Psychological outcomes following surgical and endoscopic bariatric procedures: A systematic review

Dean Spirou[1]

Jayanthi Raman[1]

Evelyn Smith[2, 3]

[1] Discipline of Clinical Psychology, Graduate School of Health, University of Technology Sydney, NSW, Australia. Email: spirou.dean@gmail.com; jayanthi.raman@uts.edu.au

[2] School of Social Sciences and Psychology, Western Sydney University, NSW, Australia. Email: evelyn.smith@westernsydney.edu.au

[3] Translational Health Research Institute, Western Sydney University, NSW, Australia

Key words: Bariatric surgery, endoscopic procedures, psychological outcomes

Running title: Psychological outcomes after bariatric procedures

Corresponding author: Dean Spirou

Institution: University of Technology

Institutional Address: 100 Broadway, Ultimo 2007, NSW, Australia

Department: Discipline of Clinical Psychology, Graduate School of Health

E: spirou.dean@gmail.com

W: gsh.uts.edu.au

Conflicts of Interest Statement: The authors have no competing interests.

Abstract

Obesity is a leading global epidemic. Bariatric surgery is the only treatment demonstrating substantial long-term weight loss and medical benefits. However, there is limited research on the psychological outcomes following surgery. Therefore, the primary aim of this study was to systematically review depression, anxiety, and binge eating outcomes at different time points following bariatric surgery and identify whether bariatric surgery significantly reduces psychological symptoms over time. These outcomes were also examined among endoscopic bariatric procedures as a secondary aim. Forty-eight studies met inclusion criteria. Findings suggested that most patients experience a short-term reduction in anxiety and depression symptoms from pre-surgery. However, over time, these symptoms increase and may even return to pre-surgery levels. Furthermore, while binge eating was uncommon after surgery, other disordered eating patterns may emerge. Binge eating may also re-start over time as the stomach enlarges again. Overall, the complex psychological difficulties faced by individuals with obesity continue after surgery and may contribute to longer-term weight recidivism. More comprehensive and standardised psychological assessment procedures, including clinical interviews and longer-term follow up, may provide insight into the psychological mechanisms maintaining weight management issues, and may serve as a starting point for improving the long-term success of patients with obesity.

Psychological outcomes following surgical and endoscopic bariatric procedures: A systematic review

Obesity, commonly defined as an excessive accumulation of adipose tissue, is one of the largest preventable and treatable public health concerns.[1] Obesity has significant economic, social, and health implications and affects individuals and families worldwide.[1,2] Obesity weight loss treatments have included lifestyle/behavioural interventions, pharmacological interventions, surgical interventions, and endoscopic bariatric procedures.[2] Generally, a multifactorial approach to treating obesity is most effective, which includes combining treatment approaches. Individually, lifestyle/behavioural interventions have been shown to produce short-term reductions in weight,[3,4] while newer pharmacological approaches have received increasing support for their efficacy.[5] More recently, endoscopic bariatric procedures have also shown promising metabolic outcomes.[6] Endoscopic bariatric procedures emerged as a viable non-surgical alternative to bariatric surgery.[6] Although in its infancy, endoscopic procedures appear to be more economical and have less adverse side effects, health risks, and mortality compared to bariatric surgery.[6] These procedures can be categorised into restrictive-type, malabsorptive, endoscopic gastroplasty techniques, and evolving endoscopic techniques.[6] However, bariatric surgery (metabolic surgery) is the only treatment demonstrating long-term effectiveness in achieving significant weight loss and medical benefits (e.g., remission of type-2 diabetes, metabolic syndrome, hypertension, sleep apnoea).[7-10] Bariatric surgery restricts the intake of food or the body's ability to absorb food, or both.[8] While several types of bariatric surgery have been utilised since its inception, the most commonly used today is gastric bypass and sleeve gastrectomy (i.e., gastric sleeve).[8] Surgery is typically performed laparoscopically, while open procedures are rarely used in modern practice.

Obesity is associated with several health complications such as type-2 diabetes, hypertension, cardiovascular disease, cancer, and musculoskeletal disorders.[1,2] These health complications impinge on one's quality of life and may affect important areas of functioning. Along with numerous metabolic complications, individuals with obesity experience significant psychological difficulties. The most prevalent psychological difficulty experienced by individuals with obesity is depression.[11,12,13] Research has shown that individuals with obesity have a 55% greater chance of developing depression and individuals with depression have a 58% greater chance of developing obesity.[14] Furthermore, 45% of bariatric surgery candidates present with a depressive disorder,[15] while 56% have experienced a depressive disorder throughout their life.[16] Higher lifetime prevalence rates have been reported among women presenting for surgery, with up to 60% experiencing a depressive disorder across the lifetime.[17] Research also indicates that bariatric surgery patients are at a significantly greater risk of attempting and dying by suicide following surgery, and are four times more likely to die by suicide than the general community.[18-21] Therefore, given the association between depression and obesity, and the increased risk of suicide, there is an urgent need to further understand the role of depression in weight loss management.

Furthermore, individuals with obesity have a significantly greater risk of developing an anxiety disorder compared to normal-weight counterparts.[22] The prevalence of anxiety disorders among bariatric surgery candidates ranges from 15 to 25%, with some studies reporting that up to 87% of individuals present with moderate to severe anxiety symptoms.[23-27] Although the link between anxiety and obesity is unclear, severe anxiety has been associated with increased intake of high-fat food, which is implicated in weight gain and obesity.[28] Anxiety has been linked to activation of the hypothalamic-pituitary-adrenal axis, which is the body's stress response.[29] Prolonged dysregulation of the hypothalamic-pituitary-adrenal axis, and in turn chronic stress, contributes to increased appetite and cravings for

highly-fat and sugar dense foods, factors which have been found to contribute to weight gain and obesity.[30-32] Similarly, emotional eating, which is a coping response to negative emotions and stress, has been related to weight gain.[33] Therefore, in response to anxiety and stress, individuals may self-regulate through unhelpful eating patterns and behaviour, which inadvertently contribute to weight gain.

An unhelpful eating behaviour common among individuals with obesity is binge eating. Binge eating refers to (1) eating a quantity of food that is relatively larger than what most people would consume under similar conditions, and (2) a feeling of being unable to stop or control what or how much is being eaten during that period.[34] In addition, binge eating disorder (BED) is characterised by recurrent episodes of binge eating over a three-month period along with associated symptoms (e.g., feeling disgusted with oneself, depressed, or very guilt afterward) and marked distress.[34] Binge eating is highly prevalent among bariatric surgery candidates and has been shown to range from 6 to 35%, with some studies reporting prevalence rates as high as 50%.[27,35-40] Binge eating symptoms have been associated with weight regain, reduced weight loss, higher body mass index (BMI), poorer mental health, and persistent eating difficulties following bariatric surgery.[36,41-44] The impact of binge eating on psychological and medical difficulties pre-and post-surgery is noteworthy and highlights the need for further investigating this behaviour among bariatric surgery patients.

