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Mental Disorders and Weight Change in a Prospective Study of Bariatric Surgery Patients: 7 Years of Follow-up

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Abstract

Background: Long-term, longitudinal data are limited on mental disorders after bariatric surgery.

Objective: To report mental disorders through 7 years post-surgery and examine their relationship with changes in weight and health-related quality of life (HRQoL).

Setting: Three U.S. academic medical centers.

Method: As a sub-study of the Longitudinal Assessment of Bariatric Surgery Consortium, 199 adults completed the Structured Clinical Interview for DSM-IV prior to Roux-en-Y Gastric Bypass (RYGB) or Laparoscopic Adjustable Gastric Band (LAGB). Participants who completed 1 follow-up through 7-years post-surgery are included (n=173; 86.9%). Mixed models were used to examine mental disorders over time, and among the RYGB subgroup (n=104), their relationship with long-term (4 years) pre- to post-surgery changes in weight and HRQoL, measured with the Short Form-36 Health Survey, and with weight regain from nadir.

Results: Compared with pre-surgery (34.7%), the prevalence of having any mental disorder was significantly lower 4 years (21.3%; p<.01) and 5 years (19.2%; p=.01), but not 7 years (29.1%; p=.27) following RYGB. The most common disorders were not related to long-term weight loss

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post-RYGB. However, independent of weight change, mood and anxiety disorders, both pre- and post-surgery, were significantly related to less improvement in mental (but not physical) HRQoL. Having a concurrent mood disorder appeared to be associated with greater weight regain (6.4% of maximum weight lost, 95% CI, -0.3–13.1), but this was not statistically significant ($p=0.06$).

Conclusions: Bariatric surgery does not result in consistent long-term reductions in mental disorders. Mood disorders may impact long-term outcomes of bariatric surgery.

Trial registration: [ClinicalTrials.gov](https://clinicaltrials.gov/) ().

Keywords

Bariatric surgery; gastric bypass; laparoscopic adjustable gastric banding; mental disorders; weight change; quality of life; mood disorders

Although bariatric surgery is the most effective treatment for severe obesity, resulting in long-term weight loss and improvements in obesity-related comorbid conditions^(1–5) and health-related quality of life,^(6–8) a substantial proportion of patients experience inadequate weight loss or significant weight regain.⁽⁹⁾ Patterns of weight change vary by surgical procedure and among patients who have the same procedure.⁽¹⁰⁾ Weight regain may be caused by operation-specific or patient-specific (mental health, health-related behaviors, endocrinopathies/metabolic) factors.⁽⁹⁾ With respect to mental health, mental disorders are relatively common among adults who undergo bariatric surgery,⁽¹¹⁾ and have been related to impaired quality of life.^(12,13) A clearer understanding of how mental disorders relate to long-term weight change and quality of life will inform the development of personalized approaches to optimizing outcomes.

Available evidence suggests that mental disorders are associated with poorer weight loss following bariatric surgery. Three methodologically rigorous studies utilizing structured interviews have examined the relationship of mental disorders and weight loss following different types of bariatric surgery.^(14–16) In a sample of 207 patients, pre-surgery lifetime history of mental disorders, particularly mood or anxiety, predicted modestly poorer weight loss at 6-months following gastric bypass.⁽¹⁴⁾ In a separate sample of 107 patients who underwent gastric bypass or banding, pre-surgery lifetime history of anxiety disorders, or the presence of both pre-surgery anxiety and mood disorders (lifetime or current), were negatively associated with weight loss at 2–3 years post-surgery.⁽¹⁵⁾ Additionally, although a pre-surgery mood disorder alone (lifetime or current) was not significantly associated with weight loss, a concurrent post-surgery mood disorder was.⁽¹⁵⁾ In contrast, an interim report from the Longitudinal Assessment of Bariatric Surgery (LABS) Psychosocial study, documented that among 165 patients, neither anxiety nor mood disorders (current or lifetime history at time of surgery, or post-surgery current) were significantly associated with weight loss at 3 years following gastric bypass or laparoscopic adjustable gastric band, adjusting for surgical procedure.⁽¹⁶⁾ However, current post-surgical eating disorders, although uncommon (1–3% during follow-up), were associated with less weight loss.⁽¹⁶⁾ Therefore, results vary across extant studies, none extend beyond 3 years post-surgery, and none examine the relationship between mental disorders and weight regain from the post-surgery weight nadir.

In the current investigation, we extend findings from the interim report from the LABS Psychosocial study⁽¹⁶⁾ by documenting mental disorders through 7 years by surgical procedure. Our primary aims were to evaluate long-term (4 years) pre- to post-surgery changes in mental disorders and to evaluation associations between mental disorders and long-term change in weight. Secondary aims were to evaluate associations between mental disorders and long-term change in health-related quality of life, as well as weight regain following maximum weight loss.

