recommended dose of diuretics (water pills) in order to avoid gaining weight after binge eating?

Circle one: Yes No

If yes: How often, on average, was that?

- A. Less than once a week
- B. Once a week
- C. Two or three times a week
- D. Four or five times a week
- E. More than five times a week

21) During the past 3 months, did you ever fast (not eat anything at all for at least 24 hours) in order to avoid gaining weight after binge eating?

Circle one: Yes No

If yes: How often, on average, was that?

- A. Less than once a week
- B. Once a week
- C. Two or three times a week
- D. Four or five times a week
- E. More than five times a week

22) During the past 3 months, did you ever exercise for more than 1 hour specifically in order to avoid gaining weight after eating?

Circle one: Yes No

If yes: How often, on average, was that?

- A. Less than once a week
- B. Once a week
- C. Two or three times a week
- D. Four or five times a week
- E. More than five times a week

23) During the past 3 months, did you ever take more than twice the recommended dosage of a diet pill in order to avoid gaining weight after binge eating?

Circle one: Yes No

If yes: How often, on average, was that?

- A. Less than once a week
- B. Once a week
- C. Two or three times a week

- D. Four or five times a week
- E. More than five times a week

Night Eating Questionnaire

Directions: Please circle ONE answer for each question.

1. How hungry are you usually in the morning?

0 1 2 3 4
Not at all A little Somewhat Moderately Very

2. When do you usually eat for the first time??

0 1 2 3 4
Before 9AM 9:01 to 12PM 12:01 to 3PM 3:01 to 6PM 6:01 or later

3. Do you have cravings or urges to eat snacks after supper, but before bedtime?

0 1 2 3 4
Not at all A little Somewhat Very much so Extremely so

4. How much control do you have over your eating between supper and bedtime?

0 1 2 3 4
Not at all A little Some Very much Complete

5. How much of your daily food intake do you consume *after* suppertime?

0 1 2 3 4
0% 1-25% 26-50% 51-75% 76-100%
(none) (up to a quarter) (about half) (more than half) (almost all)

6. Are you currently feeling blue or down in the dumps?

0 1 2 3 4
Not at all A little Somewhat Very much so Extremely

7. When you are feeling blue, is your mood lower in the:

0 1 2 3 4
Early Morning Late Morning Afternoon Early Evening Late Evening/Night
_____ Check here if your mood does not change during the day.

8. How often do you have trouble getting to sleep?

0 1 2 3 4
Never Sometimes About half the time Usually Always

9. Other than only to use the bathroom, how often do you get up at least once in the middle of the night?

0 1 2 3 4
Never Less than once About once More than once Every night
 a week a week a week

*****IF 0 ON #9, PLEASE SKIP TO #15*****

10. Do you have cravings or urges to eat snacks when you wake up at night?
0 1 2 3 4
Not at all A little Somewhat Very much so Extremely

11. Do you need to eat in order to get back to sleep when you awake at night?
0 1 2 3 4
Not at all A little Somewhat Very much so Extremely

12. When you get up in the middle of the night, how often do you snack?
0 1 2 3 4
Never Sometimes About half the time Usually Always

*****IF 0 ON #12, PLEASE SKIP TO #15*****

13. When you snack in the middle of the night, how aware are you of your eating?
0 1 2 3 4
Not at all A little Somewhat Very much so Completely

14. How much control do you have over your eating while you are up at night?
0 1 2 3 4
None at all A little Some Very much Complete

15. How long have your difficulties with night eating been going on?
_____ months _____ years

Self-Reported Weight

1. Select the statement that best describes you.

“During the past 6 months, my weight has ...”

- decreased by 10 lbs. or more
- decreased by 5 to 10 lbs.
- been relatively stable
- increased by 5 to 10 lbs.
- increased by 10 lbs. or more

2. What is your current weight? **Important instructions: If possible, please weigh yourself using a scale while wearing light clothing without shoes.**

_____ pounds (lbs.)

3. Did you use a scale to weigh yourself for the previous question?

Yes No

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Biography

Erin Martinez has a long-standing interest in eating disorders and obesity. She conducted her senior thesis under Drs. Kelly Brownell and Marlene Schwartz at Yale University, where she graduated *summa cum laude* in 2002. She spent the next two years at the University of Texas at Austin, working as a project manager for a large-scale eating disorder prevention program under Dr. Eric Stice. Erin continued to hone her interests as a graduate student at Duke, where she received a pre-doctoral National Research Service Award (NRSA) to conduct her dissertation research, and where she also completed extensive clinical training in the treatment of eating disorders under Dr. Nancy Zucker. Erin also discovered a passion for Dialectical Behavior Therapy (DBT) during graduate school. She is currently an intern in behavioral medicine at Palo Alto VA and has accepted a clinical post-doctoral residency at the University of California at San Diego/San Diego VA. She lives with her husband, two dogs, and two cats, all of whom are happy to be newly minted Californians. On second thought, the cats are rather indifferent, as cats are wont to be.