While the medical benefits of bariatric surgery have been well established,[7-10] the psychological outcomes following surgery are less studied and less understood. Furthermore, the extent to which bariatric surgery alleviates psychological difficulties in individuals with obesity remains unanswered. This is an important clinical question for the field of obesity given the high co-occurrence of psychological difficulties and the impact of psychological factors on weight loss, weight regain, and weight maintenance.[14,22,41]

Previous research has shown mixed psychological outcomes following bariatric surgery. Although most patients show reduced psychological symptoms, a significant portion experience persisting psychological concerns, and in some cases worsening mental health.[45-50] Methodological limitations such as a lack of structured clinical interviews or short follow up periods may account for some of this variance. Past research has highlighted the need for systematically examining psychological outcomes through longer-term follow up studies to investigate the sustained effects of obesity treatment once short-term benefits have begun to wane.[46,47,49,50] Furthermore, as a systematic review in this area has not been conducted for over 16 years, the current systematic review provides an important update for the field of obesity.

The present review examined research over the past 16 years, and to our knowledge, is the first review to systematically examine depression, anxiety, and binge eating symptoms based on follow up period in bariatric surgery and endoscopic bariatric procedure patients. This review extends previous research by investigating longer-term follow up periods and including all post-treatment time points. The primary aim of this study was to systematically review depression, anxiety, and binge eating outcomes at different time points (i.e., 6, 12, 24, 36, 48, and 60 months) following bariatric surgery, and to identify whether bariatric surgery significantly reduces psychological symptoms over time. These outcomes were also examined among endoscopic bariatric procedures as a secondary aim of the study.

Method

Protocol and registration

The current systematic review was completed according to the preferred reporting items for systematic reviews (PRISMA) guidelines[51] and was registered with the PROSPERO international prospective register of systematic reviews (CRD42018092816; available from; http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018092816).

Eligibility criteria

Population. Eligible studies contained participants 18 years or older who underwent surgical or endoscopic bariatric procedures for weight loss.

Intervention. Eligible studies contained medically acceptable surgical or endoscopic bariatric procedures. While some procedures are not routinely performed any longer in developed countries, they may be utilised in other parts of the world for research or clinical purposes, and were therefore included to highlight the variability in practice and to examine whether any of these procedures had an opposite effect on outcomes. Studies that combined procedures were included, while studies that contained participants with re-operations were excluded.

Outcome. Depression, anxiety, and binge eating were the primary psychological variables investigated in this review. These variables were chosen because they are the most prevalent psychological difficulties among bariatric surgery candidates.[35,45] Outcomes of interest were changes in depression, anxiety, and binge eating symptoms (means, standard deviations) or clinical diagnosis (percentages or number) following surgical or endoscopic bariatric procedures. Eating behaviour other than binge eating was excluded from this review.

Eligible studies contained both pre-and post-treatment data and a minimum 1 month follow up period. Studies were not excluded for short follow up period to capture all post-treatment functioning. Eligible studies contained standardised measures, clinical interviews, and/or structured diagnostic interviews of psychological functioning, including the Beck Depression Inventory (BDI),[52] Beck Depression Inventory-II (BDI-II),[53] Patient Health Questionnaire (PHQ),[54] Hospital Anxiety Depression Scale (HADS),[55] Beck Anxiety Inventory (BAI),[56] State-Trait Anxiety Inventory (STAI),[57] Binge Eating Scale (BES),[58] Binge Scale Questionnaire (BSQ),[59] Eating Disorder Examination Questionnaire (EDE-Q),[60] Questionnaire on Eating and Weight Patterns (QEWP),[61] Structured Clinical Interview for

Diagnostic and Statistical Manual of Mental Disorders-fourth edition (SCID),[62] Eating Disorder Examination (EDE),[63] and Mini International Neuropsychiatric Interview (MINI).[64] The BDI/II, HADS, and BES were included as they are validated measures of psychological symptoms in bariatric surgery candidates and individuals with obesity.[65-67] The EDE, SCID, and MINI were included as they are "gold standard" clinical diagnostic measures, while the PHQ-9, STAI, BSQ, and QEWP were included due to their commonality. Variations of eligible assessment measures such as cross-culturally validated, or internationally translated versions were also included. Studies not explicitly reporting on diagnosis or symptoms were not included in the review. All other measures were excluded from analyses.

Comparison. Eligible studies included any form of active (e.g., conventional treatment, behavioural/lifestyle intervention, alternative intervention), or inactive control (e.g., participants awaiting weight loss intervention). Studies without a comparison group such as case series designs were also included.

Study design. Observational designs such as cross-sectional studies, prospective longitudinal studies, and case-control studies were eligible. Experimental, quasi-experimental, and non-randomised designs were also included. Meta-analyses, study protocols, case studies, and other reviews were excluded. Studies with small sample sizes (n <20) were also excluded. Furthermore, this review focused on international and domestic studies published from 2002 onwards, in English peer-reviewed journals. Studies published prior to 2002 were excluded from this review because Bocchieri *et al.*[46] and Herpetz *et al.*[47] comprehensively reviewed the literature from 1974 to 2000 and 1980 to 2002, respectively.

Information sources and search strategy

A systematic search of the electronic databases PsycINFO, PubMed, EMBASE (Ovid), Web of Science, and Scopus was performed. This search covered studies published from January 1st, 2002 to August 22nd, 2018, which was the date these databases were last

searched. Other than the dates of coverage, no other search limits were imposed. The electronic search strategy focused on a title, abstract, and keyword search in each database (see Table 1 for search terms) and contained three topics: (1) type of bariatric surgery; (2) type of endoscopic bariatric procedure; and (3) psychological construct (depression, anxiety, binge eating). Database searches were complemented by hand-searching the reference lists of included studies, where additional studies were sourced.

Table 1 Search terms

Study selection

Three authors (DS, ES, JR) independently completed the study selection process. Initially, the studies identified through database searching and additional sources were screened for duplicates, which were subsequently removed. The title and abstracts of the remaining studies were screened, and non-relevant studies were excluded. The full text of the remaining studies was assessed for eligibility. Disagreements regarding study eligibility were resolved through structured discussion among all three authors. The final studies included in the review (n = 48) were agreed upon by all the authors.

Risk of bias assessment

For each included study, two authors (DS, JR) independently completed the quality assessment tool for observational cohort and cross-sectional studies (see Supplementary Material 1).[68] This 14-item tool is designed to measure the risk of selection bias, information bias, measurement bias, or confounding variables within each study. Each author evaluated studies according to these criteria and provided an overall rating for each study. Disagreements regarding study quality were resolved through consensus between authors with the potential of further assistance from the third author (ES), if necessary.

Data extraction

For each study that met inclusion criteria, one author (DS) extracted important information into tables, which were developed specifically for this review (see Supplementary Material 2). The extracted information included sample characteristics (i.e., sample size, mean age of sample, gender distribution, follow up period, dropout rate), study design, inclusion/exclusion criteria, type of surgery, outcome measure, and outcomes. A second author (ES) reviewed data extraction tables for completeness and accuracy.