MATERIALS AND METHODS

Design, setting, and participants

The current study is part of the National Institutes of Health (NIH)-funded LABS consortium of studies, which has been described in detail.⁽¹⁷⁾ This report extends findings from the 3-year follow-up of the LABS-3 Psychosocial study,⁽¹⁶⁾ which was a prospective cohort study conducted with 202 patients, most of whom also participated in LABS-2,⁽⁵⁾ at three of the six LABS-2 clinical centers: The Neuropsychiatric Research Institute, Fargo, ND; Columbia-Weill Cornell Medical Centers in New York, NY; and the University of Pittsburgh and Duquesne University in Pittsburgh, PA. The Institutional Review Boards at each center approved the protocol and consent forms, and all participants provided written informed consent prior to data collection.

Of the 202 LABS-3 participants, 199 who underwent RYGB or Laparoscopic Adjustable Gastric Band (LAGB) were considered for the current report. Of those, 173 (104 RYGB and 69 LAGB) had pre-surgery data plus at least 1 follow-up assessment through 7-years post-surgery and were included in the analysis sample.

Measures

During in-person assessments, weight was measured on a standard scale (Tanita Body Composition Analyzer, model TBF-310). If this weight was not obtained per protocol, weight measured by research or medical personnel on a non-study scale was utilized. If neither was available, a participant's self-reported weight was used. Among adults who have undergone bariatric surgery, differences between in-person and self-reported weights have been shown to be small (1 kilogram) and not to differ by measured Body Mass Index (BMI) or degree of post-surgery weight change.⁽¹⁸⁾ The weights of women in their 2nd or 3rd trimester of pregnancy or within 6 months post-partum were censored. Change in weight from surgery was calculated as percentage of pre-surgery weight, i.e., $[100 * (\text{post-surgery weight} - \text{pre-surgery weight}) / \text{pre-surgery weight}]$. A negative number represents weight loss. Weight regain from post-surgery weight nadir was calculated as percentage of maximum weight lost, i.e., $[100 * (\text{post-nadir weight} - \text{nadir weight}) / (\text{pre-surgery weight} - \text{nadir weight})]$, which performs better than other common measures of weight regain in terms of association with clinical outcomes.⁽¹⁹⁾

Participants were interviewed using the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (SCID) Patient Version⁽²⁰⁾ to assess Axis I mental disorders prior to surgery. Interviews were conducted independently of the

routine pre-surgery screening process, and repeated, again independently of clinical care, at 2-, 3-, 4-, 5- and 7-years post-surgery. Lifetime history was assessed at the pre-surgery assessment only. Current disorder, based on meeting diagnostic criteria within the past month, was rated at all assessments. Eating disorders included bulimia nervosa, binge eating disorder, and anorexia nervosa only; evaluators did not evaluate sub-threshold disorders that may be classified as “not otherwise specified”. Groups were created including participants with no mental disorder at any assessment (no history of disorder); current mental disorder at the specified post-surgery assessment, whether or not there was current or lifetime disorder at the pre-surgery assessment (post-surgery disorder); and no current mental disorder at the specified post-surgery assessment, but current or lifetime disorder at the pre-surgery assessment (pre-surgery disorder only).

Participants reported the names and frequency of use, but not indication, of all prescribed medications currently taken using a study-specific medication form. Antidepressant medication use was defined as taking a medication classified as an antidepressant at least daily; antianxiety medication use was defined as taking a medication classified as an antianxiety medication at least daily; and psychiatric medication use was defined as use of antidepressant or antianxiety medication, or a medication classified as a drug for mania, a central nervous system stimulant, or an antipsychotic at least daily. Psychiatric medication at each post-surgery assessment was categorized based on the status at the pre-surgery assessment and current status at the specified post-surgery assessment: no use pre- or post-surgery (no use); use post-surgery, whether or not there was use pre-surgery (post-surgery use); and no current use at the specified post-surgery assessment, but current use at the pre-surgery assessment (pre-surgery use only).

The Medical Outcomes Study 36-item Short-Form Health Survey (SF- 36) is a measure of health-related quality of life with well documented validity and sensitivity to change.^(21,22) This study utilized the two composite scores, the mental component summary (MCS) and physical component summary (PCS), which are commonly used patient-reported outcome measures of bariatric surgery.⁽²³⁾ Norm-based methods were used to transform the scores to a mean of 50 and standard deviations of 10 in general U.S. population samples (range 0–100).⁽²⁴⁾ Higher scores imply less disability/better function. Change in score from surgery was calculated as post-surgery score – pre-surgery score, thus a positive number indicates improvement.

Data Analysis

Analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC, USA). Statistical significance was set at $p < .05$; tests were two-sided. Data were assumed to be missing at random. Mixed models, described below, utilized all available data, and controlled for factors related to missing follow-up data (site and age) as fixed effects. All analysis was stratified by participants’ initial surgical procedure. Descriptive statistics (frequencies and percentages for categorical variables; medians, 25th-75th percentiles, and ranges for continuous variables) were used to summarize pre-surgery characteristics. Participants who were excluded from the analysis due to missing data were compared with those in the analysis sample using the Chi Square or Fisher’s Exact test for categorical variables,

Cochrane-Armitage test for ordinal variables, and the Wilcoxon rank sum test for continuous variables.