Data synthesis & analysis

A qualitative synthesis of the outcomes of depression, anxiety, and binge eating following surgical and endoscopic bariatric procedures were presented in this systematic review. Due to insufficient studies at each follow up period, a meta-analysis was not feasible. Demographic and study characteristics of the included studies were synthesised and presented in tables. Depression (Table 2), anxiety (Table 3), and binge eating (Table 4) outcomes were analysed and presented individually. Psychological symptoms (means, standard deviations) and clinical diagnoses (percentages or number) were reported as having significantly ($p = < 0.05$) reduced, increased, or not significantly changed ($p = > 0.05$) and having stayed the same over time (i.e., symptoms persisting). To assist with the interpretation and analysis of results, each psychological construct was organised according to follow up period and presented in figures (see Figure 1 for depression, Figure 2 for anxiety, and Figure 3 for binge eating). Some studies measured outcomes over a period (e.g., 6 to 12 months) and were therefore categorised according to their final follow up. Studies that did not naturally fit into a category were rounded to the nearest category (e.g., 38 months follow up rounded to 36-month category) or next appropriate category. Studies with follow up data at 60 months or more were grouped together. Some studies reported a significant reduction in symptoms across one time point (e.g., pre-surgery to 6 months post-surgery) but a significant increase in

symptoms across another (e.g., 6 months post-surgery to 12 months post-surgery), while other studies reported a significant reduction on one measure or intervention, but not another. These studies were reported multiple times within a category to reflect all outcomes.

Table 2 Characteristics of depression studies by follow up period

Table 3 Characteristics of anxiety studies by follow up period

Table 4 Characteristics of binge eating studies by follow up period

Figure 1 Depression

Figure 2 Anxiety

Figure 3 Binge eating

Results

Study selection

A flowchart of the study selection process is presented in Figure 4. A total of 1501 title and abstracts and 114 full text articles were reviewed. Of these, 1387 studies were excluded based on title and abstract and a further 66 studies were excluded following full text examination. As a result, a total of 48 studies were included in this systematic review.

Figure 4 PRISMA flowchart of the study selection process.

Study characteristics

The 48 studies that met inclusion criteria were mostly observational cohort studies. Thirty-nine studies reported on depression, 23 reported on anxiety, and 19 reported on binge eating. Some studies reported on all three outcomes. Only two studies reported on endoscopic bariatric procedures, highlighting an urgent area of research and an important aim of this review.[69,70] Therefore, results were discussed with reference to bariatric surgery and were not reflective of endoscopic bariatric procedures. On average, samples were primarily composed of females (80%) and the mean age prior to surgery was 41.7 years. Most studies adhered to recommended BMI criteria.[2] Sample sizes ranged from 20 to 2146 participants and the average dropout rate post-surgery was 30%. The median follow up time after surgery was 12 months and the range was one to 120 months. Fifteen different types of bariatric surgery methods were utilised, the most common being gastric bypass surgery (40%) followed by laparoscopic adjustable gastric banding (28%) and sleeve gastrectomy (15%). Thirty-eight studies utilised questionnaires to assess psychological outcomes, 10 studies used structured diagnostic interviews or clinical interviews, and one study used a combination of both questionnaires and interviews. Depression and binge eating outcomes were assessed through seven different assessment measures, while anxiety outcomes were assessed through five different assessment measures (see Table 5 for measures).

Table 5 Assessment measures

Risk of bias assessment

According to the quality assessment tool for observational cohort and cross-sectional studies,[68] there were 30 studies rated as “good”, 18 studies rated as “fair”, and zero studies rated as “poor”. Agreement between authors (DS, JR) was determined to be good (81%). As

expected, the risk of bias within and across studies was low, which was likely due to the pre-selected inclusion and exclusion criteria. The most common cause of bias was self-report measures, high dropout rates, and inadequate follow up regarding both the frequency and the length.

Depression outcomes

1-6 months. There were 13 studies that measured depression outcomes at or prior to six months post-treatment. One study[71] found a reduction in symptoms at one-month follow up; however, this was not found in another study at two months follow up,[72] despite both studies using Roux-en-Y gastric bypass (RYGB). Ten studies reported on depression symptoms or changes in clinical diagnosis at six months post-surgery, and two after endoscopic bariatric procedures. Eleven out of these 12 studies reported a reduction in depression symptoms from pre-treatment.[11,39,69,70,72-78] One study compared laparoscopic sleeve gastrectomy (LSG) with laparoscopic greater curvature plication (LGCP) and found a reduction only with LSG.[77] One study found that pre-surgery depression symptoms stayed the same at six month follow up.[26] This was the only study to use a clinical diagnosis and structured clinical assessment (a more reliable assessment of depression) instead of questionnaires. Furthermore, the only two studies on endoscopic bariatric procedures found a significant reduction in depression symptoms at three[70] and six months follow up.[69,70]

Seven studies conducted RYGB [11,71,72,73,78] or gastric bypass (GBY),[26,75] four used LSG[39,76,77] or sleeve gastrectomy (SG),[11] and two used laparoscopic adjustable gastric banding (LAGB).[11,72] Other studies used LGCP,[77] duodenal switch (DS),[74] biliopancreatic diversion with duodenal switch (BDP/DS),[11] or intragastric balloon.[69,70] Apart from the documented differences above, there were no other differences in depression outcomes.

12 months. There were 19 studies that collected their follow-up data at around 12 months post-surgery. Seventeen out of these 19 studies reported a reduction in depression

symptoms from pre surgery,[11,12,23-25,37,74,75,77,79-86] but two studies found that depression symptoms remained the same from six month follow up.[71,72] One of these studies collected their data between six to 10 months post-surgery and found that pre-surgery depression symptoms reduced from 78% to 44%.[23] Two of these studies used clinical assessments and found an overall reduction of people with depression,[24,86] whereas one did not.[25] However, the study that did not find a reduction using a clinical assessment, did find a reduction in symptoms on a questionnaire.[25]

Twelve studies conducted RYGB[11,25,71,72,83,85] or GYB[24,75,79,80,82,86] and seven used LAGB.[11,12,37,72,84-86] Other studies used LSG or SG, LGCP, BPD, DS, vertical gastroplasty (VG), and gastric banding (GB). These procedures were not very commonly used, and they reflected similar findings; except for LGCP,[77] which did not find a reduction in depression symptoms. Several studies used more than one procedure,[11,24,72,77,81,83,85,86] but only one examined the differences between procedures.[85] There were no other differences in depression outcomes.

24 months. There were nine studies that collected their follow up data at around 24 months post-surgery. Eight out of these nine studies reported a reduction in depression symptoms from pre surgery,[11,12,35,81,82,86-88] but one study found that pre-surgery depression symptoms remained the same at 24 month follow up.[27] Two of these studies used clinical assessments and found an overall reduction of people with depression,[35,86] whereas one did not.[27]

Six studies conducted RYGB[11,27,87,88] or GBY[82,86] and six used LAGB.[11,12,27,35,86,87] Other studies used SG, BPD/DS, VG, and GB, but these were not very commonly used, and they found similar outcomes to other surgery options. There were no other differences in depression outcomes.

36 months. There were seven studies that collected their follow up data at around 36 months post-surgery. Six out of these seven studies reported a reduction in depression symptoms from pre surgery,[11,12,24,86,89,90] but one study found that pre-surgery depression symptoms remained the same at 36 month follow up.[27] One of these studies used a clinical assessment and found an overall reduction of people with depression,[86] whereas another did not.[27] One study found a significant increase in depression symptoms from 12 to 36 months post-surgery, despite showing a reduction from pre-surgery.[11] Furthermore, one study found that those who undertook surgery (GB group) had a greater reduction in depression symptoms compared to those who received non-surgical intervention.[89]

Five studies conducted RYGB[11,27,90] or GBY,[24,86] five used LAGB,[11,12,27,86,90] two used SG,[11,86] and two used GB.[24,89] One study used multiple procedures (e.g., RYBG, LAGB, SG, GBY BDP/DS) and was the only study to find a significant increase in depression symptoms.[11] There were no other differences in depression outcomes.

48 months. There were six studies that collected their follow up data at around 48 months post-surgery. Five out of these six studies reported a reduction in depression symptoms from pre-surgery,[12,40,88,91,92] but one study found that depression symptoms returned to pre-surgery levels, after having reduced at earlier time-points.[86] One study used a clinical diagnosis and structured clinical assessment instead of questionnaires, and this was the only study to find depression symptoms return to pre-surgery levels.[86] One study found that those who undertook surgery (GB group) had a greater reduction in depression symptoms compared to those who received non-surgical intervention.[91] Furthermore, one study measured outcomes from 24 to 59 months post-surgery and found a reduction in depression symptoms from pre-surgery.[88]

Two studies conducted LAGB,[12,86] two used GB,[91,92] two used RYGB[88] or GBY,[86] two used LSG[48] or SG,[86] and one study used VG.[92] There were no other differences in depression outcomes.

≥ 60 months. There were seven studies that collected their follow up data at or after 60 months post-surgery. Five out of these seven studies reported a reduction in depression symptoms from pre-surgery.[13,66,88,91,93] However, one study found that depression symptoms returned to pre-surgery levels, after having reduced at earlier time-points,[86] while another study found that pre-surgery depression symptoms remained the same at 60 month follow up.[36] These two studies were the only ones to use a clinical diagnosis and structured clinical assessment instead of questionnaires.[36,86] One study found a reduction in depression symptoms from pre-surgery, but a significant increase in depression symptoms from 12 to 60 months post-surgery.[88] One study found that those who undertook surgery (GB group) had a greater reduction in depression symptoms at 60 and 72 months follow up compared to those who received non-surgical intervention.[91] Similarly, one study found that those in the surgical group (GB) had a greater reduction in depression symptoms at 67 and 86 month follow up compared to those in the non-surgical group.[13] Only one study measured depression symptoms at 120 months follow up and found a reduction from pre-surgery.[66] Some studies measured multiple time-points beyond 60 months post-surgery, but they reflected similar outcomes to their findings at 60 months.[13,86,91]

Three studies conducted RYGB[88] or GBY,[66,86] three used GB,[13,66,91] two used LAGB,[36,86] one used BPD/DS,[93] and one study used vertical banded gastroplasty (VBG).[66] There were no other differences in depression outcomes.

Overall depression outcomes. Overall, these findings suggest that pre-surgery depression diagnosis or depression symptoms reduce for most individuals at six, 12, and 24 months after bariatric surgery. However, at 36, 48, and 60 months follow up, depression

symptoms increase after having reduced at earlier time-points and may even return to pre-surgery levels. This is more consistently found when depression is assessed by a psychologist, rather than by self-report.

Anxiety outcomes

1-6 months. There were six studies that measured anxiety outcomes at or prior to six months post-treatment. Five out of these six studies reported a reduction in anxiety symptoms from pre-surgery,[39,69,74,76,77] but one study found that pre-surgery generalised anxiety disorder stayed the same at six months follow up.[26] This was the only study to use a clinical diagnosis and structured clinical assessment instead of questionnaires.[26] One study compared LSG with LGCP and found a reduction only with LSG at three and six months follow up.[77] Furthermore, the only study on endoscopic bariatric procedures found a significant reduction in anxiety symptoms at six months follow up.[69]

Three studies conducted LSG,[39,76,77] one used LGCP,[77] one used GBY,[26] one used IB,[69] and one study used DS.[74] Other than LGCP, all procedures reflected similar findings. There were no other differences in anxiety outcomes.

12 months. There were nine studies that collected their follow up data at around 12 months post-surgery. Seven out of these nine studies reported a reduction in anxiety symptoms from pre-surgery,[23,25,74,77,81,82,85] but two studies found that pre-surgery anxiety symptoms stayed the same at 12 month follow up.[24,83] One study collected their data between six to 10 months post-surgery and found that pre-surgery anxiety symptoms reduced from 87% to 57%.[23] One study used a clinical assessment and found an overall reduction of people with an anxiety disorder,[25] whereas another did not.[24] However, the study that found a reduction using a clinical assessment, did not find a reduction in symptoms on an anxiety questionnaire.[25]

Five studies conducted RYGB[25,83,85] or GBY,[24,82] two used GB,[24,81] two used BPD,[83,85] and two used LSG[77] or SG.[83] Other studies used LAGB,[85] DS,[74] VG,[81] and LGCP.[77] These procedures were not very commonly used, and they reflected similar findings; except for LGCP,[77] which did not find a reduction in anxiety symptoms. Several studies used more than one procedure,[24,77,81 83,85] but only one examined the differences between procedures.[85] There were no other differences in anxiety outcomes.

24 months. There were five studies that collected their follow up data at around 24 months post-surgery. Three out of these five studies reported a reduction in anxiety symptoms from pre-surgery.[35,82,88] However, one study found that anxiety symptoms returned to pre-surgery levels, after having reduced at an earlier time-point,[81] while another study found that pre-surgery anxiety symptoms remained the same at 24 months follow up.[27] Furthermore, one of these studies used a clinical assessment and found an overall reduction of people with an anxiety disorder,[35] whereas another did not.[27]

Three studies conducted RYGB[27,88] or GBY,[82] two used LAGB,[27,35] and one study used a combination of VG and GB.[81] There were no other differences in anxiety outcomes.

36 months. There were four studies that collected their follow up data at around 36 months post-surgery. Two out of these four studies reported a reduction in anxiety symptoms from pre-surgery,[27,89] but two studies found that pre-surgery anxiety symptoms stayed the same at 36 months follow up.[24,90] One of these studies used a clinical assessment and found an overall reduction of people with an anxiety disorder,[27] whereas another did not.[24] One study found that those who undertook surgery (GB group) had a greater reduction in anxiety symptoms compared to those who received non-surgical intervention.[89]

Three studies conducted RYGB[27,90] or GBY,[24] two used LAGB,[27,90] and two used GB.[24,89] There were no other differences in anxiety outcomes.

48 months. There were four studies that collected their follow up data at around 48 months post-surgery. Two out of these four studies reported a reduction in anxiety symptoms from pre-surgery,[88,89] but two studies found that pre-surgery anxiety symptoms stayed the same at 48 months follow up, or returned to pre-surgery levels, after having reduced at an earlier time-point.[92,94] One of these studies compared a surgical (BPD) and non-surgical group and found that pre-surgery state and trait anxiety remained the same at 48 months follow up.[94] One study found that those who undertook surgery (GB group) had a greater reduction in anxiety symptoms compared to those who received non-surgical intervention.[89] Furthermore, one study measured outcomes from 24 to 59 months post-surgery and found a reduction in anxiety symptoms from pre-surgery.[88]

Two studies conducted GB,[89,92] one used RYGB,[88] one used BPD,[94] and one study used VG.[92] There were no other differences in anxiety outcomes.