Descriptive statistics were used to summarize the prevalence of mental disorders and psychiatric medication use, as well as the distributions of mental status for any disorder, the most common types of disorders (i.e., any mood disorder, any anxiety disorder, and any eating disorder), and medication use, by post-surgery assessment and surgical procedure. Log binomial mixed models were used to estimate prevalence of these mental disorders and medication use by time since surgery. Pairwise comparisons were made between pre-surgery and years 4–7 to evaluate long-term pre-to post-surgery change.

Descriptive statistics were used to report change from surgery in weight and the SF-36 MCS and PCS scores. Linear mixed models fit using maximum likelihood with a person-level random intercept were used to test and estimate associations between the most common types of mental disorders and medication use with long-term (i.e., 4–7 years) weight change from surgery, controlling for factors related to missing follow-up data (site and age), as well as sex, race, and pre-surgery BMI based on our prior report,⁽¹⁶⁾ with time since surgery entered as a continuous fixed effect. The comparison groups for modelling were 1) post-surgery disorder and 2) pre-surgery history of disorder only, versus 3) no history of disorder (i.e., reference), and 1) post-surgery medication use and 2) pre-surgery medication use only, versus 3) no medication use (i.e., reference). Due to the low frequency of full threshold eating disorders 4 years (n=1), post-surgery disorder and pre-surgery disorder only were further collapsed and compared to no pre-surgery history (reference). Owing to substantial overlap, history of mood disorder and history of anxiety disorder were considered in separate models, with pre-surgery history of eating disorder and psychiatric medication use in both. Seventy-two of the 104 RYGB participants had the required data for this analysis. With a sample size of 72 and a standard deviation of 11.4% in percentage weight change across long-term follow-up, there was 80% power to detect a difference of 7.0–8.9% between exposure groups. Due to inadequate statistical power to detect this level of difference in the smaller sample of LAGB (i.e., 37 of 69 participants had the required data), this and the remaining analysis was limited to the larger sample of RYGB.

The modeling described above was repeated replacing long-term weight change with long-term change in the SF-36 MCS and PCS scores (i.e., from pre-surgery to 4–7 years post-surgery), and also controlling for the respective pre-surgery score and weight change from surgery.

A linear mixed model was used to investigate if there was a trend in weight regain by time from weight nadir, with time since weight nadir entered as a continuous fixed effect, controlling for factors related to missing follow-up data (site and age). Likewise, Poisson mixed models with robust error variance were used to evaluate if there was a trend in the prevalence of mood disorders, anxiety disorders, and psychiatric medication use, respectively, by time from weight nadir. Finally, a linear mixed model was used to investigate the association between concurrent mood disorder, anxiety disorder, and psychiatric medication use with weight regain from weight nadir, with time since weight

nadir entered as a continuous fixed effect, controlling for site, age, sex, race, and pre-surgery BMI.

RESULTS

Data Completeness

Of 104 RYGB participants in the analysis sample, 91 (87.5%) completed the SCID DSM-IV at year 2, 77 (74.0%) at year 3, 62 (59.6%) at year 4, 52 (50.0%) at year 5, and 55 (52.9%) at year 7; weight data were collected at 94.8% (887/936) of all assessments, 94.2% (588/624) of assessments at which SCID data was due. Of the 69 LAGB participants, 63 (91.3%) completed the SCID at year 2, 53 (76.8%) at year 3, 45 (65.2%) at year 4, 39 (56.5%) at year 5, and 43 (62.3%) at year 7; weight data were collected at 90.3% (561/621) of all assessments, 89.1% (369/414) of assessments at which SCID data was due. By the 7 year follow-up, 6 (5.8%) RYGB participants and 2 (3.2%) LAGB participants had died and thus were ineligible for follow-up.

Of the 1448 weights measured among RYGB and LAGB participants across all assessments, 72.3% were measured per-protocol, 3.0% were determined by research or medical personnel on a non-study scale, and 24.6% were self-reported.

Participant Characteristics

Characteristics of the analysis sample, by initial surgical procedure, are reported in Table 1. The majority (60.1%; n=104) underwent RYGB, and a minority (39.9%; n=69) received a LAGB. Among both procedure groups, over 80% of participants were women and over 90% were white. Median (IQR) pre-surgery BMI was 46.9 kg/m² (43.1, 52.0) for RYGB and 43.5 kg/m² (40.8, 46.7) for LAGB. The pre-surgery SF-36 MCS scores indicated both surgical groups had similar mental health-related quality of life compared to the general US population (medians of 50.6 for RYGB and 52.1 for LAGB), while their PCS scores indicated their physical health-related quality of life was substantially poorer (medians of 35.1 and 37.1, respectively).

A comparison of participants included in the analysis sample versus those excluded for missing data is available in supplemental material (STable 1). There were no statistically significant differences between groups.

By the 7 year follow-up, no participants in the RYGB subgroup had a revision, reversal, or new procedure related to weight, whereas in the LAGB subgroup, 2 patients had port revisions, 3 had reversals of the initial surgery without a new procedure, and 6 had new procedures related to insufficient loss or weight regain.