≥ 60 months. There were four studies that collected their follow up data at or after 60 months post-surgery. Two out of these four studies reported a reduction in anxiety symptoms from pre-surgery.[66,91] but two studies found that pre-surgery anxiety symptoms stayed the same at 60 months follow up, or returned to pre-surgery levels, after having reduced at an earlier time-point.[88,93] One of these studies found a significant increase in anxiety symptoms from 23 to 60 months post-surgery and from 24-59 to 60 months post-surgery, despite having reduced from pre-surgery to 23 months.[88] One study found that those who undertook surgery (GB group) had a greater reduction in depression symptoms at 60 and 72 months follow up compared to those who received non-surgical intervention.[91] Only one study measured anxiety symptoms at 120 months follow up and found a reduction from pre-surgery.[66]

Two studies conducted RYGB[88] or GBY,[66] two used GB,[66,91] one used BPD/DS,[93] and one study used VBG.[66] There were no other differences in anxiety outcomes.

Overall anxiety outcomes. Overall, 48% of studies (11 out of 23 studies) found that pre-surgery anxiety diagnosis or anxiety symptoms remained the same at follow up or increased after having reduced at earlier time-points. Furthermore, these findings suggest that at six, 12, and 24 months after bariatric surgery, anxiety symptoms reduce for most bariatric surgery patients. However, at 36, 48, and 60 months follow up, anxiety symptoms may increase after having reduced at earlier time-points and may even return to pre-surgery levels.

Binge eating outcomes

1-6 months. There were three studies that measured binge eating outcomes at six months post-surgery. Two out of these three studies reported a reduction in binge eating symptoms from pre-surgery.[95,96] The third study used a clinical assessment and found that pre-surgery BED reduced from 35% to 0%, however this study did not indicate whether this was a statistically significant reduction.[39]

One study conducted RYGB,[95] one used LSG,[39] and one used a combination of SG and GBY.[96] There were no other differences in binge eating outcomes.

12 months. There were seven studies that measured binge eating outcomes at 12 months post-surgery. Five out of these seven studies reported a reduction in binge eating symptoms from pre-surgery,[37,44,79,85,97] but two studies did not report whether changes were statistically significant.[80,98] One study used a clinical assessment and found that pre-surgery BED reduced from 100% to 8%, however this study did not indicate whether this was a statistically significant reduction.[98] Similarly, one study found that pre-surgery BED and weekly binge eating reduced from 10% and 24% to 0% and 0.7% respectively; however, this study did not indicate whether this was a statistically significant reduction.[80]

Six studies conducted RYGB[44,85,97,98] or GBY,[79,80] three used LAGB,[37,85,98] one used SG,[97] and one study used BPD.[85] Only one study examined the differences between procedures.[85] There were no other differences in binge eating outcomes.

24 months. There were six studies that collected their follow up data at around 24 months post-surgery. Three out of these six studies reported a reduction in binge eating symptoms from pre-surgery,[43,88,97] but three studies did not report whether changes were statistically significant, despite all finding a decrease in BED from pre to post-surgery.[27,35,99] All three of these studies also used a clinical diagnosis and clinical assessment.[27,35,99] Furthermore, one study measured outcomes from eight to 24 months post-surgery and found a reduction in binge eating symptoms from pre-surgery.[43]

Four studies conducted RYGB,[27,88,97,99] four used LAGB,[27,35,43,99] and one study used SG.[97] There were no other differences in binge eating outcomes.

36 months. There were four studies that collected their follow up data at around 36 months post-surgery. Two out of these four studies reported a reduction in binge eating symptoms from pre-surgery,[90,97] but two studies using clinical assessments did not report whether changes were statistically significant,[27,38] One study measured outcomes from 18 to 35 months post-surgery and found that pre-surgery BED reduced from 29% to 3%, however this study did not indicate whether this was a statistically significant reduction.[38] Similarly, one study found that pre-surgery BED reduced from 6% to 3%, however this study did not indicate whether this was a statistically significant reduction.[27]

Four studies conducted RYGB,[27,38,90,97] two used LAGB,[27,90] and one study used SG.[97] There were no other differences in binge eating outcomes.

48 months. There were two studies that collected their follow up data at around 48 months post-surgery. One study measured outcomes from 24 to 59 months post-surgery and found a reduction in binge eating symptoms from pre-surgery.[88] The other study used a clinical assessment and found that pre-surgery BED reduced from 13% to 2%, however this study did not indicate whether this was a statistically significant reduction.[40]

One study used RYGB,[88] while the other used LSG.[40] There were no other differences in binge eating outcomes.

≥ 60 months. There were three studies that collected their follow up data at or after 60 months post-surgery. One study measured outcomes from 25 to 68 months post-surgery and found a reduction in binge eating symptoms from pre-surgery.[43] One study found that binge eating symptoms returned to pre-surgery levels, after having reduced at earlier time-points, and that binge eating symptoms significantly increased from 23 to 60 months post-surgery.[88] The final study used a clinical assessment and found that pre-surgery BED stayed the same at 60 months follow up.

Two studies used LAGB[36,43] and one study used RYGB.[88] There were no other differences in binge eating outcomes.

Overall binge eating outcomes. Overall, these findings suggest that pre-surgery BED diagnosis or binge eating symptoms reduce for most individuals after bariatric surgery. However, at longer-timer follow up, binge eating may re-start again and may even return to pre-surgery levels. Furthermore, it is unclear whether more bariatric surgery patients experience ongoing binge eating concerns as several studies did not explicitly indicate whether changes in binge eating were statistically significant.

Discussion

The current systematic review investigated the psychological functioning of individuals with obesity following surgical and endoscopic bariatric procedures. To our knowledge, this is the most recent systematic review of this area, since Herpetz *et al.*[47] in 2003. Furthermore, this was the first review to systematically stratify depression, anxiety, and binge eating outcomes by follow up period in bariatric surgery and endoscopic bariatric procedure patients.

Depression

Overall, the impact of bariatric surgery on depression varied across studies. The findings of this review suggest that pre-surgery depression diagnosis or depression symptoms reduce for most individuals at six, 12, and 24 months after bariatric surgery. However, from 36 month follow up and onwards, depression symptoms increase after having reduced at earlier time-points and may even return to pre-surgery levels.

These findings support the notion of a postoperative "psychological honeymoon period", where significant weight loss due to surgery temporarily negates the impact of depression, only to re-emerge once the surgical benefits wane.[24,90,100] One explanation for this effect is that weight re-gain often occurs several years after surgery, which is a factor associated with increasing depression symptoms.[66] However, the direction of this relationship is still unclear. An alternative explanation is that with the significant reduction in weight, individuals increase physical activity and exercise and re-engage in pleasurable experiences, thereby improving their mood. In addition, the positive feelings and helpful thoughts associated with weight loss may motivate the patient to live in line with their values and further elevate their mood.[101] However, once weight loss plateaus or weight re-gain occurs, the individual disengages with pleasurable and valued activities and underlying core beliefs resurface, re-eliciting depression. Similarly, significant weight loss may impact depression on a biological level. Research suggests that individuals with obesity and depression both show activation of the inflammatory response system as well as higher levels of proinflammatory cytokines (e.g., interleukin-6, tumor necrosis factor-α) compared to matched controls.[102,103] Weight loss induced by diet, physical exercise, and surgical interventions has been shown to decrease pro-inflammatory markers and increase anti-inflammatory markers in obesity,[104,105] factors which have been linked to a reduction in depression symptoms.[106,107] Thus, surgically-induced weight loss not only improves medical complications, but it also decreases

inflammation in the body, which may play a role in reducing depression symptoms for bariatric surgery patients. Furthermore, patient expectations of treatment may also contribute to depression symptomology. For example, some individuals may not achieve their goal weight, or if they do, it does not shift their negative self-perception as expected. Others may have had an experience incongruent with their expectations, such as unanticipated medical complications. Unmet or unrealistic expectations of weight loss, or an unshifted negative self-perception following treatment may be related to increasing depression symptoms over time. Therefore, whether due to a biological vulnerability to depression, re-emerging core beliefs, or reverting to old ways of thinking and behaving, many individuals experience significant mood difficulties following surgery.

Anxiety

The impact of bariatric surgery on anxiety also varied across studies. In this review, 48% of studies found that pre-surgery anxiety diagnosis or anxiety symptoms remained the same at follow up or increased after having initially reduced. This review also found that most bariatric surgery patients experience a short-term reduction in anxiety symptoms, but over time, anxiety symptoms increase and may even return to pre-surgery levels. One explanation for these findings is that unlike depression, treatment for anxiety involves exposing the patient to the anxiety-provoking stimuli, rather than re-engaging with pleasurable and valued activities.[108] Therefore, anxiety disorders are less affected by bariatric surgery because underlying cognitive and behavioural factors that maintain anxiety, are not directly targeted. Alternatively, these findings may be a result of the unspecific assessment and reporting of anxiety outcomes in the literature. Studies that reported on changes in diagnoses commonly clustered anxiety disorders together (e.g., post-traumatic stress disorder, generalised anxiety disorder, social phobia) therefore not accounting for variations among disorders. Additionally, self-report questionnaires, which were the most common assessment

method used, may be ineffective in differentiating the physiological experience of anxiety from the physiological sensations of obesity, further confounding outcomes. However, regardless of whether results are due to inadequate assessment methods or the greater resistance of anxiety to bariatric surgery, half of patients experience persisting anxiety concerns following surgery.

Binge eating

In contrast, the impact of bariatric surgery on binge eating demonstrated a more consistent pattern. The findings of this review suggest that pre-surgery binge eating symptoms or clinical diagnosis reduce for most individuals after bariatric surgery but may re-start again at longer-term follow up. This is unsurprising given that bariatric surgery anatomically restricts the capacity to objectively binge eat or overeat. As objective binge episodes are required to diagnose BED, most individuals will not meet diagnostic criteria post-surgery. However, it is unclear whether more bariatric surgery patients experience persisting binge eating difficulties as several studies did not explicitly indicate whether changes in binge eating were statistically significant. Nevertheless, many researchers argue that new disordered eating behaviours develop or exacerbate post-surgery such as grazing, loss of control eating, and vomiting.[38,99,109,110] Grazing is the repetitive and unplanned consumption of smaller quantities of food across time, without the sense of loss of control.[110] Research suggests that grazing behaviour and loss of control eating, which may persist or worsen post-surgery, is associated with less weight loss, weight regain, and elevated psychological difficulties.[37,38,40,42,99,110-112] In addition, vomiting is linked to several medical complications including gastroesophageal reflux disease, cardiac arrhythmias, and electrolyte abnormalities.[113] Vomiting may also be the result of overeating or attempts to binge eat.[47,109] Therefore, while individuals may be physiologically unable to objectively binge eat, many

may develop postoperative disordered eating behaviour which may be equally harmful and require equal investigation.

Effect of procedure-type on psychological outcomes

This review also investigated the impact of procedure-type on psychological outcomes. The three most common procedures identified in this review (GBY, LAGB, SG) did not demonstrate significantly different psychological outcomes. While these results may have been biased by the small number of studies in each group, there is limited theoretical and empirical evidence to suggest that depression and anxiety varies according to procedure-type.[86] However, some studies have shown that post-surgery depression and anxiety symptoms differ based on the procedure used[11,77] but it is unclear why these differences occurred. One explanation may be related to differences in weight loss outcomes between groups, however these outcomes were not reported. Another explanation is that some surgeries induce more anxiety or fear than others due to their irreversible nature; however, this requires further investigation. In addition, previous research has found differences in weight loss and disordered eating behaviour based on procedure-type. For example, gastric bypass has been shown to produce greater weight loss than LAGB, and restrictive surgery procedures have shown a differential impact on post-surgery eating behaviour compared to malabsorptive procedures or combined procedure-types.[47,114] Nonetheless, it remains unclear whether any bariatric procedures lead to long-term improvement of disordered eating behaviours.[115] Interestingly, LAGB was the second most common procedure identified in this review and accounted for 28% of all procedures. The high frequency of LAGB reported in the literature is concerning, given that surgeons have moved away from this procedure in modern practice. This finding suggests that some parts of the world may be following outdated bariatric surgery procedures, which may put their patients at psychological and medical risk. Furthermore, findings from this review suggest that the type of assessment

method and the length of follow is more likely to account for the variation in psychological outcomes than the procedure-type used.

Limitations of the current research

The findings of this review should be interpreted with consideration due to the methodological limitations of the articles reviewed. Firstly, as past reviews have pointed out,[46,47] it is not viable for an obesity surgery study to meet the criteria of a level one evidence category due to the ethical implications of random allocation to surgery. Therefore, most of the reviewed studies corresponded to a lower evidence category than is typically expected in a systematic review. Secondly, over 80% of bariatric surgery patients were women. Research suggests that compared to men, women present more frequently to weight loss treatment, experience greater levels and intensity of psychopathology (e.g., depression and body image disturbances), and suffer considerably more due to socio-cultural idealisations of thinness.[116] Thirdly, 30% of bariatric surgery patients did not attend post-surgery follow up consultations. Individuals that do not attend review appointments may have regained weight, experienced greater difficulties losing weight, or may have underlying and persisting psychological difficulties. Similarly, individuals who perceive themselves to be managing inadequately (psychologically or medically) may avoid review appointments due to shame or fear of negative evaluation from health professionals. It is also noteworthy that the psychosocial evaluation of most patients before surgery was partly required as a prerequisite for surgery and health insurance claims. As binge eating disorder was previously considered a contraindication for surgery, many bariatric surgery candidates may have underreported their concerns due to fears of ineligibility for surgery.[117] Therefore, due to the high dropout rates, disproportionate presentation of women, inability to randomly allocate patients to surgery, and potential underreporting, the results of this review should be interpreted carefully.