Mental Disorders through 7 years Post-Surgery

Table 2 provides the observed prevalence of having any mental disorder, as well as specific types of disorders (e.g., any mood disorder), individual disorders (e.g., major depressive disorder), and psychiatric medication use, by time in relation to surgery and surgical procedure. Modeled prevalence estimates, and comparisons with pre-surgery values are provided in supplemental material (STable 2). Four years following RYGB, the prevalence

of having any mental disorder, or specifically any anxiety disorder but not any mood disorder, was significantly lower than pre-surgery (e.g., 21.3%, 95% CI, 12.1–31.6, had any mental disorder at year-4, vs 34.7% 95% CI, 20.5–44.3, pre-surgery; $p=.005$); however, by year-7 there was not a significant difference with pre-surgery prevalence estimates (e.g., 29.1%, 95% CI, 17.3–41.7, had any mental disorder at year-7; $p=.27$; STable 2). Almost 10% of participants had an eating disorder pre-RYGB, whereas no one did by year-7. However, there was not sufficient statistical power to formally compare the prevalence of this or other disorders by time point.

Compared to pre-surgery, there was not a significant difference in any mental, any mood, or any anxiety disorder 4 years following LAGB. However, the prevalence of having any mental disorder was significantly lower at year-7 (4.7%, 95% CI, 2.0–12.5, vs 25.0% 95% CI, 16.0–35.4, pre-surgery; $p=.01$). This was not true for any mood or any anxiety disorder, perhaps due to limited statistical power (e.g., 2.3%, 95% CI, 1.9–7.9, had any anxiety disorder at year-7, vs 11.8% 95% CI, 4.5–18.8, pre-surgery; $p=.10$; STable 2).

Prevalence of psychiatric medication use during long-term follow-up was not significantly different from pre-surgery at long-term follow-up among the RYGB or LAGB subgroups (STable 2).

Mental Disorders and Long-term Changes in Weight and Health-Related Quality of Life after Roux-en-Y Gastric Bypass

Pre- to post-surgery change in weight and SF-36 scores by time since surgery among those who underwent RYGB are available in supplemental material (STable 3). At year 7, median weight change was –27.8% of pre-surgery weight (IQR: –34.3, –20.2); median change in MCS score was 0.6 (IQR: –5.3, 7.5), and median change in PCS score was 9.6 (IQR 2.0, 16.2).

Having a pre-surgery history of any eating disorder was not significantly related to long-term weight change; the same was true for a pre-surgery history or concurrent post-surgery mood disorder, anxiety disorder, or psychiatric medication use (p for all $>.05$; Table 3).

Associations between mental disorders and long-term changes from surgery in SF-36 scores are shown in Table 4. With adjustment for change in weight, having a post-surgery mood disorder or a post-surgery anxiety disorder were negatively related to improvement in the MCS score ($B=-16.7$, 95% CI, –22.1, –11.4, and $B=-15.5$, 95% CI, –20.7, –10.2, respectively) versus no pre-surgery history of the respective disorder. Associations with pre-surgery histories of mood or anxiety disorders only (i.e., versus no pre-surgery histories) were weaker, but still significant ($B=-7.0$, 95% CI, –11.3, –2.7, and $B=-5.8$, 95% CI, –10.3, –1.3, respectively). In contrast, there were no significant associations between mental disorders and change in the PCS score (Table 4). This was also true without adjustment for weight change (data not shown).

Post-surgery Mental Disorders and Weight Regain after Roux-en-Y Gastric Bypass

Weight regain occurred a median (IQR) of 2.1 (2.0, 3.0) years following RYGB. Weight regain and the prevalence of mood and anxiety disorders by time since post-surgery weight

nadir is shown in Table 5. Median (IQR) weight regain was 8.3% (4.8, 12.6) of maximum weight lost one year following the individual's weight nadir, and increased through 5 years following weight nadir (p for linear trend <.001) when the median (IQR) reached 27.0% (17.4, 39.8) of maximum weight lost. The prevalence of mood and anxiety disorders also increased between 1 and 5 years following weight nadir (p for linear trends <.001), whereas medication use did not (p for linear trend=.23).

Having a concurrent mood disorder post-surgery appeared to be associated with greater weight regain, but did not reach statistical significance ($B=6.4$, 95% CI, -0.3 , 13.1 , for percentage of maximum weight lost; $p=0.06$). There was not a significant association between concurrent post-surgery anxiety disorder ($B=3.5$, 95% CI, -3.5 , 10.4 , $p=0.33$) or psychiatric medication use ($B=-4.0$, 95% CI, -9.6 , 1.6 , $p=0.16$) with weight regain.

DISCUSSION

This study extends our previous report⁽¹⁶⁾ of mental disorders among bariatric surgery patients through 7-years. As compared to that report⁽¹⁶⁾ in which the prevalence of mental disorders was significantly lower at both 2 and 3 years post-surgery versus pre-surgery, long-term follow-up yielded inconsistent results. Specifically, following RYGB, the prevalence of any mental disorder was significantly lower than pre-surgery at both the 4 and 5 year assessments, but not at the 7 year assessment, while the opposite was true following LAGB. Although mental disorders were not related to percent weight change 4–7 years post-surgery, concurrent post-surgery mood disorder appeared to be related to weight regain from weight nadir after RYGB. In addition, having a concurrent (and to a lesser degree, a pre-surgery history only) mood or anxiety disorder were associated with less improvement in mental health related quality of life, independent of change in weight.

Although a growing body of research suggests that post-surgery mental disorders and symptoms, including depression, are associated with post-surgery changes in weight, ^(15,25,26) no previous studies have looked at the relationship of mental disorders to weight regain from the post-surgery nadir. In the present study, post-surgery mood and anxiety disorders were not related to weight change through 7 year follow-up, but there was indication that post-surgery mood disorders (but not anxiety disorders) might be related to weight regain among the RYGB subsample, independent of psychiatric medication use. However, this analysis was limited by sample size ($n=90$) and the association did not reach statistical significance ($p = .06$). As mood disorders and weight regain were measured concurrently, it is not possible to identify the direction of the association. Additionally, the percentage of regain in the present report relative to maximal weight loss is not comparable to other studies that measured regain as a percentage of pre-surgery weight.⁽⁵⁾

The literature suggests that binge eating, binge eating disorder, and loss of control eating post-surgery has been associated with less weight loss or more weight regain.⁽²⁷⁾ In our initial report, the very small subset of patients who had eating disorders through 3-year follow-up lost 6.7% less weight after LAGB or RYGB.⁽¹⁶⁾ In the present study, pre-surgery eating disorders were not related to weight loss or regain. It remains possible that post-surgery eating disorders are related to long-term weight loss or weight regain. However,

their limited occurrence post-surgery when reduced gastric capacity makes it more difficult to consume objectively large amounts of food, necessary for meeting diagnostic criteria for bulimia nervosa and binge eating disorder, precluded meaningful analysis. Although this report evaluated full threshold eating disorders only, there is evidence from the LABS-3 cohort and other samples that sub-threshold eating disorders and symptoms may also contribute to suboptimal weight loss post-surgery. (27–29)

Previous research suggests that mental disorders are associated with reduced health-related quality of life in bariatric surgery patients. We found that pre- and post-surgery mood and anxiety disorders were negatively related to long-term pre- to post-surgery improvements in mental, but not physical, health-related quality of life in the RYGB subsample, independent of change in weight. Thus, our data suggest that interventions to address these mental disorders in the context of bariatric surgery may have the potential to optimize mental health-related quality of life, which encompasses energy, as well as the social and emotional aspects of wellbeing. This finding merits further exploration utilizing research designs that can tease apart the temporal relationships among weight, mental disorders, and quality of life.

Strengths of the present investigation include a sample from 3 geographically diverse clinical centers followed for up to 7 years post-surgery, and use of a semi-structured interview for the assessment of mental disorders that was administered separately from clinical care and did not influence approval for surgery. Limitations include potential bias due to self-selection or attrition. Although we utilized analytic techniques that make use of all available data, due to the initial sample sizes and loss to follow-up, as well as the low frequency of specific types of mental disorders, statistical power was limited for some analyses and precluded other analyses. Given estimated prevalence of mental disorders among participants varied widely across long-term follow-up (i.e., years 4–7), results need confirmation in another study. Additionally, per standard SCID protocol, we assessed past month psychopathology at follow-up. Therefore, we may not have detected all post-surgery disorders, as patients who did not meet diagnostic criteria in the past month could have met the criteria during a period we did not capture. Additionally, the SCID screener for alcohol use disorder requires reporting having consumed five or more drinks on one occasion, a threshold that is too high considering evidence that alcohol pharmacokinetics may be altered following some procedures resulting in significantly elevated serum levels^(30,31) Finally, we did not document the reason medication was prescribed. Although the prevalence of continuing, recurring, or incident depression was low following surgery, a large proportion of patients were taking antidepressant medications throughout the study period, and it remains possible that patients had mood disorders that were being controlled with medication.

In summary, a key finding to emerge from this long-term follow-up is that the prevalence of having a mental disorder is similar or lower at 4 through 7 years post-surgery, when compared with pre-surgery. Additionally, post-surgery mood disorders may be related to weight regain from weight nadir post-RYGB, and independent of change in weight, mood and anxiety disorders are related to less long-term improvement in mental health-related quality of life. Future research will need to include larger samples, high risk populations, or

focus on sub-threshold symptoms that may be clinically meaningful, but do not meet full diagnostic criteria. Results suggest that interventions to optimize outcomes may want to focus on careful post-surgery monitoring of body weight and mental disorders. Additionally, future studies should include a full range of outcomes that are important to patients in addition to weight change and quality of life.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Compared to pre-surgery, the prevalence of having a mental disorder was not consistently lower in the long-term following RYGB or LAGB.
- Mood and anxiety disorders were related to less improvement in mental quality of life post-RYGB.
- Post-surgery mood disorders may be related to weight regain from the nadir post-RYGB.
- Patients may benefit from careful post-surgery monitoring of mental disorders.