Furthermore, a significant limitation identified in this review is the over-reliance on self-report instruments to assess psychological functioning. Less than one-third of studies used structured diagnostic interviews or clinical interviews to assess psychological symptoms. However, more than half of the depression and anxiety studies that used clinical assessments found that pre-surgery symptoms remained the same at follow up. These findings question the reliability of different assessment methods. For example, self-report measures may be ineffective in differentiating the physiological sensations of obesity from anxiety symptoms or may overlook whether anxious cognitions are exclusive to the experience of obesity. They may also fail to identify new disordered eating behaviour that occurs in lieu of binge eating such as grazing, loss of control eating, and vomiting. Similarly, individuals completing self-report measures may find it difficult to report on their binge eating habits due to a lack of insight or understanding. Alternatively, while underutilised, clinical interviews provide insight into the individual's experience of treatment, including perceived support, expectations, and challenges. They are also more reliable at identifying new disordered eating patterns that emerge post-surgery as well as providing context to results on self-report measures. For example, they may identify that individuals report highly on a social anxiety measure because they fear negative evaluation *specifically* about their weight, shape, or appearance. Overall, clinical interviews provide a more in-depth understanding of the complexities of the patient, which may be vital for improving treatment outcomes for bariatric surgery patients.

Another significant limitation identified in this review is the lack of long-term follow up studies. Most studies examined psychological outcomes at 12 months, while fewer studies assessed outcomes beyond 24 months. This is important to consider when interpreting the results of this review because different trends emerge depending on the length of follow up. For example, in depression, a pattern of reduced symptoms was typically observed six to 24

months following surgery, while an increase in symptoms was observed from 36 months and beyond. Not examining outcomes at longer-term follow up may misinform researchers and clinicians and lead to varied conclusions. This may be one factor contributing to mixed results in psychological functioning. Finally, this review was limited in the ability to draw conclusions on endoscopic bariatric procedures, as only two studies examined this treatment option.

Implications and recommendations for future research and clinical practice

As past research has highlighted, there is a greater need to focus on the psychological well-being of patients undergoing bariatric surgery.[118] This review contributes to elucidating the relationship between bariatric surgery and longer-term psychological functioning. However, given the limitations in the literature and current findings, there are several areas that should be explored to advance the field. Firstly, there is a need for more comprehensive and standardised psychological assessment procedures among bariatric surgery candidates. This includes the use of clinical assessments, which should be a mandatory component of clinical practice. Clinical assessments should focus on identifying existing psychological difficulties in patients as well as persisting or newly developed disordered eating behaviour. For example, assessing for loss of control eating after surgery rather than binge eating, as binge eating may be difficult to quantify after surgery due to the restricted amount of food that is tolerated. The use of thorough psychological assessment procedures will lead to more informed conclusions about patient psychological functioning compared to self-report measures, which do not adequately capture psychological functioning among bariatric surgery patients. Similarly, clinical practice should prioritise the treatment of both the medical and psychological complications associated with obesity. Not only will this ensure a holistic approach to treatment, but evidence suggests that psychological support is a vital

adjunct to obesity treatment and contributes to greater weight loss and more sustainable outcomes compared to bariatric surgery alone.[119,120]

Secondly, the findings of this review highlight the necessity of examining psychological outcomes beyond 36 months to adequately allow for psychological and physical (i.e., hormone) adjustment following bariatric surgery. Adopting a minimum follow up period will enable researchers and clinicians to examine the sustained effects of surgery and more accurately comment on the long-term psychological outcomes of surgical intervention. Additionally, future research should examine more complex and enduring psychological factors such as schema style, emotional coping strategies, and history of traumatic experiences. Understanding these more pervasive and enduring psychological factors may contribute to identifying subgroups of patients who have a profile more likely to impede the long-term success of treatment. Future research should also continue to investigate the psychological and medical predictors of obesity treatment outcomes to identify those vulnerable to persisting difficulties. Future reviews should focus on identifying specific cognitive, behavioural, and personality factors unique to bariatric surgery candidates as well as the role of executive deficits and other psychological maintaining factors in obesity. Finally, with the recent emergence of endoscopic bariatric procedures for individuals with obesity, future research should investigate the short and long-term impact of these procedures on psychological functioning.

Summary

This review was the first to systematically examine depression, anxiety, and binge eating symptoms following surgical and endoscopic bariatric procedures, and to report outcomes based on follow up period. Findings from this review suggest that pre-surgery depression and anxiety symptoms reduce for most individuals in the short-term; however, over time, symptoms may increase and may even return to pre-surgery levels. Changes in

anxiety symptoms also appear to be more resistant to bariatric surgery than depression symptoms. These findings are consistent with the notion of a psychological honeymoon period following surgery. Evidence from this review suggests that the psychological honeymoon period may last up to 36 months for bariatric surgery patients. In contrast, BED was rarely identified following surgery, potentially due to the anatomical restrictions of bariatric surgery procedures. However, other disordered eating patterns are found to emerge, and binge eating may re-start over time as the stomach enlarges again. Thus, BED findings may be oversimplified and may mislead researchers and clinicians.

Conclusion

Overall, findings from this review provide evidence that bariatric surgery does not sufficiently reduce psychological symptoms over time and that a significant number of individuals experience elevated psychological difficulties. Therefore, it is imperative that we begin to pay attention to the psychological mechanisms that may jeopardise successful long-term weight management following bariatric surgery. More comprehensive and standardised psychological assessment procedures including clinical interviews and at minimum, 36 months follow up, may provide significant insight into the underlying mechanisms that contribute to longer-term weight recidivism. This will serve as a starting point for psychological interventions to begin addressing the psychological mechanisms maintaining long-term weight management issues in patients with obesity.

Conflicts of Interest Statement

The authors have no competing interests.

References

1. World Health Organization (WHO). Overweight and Obesity Factsheet [document of the internet; updated 2018 Feb 16; cited 2018 Oct 25] Available from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
2. National Institute for Health and Care Excellence. Obesity: identification, assessment and management. NICE clinical guideline (CG189). London: Department of Health. 2014.
3. Lv N, Azar KM, Rosas LG, Wulfovich S, Xiao L, Ma J. Behavioral lifestyle interventions for moderate and severe obesity: a systematic review. *Prev Med.* 2017; 100: 180-193. doi:10.1016/j.ypmed.2017.04.022.
4. LeBlanc ES, O'connor E, Whitlock EP, Patnode CD, Kapka T. Effectiveness of primary care–relevant treatments for obesity in adults: a systematic evidence review for the US preventive services task force. *Ann Intern Med.* 2011; 155(7): 434-447. doi:10.7326/0003-4819-155-7-201110040-00006.
5. Van Gaal L, Dirinck E. Pharmacological approaches in the treatment and maintenance of weight loss. *Diabetes Care* 2016; 39(Supplement 2): S260-S267. doi:10.2337/dcS15-3016.
6. Choi HS, Chun HJ. Recent trends in endoscopic bariatric therapies. *Clin Endosc.* 2017; 50(1): 11-16. doi:10.5946/ce.2017.007.
7. Gloy VL, Briel M, Bhatt DL, Kashyap SR, Schauer PR, Mingrone G *et al*. Bariatric surgery versus non-surgical treatment for obesity: a systematic review and meta-analysis of randomized controlled trials. *BMJ* 2013; 347: f5934. https://doi.org/10.1136/bmj.f5934.