Demographic and clinical characteristics of adults prior to bariatric surgery, by surgical procedure

Table 1.

	RYGB (N=104) No. (%)^d	LAGB (N=69) No. (%)^d
Age, years		
Median (25th–75th %-ile)	45 (34, 53)	47 (40, 54)
Range	21–68	23–67
Female	84 (80.8)	58 (84.1)
Race		
White	97 (93.3)	64 (92.8)
Black	7 (6.7)	4 (5.8)
Other	0 (0.0)	1 (1.4)
Hispanic ethnicity		
No	97 (93.3)	69 (100.0)
Yes	7 (6.7)	0 (0.0)
Married or living as married	(n=100)	(n=63)
No	43 (43.0)	19 (30.2)
Yes	57 (57.0)	44 (69.8)
Education	(n=100)	(n=62)
High school or less	19 (19.0)	10 (16.1)
Some college	46 (46.0)	24 (38.7)
College degree	35 (35.0)	28 (45.2)
Employed for pay	(n=99)	(n=64)
No	31 (31.3)	19 (29.7)
Yes	68 (68.7)	45 (70.3)
Household income, US \$	(n=100)	(n=63)
Less than 25,000	19 (19.0)	9 (14.3)
25,000–49,999	34 (34.0)	17 (27.0)
50,000–74,999	24 (24.0)	14 (22.2)
75,000–99,999	12 (12.0)	11 (17.5)
>100,000	11 (11.0)	12 (19.0)
Body mass index, kg/m ²		

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	RYGB (N=104) No. (%)^a	L/AGB (N=69) No. (%)^a
Median (25th–75th %-ile)	46.9 (43.1, 52.0)	43.5 (40.8, 46.7)
Range	36.1–76.0	33.5–65.8
SF-36 Mental Component Summary score	(n=100)	(n=64)
Median (25th–75th %-ile)	50.6 (43.0, 55.6)	52.1 (45.1, 57.7)
Range	20.8–69.4	23.8–62.8
SF-36 Physical Component Summary score	(n=100)	(n=64)
Median (25th–75th %-ile)	35.1 (26.3, 42.3)	37.1 (31.4, 45.9)
Range	13.4–54.2	17.2–55.9

Acronyms: L/AGB, laparoscopic adjustable gastric banding; RYGB, Roux-en-Y gastric bypass, SF-36, short-form health survey.

^aUnless otherwise indicated

Observed prevalence of mental disorders and psychiatric medication use pre-surgery through 7 years post-surgery, by surgical procedure

Table 2:

	Pre-surgery	Time in relation to surgery ^a , no./Total (%)				
		Year 2	Year 3	Year 4	Year 5	Year 7
RYGB						
Any mental disorder	35/101 (34.7)	15/90 (16.7)	16/76 (21.1)	13/61 (21.3)	10/52 (19.2)	16/55 (29.1)
Any mood disorder	13/104 (12.5)	4/91 (4.4)	8/77 (10.4)	9/61 (14.8)	4/51 (7.8)	8/55 (14.6)
Bipolar I disorder	1/104 (1.0)	0/91 (0.0)	0/77 (0.0)	1/61 (1.6)	1/52 (1.9)	1/55 (1.8)
Bipolar II disorder	0/104 (0.0)	0/91 (0.0)	1/77 (1.3)	0/61 (0.0)	0/52 (0.0)	1/55 (1.8)
Major depressive disorder	7/104 (6.7)	4/91 (4.4)	5/77 (6.5)	6/62 (9.7)	3/51 (5.9)	5/55 (9.1)
Dysthymia	3/104 (2.9)	1/91 (1.1)	2/77 (2.6)	2/62 (3.2)	0/51 (0.0)	0/55 (0.0)
Mood disorder not otherwise specified	2/104 (1.9)	0/91 (0.0)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	0/55 (0.0)
Mood disorder due to a general medical condition	1/104 (1.0)	0/91 (0.0)	1/77 (1.3)	0/62 (0.0)	0/52 (0.0)	1/55 (1.8)
Any anxiety disorder	22/103 (21.4)	12/91 (13.2)	7/76 (9.2)	5/62 (8.1)	8/52 (15.4)	9/55 (16.4)
Social phobia	4/104 (3.9)	3/91 (3.3)	1/77 (1.3)	3/62 (4.8)	2/52 (3.9)	1/55 (1.8)
Specific phobia	12/104 (11.5)	8/91 (8.8)	1/77 (1.3)	2/62 (3.2)	2/52 (3.9)	3/55 (5.5)
Posttraumatic stress disorder	5/104 (4.8)	3/91 (3.3)	2/76 (2.6)	3/62 (4.8)	1/52 (1.9)	2/55 (3.6)
Any schizophrenia/other psychotic disorder	1/104 (1.0)	0/91 (0.0)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	0/55 (0.0)
Delusional disorder	1/104 (1.0)	0/91 (0.0)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	0/55 (0.0)
Any substance use disorder	1/102 (1.0)	0/91 (0.0)	3/77 (3.9)	3/62 (4.8)	2/52 (3.9)	2/55 (3.6)
Alcohol abuse/dependence	0/103 (0.0)	0/91 (0.0)	3/77 (3.9)	3/62 (4.8)	2/52 (3.9)	2/55 (3.6)
Other drug abuse/dependence	1/102 (1.0)	0/91 (0.0)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	0/55 (0.0)
Any somatoform disorder	0/104 (0.0)	0/90 (0.0)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	1/55 (1.8)
Pain disorder	0/104 (0.0)	0/91 (0.0)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	0/55 (0.0)
Any eating disorder	10/104 (9.6)	1/90 (1.1)	4/77 (5.2)	1/62 (1.6)	0/52 (0.0)	0/55 (0.0)
Binge eating disorder	8/104 (7.7)	1/90 (1.1)	4/77 (5.2)	1/62 (1.6)	0/52 (0.0)	0/55 (0.0)
Bulimia nervosa	2/104 (1.9)	0/90 (0.0)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	0/55 (0.0)
Adjustment disorder	1/104 (1.0)	1/91 (1.1)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	1/55 (1.8)
Other DSM-IV Axis I disorder	1/104 (1.0)	1/90 (1.1)	0/77 (0.0)	0/62 (0.0)	0/52 (0.0)	0/55 (0.0)
Any psychiatric medication	43/100 (43.0)	35/83 (42.2)	32/81 (39.5)	38/80 (47.5)	33/82 (40.2)	37/84 (44.1)
Antidepressant medication	40/100 (40.0)	30/77 (39.0)	29/73 (39.7)	34/73 (46.6)	32/71 (45.1)	34/75 (45.3)

	Time in relation to surgery ^a , no./Total (%)						
	Pre-surgery	Year 2	Year 3	Year 4	Year 5	Year 7	Year 7
Antianxiety medication	5/100 (5.0)	8/77 (10.4)	6/74 (8.1)	10/72 (13.9)	10/68 (14.7)	9/72 (12.5)	9/72 (12.5)
L/ABG							
Any mental disorder	17/68 (25.0)	11/63 (17.5)	7/53 (13.2)	7/45 (15.6)	9/39 (23.1)	2/43 (4.7)	2/43 (4.7)
Any mood disorder	9/68 (13.2)	7/63 (11.1)	6/53 (11.3)	6/45 (13.3)	5/39 (12.8)	2/43 (4.7)	2/43 (4.7)
Bipolar I disorder	0/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Bipolar II disorder	0/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Major depressive disorder	7/69 (10.1)	7/63 (11.1)	6/53 (11.3)	6/45 (13.3)	3/39 (7.7)	2/43 (4.7)	2/43 (4.7)
Dysthymia	3/69 (4.4)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Mood disorder not otherwise specified	0/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	2/39 (5.1)	0/43 (0.0)	0/43 (0.0)
Mood disorder due to a general medical condition	0/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Any anxiety disorder	8/68 (11.8)	7/63 (11.1)	3/53 (5.7)	3/45 (6.7)	6/39 (15.4)	1/43 (2.3)	1/43 (2.3)
Social phobia	2/68 (2.9)	1/63 (1.6)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/42 (0.0)	0/42 (0.0)
Specific phobia	6/68 (8.8)	3/63 (4.8)	1/53 (1.9)	2/45 (4.4)	3/39 (7.7)	1/43 (2.3)	1/43 (2.3)
Posttraumatic stress disorder	1/68 (1.5)	0/62 (0.0)	0/53 (0.0)	1/45 (2.2)	1/39 (2.6)	0/43 (0.0)	0/43 (0.0)
Any schizophrenia/other psychotic disorder	0/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Delusional disorder	0/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Any substance use disorder	1/69 (1.5)	0/63 (0.0)	0/53 (0.0)	1/45 (2.2)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Alcohol abuse/dependence	1/69 (1.5)	0/63 (0.0)	0/53 (0.0)	1/45 (2.2)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Other drug abuse/dependence	0/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Any somatoform disorder	2/69 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Pain disorder	2/69 (2.9)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Any eating disorder	2/67 (3.0)	1/63 (1.6)	0/53 (0.0)	0/45 (0.0)	1/39 (2.6)	0/43 (0.0)	0/43 (0.0)
Binge eating disorder	2/67 (3.0)	1/63 (1.6)	0/53 (0.0)	0/45 (0.0)	1/39 (2.6)	0/43 (0.0)	0/43 (0.0)
Bulimia nervosa	0/67 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Adjustment disorder	0/67 (0.0)	0/63 (0.0)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Other DSM-IV Axis I disorder	1/67 (1.5)	1/63 (1.6)	0/53 (0.0)	0/45 (0.0)	0/39 (0.0)	0/43 (0.0)	0/43 (0.0)
Any psychiatric medication	26/64 (40.6)	23/56 (41.1)	26/57 (45.6)	22/47 (46.8)	20/48 (41.7)	20/53 (37.7)	20/53 (37.7)
Antidepressant medication	24/64 (37.5)	20/55 (36.4)	25/53 (47.2)	21/45 (46.7)	20/47 (42.6)	20/50 (40.0)	20/50 (40.0)
Antianxiety medication	7/64 (10.9)	4/55 (7.3)	5/55 (9.1)	5/45 (11.1)	5/47 (10.6)	2/50 (4.0)	2/50 (4.0)

Acronyms: DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, 4th Edition; AGB, laparoscopic adjustable gastric banding; RYGB, Roux-en-Y gastric bypass

Assessment of mental disorders not done in years 1 or 6.

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Associations between mental disorders and psychiatric medication use with long-term weight change following Roux-en-Y gastric bypass.

Table 3:

	Long-term pre-to post-surgery weight change		
	B (95% CI) ^a	DF	P
Any mood disorder (Ref=no history)			0.61
Pre-surgery history only	0.11 (-4.67,4.89)	115	
Post-surgery	1.87 (-2.46,6.20)	109	
Any eating disorder (Ref=no history)			0.97
Pre-surgery history or post-surgery	0.12 (-6.46,6.69)	61.5	
Any psychiatric medication (Ref=no use) ^b			0.22
Pre-surgery only	-1.22 (-9.78,7.33)	127	
Post-surgery	-4.13 (-9.00,0.73)	104	

^aEstimated percentage of pre-surgery weight, in years 4–7 associated with the indicated psychiatric variables, after adjustment for the other psychiatric variables, pre-surgery factors related to missing follow-up data (i.e. site and age), and sex, race, and body mass index at pre-surgery, with time entered as a fixed effect. A negative value indicates weight loss. When mood disorder was replaced by anxiety disorder, the estimates (95% CI) were 0.64 (-4.17–5.44) for pre-surgery history only and 2.17 (-2.05–6.40) for post-surgery (p= 0.56). N=72 of 104 RYGB participants.

^bBased on current medication use at pre- and post-surgery assessments. Pre-surgery history of medication use not measured.

Associations between mental disorders and psychiatric medication use with long-term change in mental and physical health-related quality of life, independent of weight change, following Roux-en-Y gastric bypass.

Table 4:

	Long-term pre- to post-surgery change				P
	SF-36 Mental Component Summary score	B (95% CI) ^a	DF	P	
Any mood (Ref=no history)					0.15
Pre-surgery history only	-7.01 (-11.34,-2.67)	4.11 (-0.81,9.03)	68.2		
Post-surgery	-16.73 (-22.08,-11.37)	4.78 (-0.96,10.53)	124		
Any eating disorder(Ref=no history)					0.72
Pre-surgery history or post-surgery	-5.00 (-10.39,0.40)	1.04 (-4.83,6.92)	60.5		
Any psychiatric medication (Ref=no use) ^b					0.89
Pre-surgery only	-1.81 (-10.64,7.02)	-2.15 (-11.14,6.84)	92.4		
Post-surgery	1.69 (-2.73,6.10)	-0.70 (-5.69,4.29)	69.2		

Acronyms: SF-36, Short-Form Health Survey.

^aEstimated pre- to post-surgery change in SF-36 score in years 4-7 post-surgery associated with the indicated psychiatric variable, after adjustment for the other psychiatric variables, pre-surgery factors related to missing follow-up data (i.e. site and age), and sex, race, pre-surgery body mass index and pre-surgery mental component summary (MCS) or physical component summary (PCS) score, respectively, and % weight change from surgery with time entered as a fixed effect. When mood disorder was replaced by anxiety disorder, the estimate (95% CI) for change in MCS score was -5.76 (-10.26, -1.26) for pre-history only and -15.46 (-20.72, -10.2) for post-surgery (p<.001); the estimate (95% CI) for change in PCS score was 4.41 (-0.82, 9.64) for pre-history only and 4.94 (-0.76, 10.64) for post-surgery (p=.14). A negative value indicates less of an improvement or a decrease in the score. N=70 of 104 RYGB participants.

^bBased on current medication use at pre- and post-surgery assessments. Pre-surgery history of medication use not measured.

Weight regain and prevalence of mental disorders by time since weight nadir among participants who underwent Roux-en-Y gastric bypass

Table 5.

	Time since weight nadir ^a				
	1 Year (n=90)	2 Years (n=88)	3 Years (n=86)	4 Years (n=75)	5 Years (n=72)
Weight regain					
% of maximum weight lost, median (25th –75th %-ile)	8.3 (4.8,12.6)	17.2 (8.6,28.0)	20.9 (13.0,33.3)	22.1 (12.9,35.5)	27.0 (17.4,39.8)
Any mood disorder, No. (%)	5 (7.1)	6 (10.9)	6 (11.8)	2 (8.7)	4 (14.3)
Any anxiety disorder, No. (%)	3 (4.4)	4 (7.3)	7 (13.7)	4 (16.7)	7 (25.0)
Any psychiatric medication, No. (%)	38 (46.9)	32 (43.2)	34 (46.0)	26 (35.1)	28 (40.6)

^aData truncated after 5 years since weight nadir due to small sample size (i.e., few participants were followed more than 5 years since weight nadir).