8. Colquitt JL, Pickett K, Loveman E, Frampton GK. Surgery for weight loss in adults. *Cochrane Database Syst Rev.* 2014; 8: CD003641. doi:10.1002/14651858.CD003641.pub4.

9. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K *et al.* Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004; 292(14): 1724-1737. doi:10.1001/jama.292.14.1724.

10. Chang SH, Stoll CR, Song J, Varela JE, Eagon CJ, Colditz GA. The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012. *JAMA Surg.* 2014; 149(3): 275-287. doi:10.1001/jamasurg.2013.3654.

11. Mitchell JE, King WC, Chen JY, Devlin MJ, Flum D, Garcia L *et al.* Course of depressive symptoms and treatment in the longitudinal assessment of bariatric surgery (LABS-2) study. *Obesity* 2014; 22(8): 1799-1806. doi:10.1002/oby.20738.

12. Dixon JB, Dixon ME, O'Brien PE. Depression in association with severe obesity: changes with weight loss. *Arch of Inter Med.* 2003; 163(17): 2058-2065. doi:10.1001/archinte.163.17.2058.

13. Schowalter M, Benecke A, Lager C, Heimbucher J, Bueter M, Thalheimer A *et al.* Changes in depression following gastric banding: a 5- to 7-year prospective study. *Obes Surg.* 2008; 18(3): 314-320. doi:10.1007/s11695-007-9316-7.

14. Luppino FS, de Wit LM, Bouvy PF, Stijnen T, Cuijpers P, Penninx BW *et al.* Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Arch Gen Psychiatry* 2010; 67(3): 220-229. doi:10.1001/archgenpsychiatry.2010.2.

15. Alabi F, Guilbert L, Villalobos G, Mendoza K, Hinojosa R, Melgarejo JC *et al.* Depression before and after bariatric surgery in low-income patients: the utility of the

beck depression inventory. *Obes Surg.* 2018; 28(11): 3492-3498. doi:10.1007/s11695-018-3371-0.

16. Glinski J, Wetzler S, Goodman E. The psychology of gastric bypass surgery. *Obes Surg.* 2001; 11(5): 581-588. doi:10.1381/09608920160557057.
17. Mühlhans B, Horbach T, de Zwaan M. Psychiatric disorders in bariatric surgery candidates: a review of the literature and results of a German prebariatric surgery sample. *Gen Hosp Psychiatry* 2009; 31(5): 414-421. doi:10.1016/j.genhosppsych.2009.05.004.
18. Peterhänsel C, Petroff D, Klinitzke G, Kersting A, Wagner B. Risk of completed suicide after bariatric surgery: a systematic review. *Obes Rev.* 2013; 14(5): 369-382. doi:10.1111/obr.12014.
19. Adams TD, Gress RE, Smith SC, Halverson RC, Simper SC, Rosamond WD *et al.* Long-term mortality after gastric bypass surgery. *N Engl J Med.* 2007; 357(8): 753-761. doi:10.1056/NEJMoa066603.
20. Tindle HA, Omalu B, Courcoulas A, Marcus M, Hammers J, Kuller LH. Risk of suicide after long-term follow-up from bariatric surgery. *Am J Med.* 2010; 123(11): 1036-1042. doi:10.1016/j.amjmed.2010.06.016.
21. Backman O, Stockeld D, Rasmussen F, Näslund E, Marsk R. Alcohol and substance abuse, depression and suicide attempts after Roux-en-Y gastric bypass surgery. *Br J Surg.* 2016; 103(10): 1336-1342. doi:10.1002/bjs.10258.
22. Gariepy G, Nitka D, Schmitz N. The association between obesity and anxiety disorders in the population: a systematic review and meta-analysis. *Int J Obes.* 2010; 34(3): 407-419. doi:10.1038/ijo.2009.252.
23. Tae B, Pelaggi ER, Moreira JG, Waisberg J, Matos LL, D'Elia G. Impact of bariatric surgery on depression and anxiety symptoms, bulimic behaviors and quality of life. *Rev*

Col Bras Cir. 2014; 41(3): 155-160. http://dx.doi.org/10.1590/S0100-69912014000300004.

24. de Zwaan M, Enderle J, Wagner S, Mühlhans B, Ditzen B, Gefeller O *et al.* Anxiety and depression in bariatric surgery patients: a prospective, follow-up study using structured clinical interviews. *J Affect Disord.* 2011; 133(1-2): 61-68. doi:10.1016/j.jad.2011.03.025.

25. Lier HØ, Biringer E, Stubhaug B, Tangen T. Prevalence of psychiatric disorders before and 1 year after bariatric surgery: the role of shame in maintenance of psychiatric disorders in patients undergoing bariatric surgery. *Nord J Psychiatry* 2013; 67(2): 89-96. doi:10.3109/08039488.2012.684703.

26. Matini D, Jolfaei AG, Pazouki A, Pishgahroudsari M, Ehtesham M. The comparison of severity and prevalence of major depressive disorder, general anxiety disorder and eating disorders before and after bariatric surgery. *Med J Islam Repub Iran* 2014; 28: 109. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4301202/.

27. Kalarchian MA, King WC, Devlin MJ, Marcus MD, Garcia L, Chen JY *et al.* Psychiatric disorders and weight change in a prospective study of bariatric surgery patients: a 3-year follow-up. *Psychosom Med.* 2016; 78(3): 373-381. doi:10.1097/PSY.0000000000000277.

28. Yannakoulia M, Panagiotakos DB, Pitsavos C, Tsetsekou E, Fappa E, Papageorgiou C *et al.* Eating habits in relations to anxiety symptoms among apparently healthy adults. A pattern analysis from the ATTICA Study. *Appetite* 2008; 51(3): 519-525. doi:10.1016/j.appet.2008.04.002.

29. Graeff FG, Zangrossi Junior H. The hypothalamic-pituitary-adrenal axis in anxiety and panic. *Psychol & Neurosci.* 2010; 3(1): 3-8. doi:10.3922/j.psns.2010.1.002.

30. Schulze MB, Manson JE, Ludwig DS, Colditz GA, Stampfer MJ, Willett WC *et al.* Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA* 2003; 292(8): 927-934. doi:10.1001/jama.2 92.8.927.

31. Adam TC, Epel ES. Stress, eating and the reward system. *Physiol Behav.* 2007; 91(4): 449-458. doi:10.1016/j.physbeh.2007.04.011.

32. Torres SJ, Nowson CA. Relationship between stress, eating behavior, and obesity. *Nutrition* 2007; 23(11-12): 887-894. doi:10.1016/j.nut.2007.08.008.

33. Bennett J, Greene G, Schwartz-Barcott D. Perceptions of emotional eating behavior. A qualitative study of college students. *Appetite* 2013; 60(1): 187-192. doi:10.1016/j.appet.2012.09.023.

34. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5®). American Psychiatric Pub 2013.

35. Hayden MJ, Murphy KD, Brown WA, O'Brien PE. Axis I disorders in adjustable gastric band patients: the relationship between psychopathology and weight loss. *Obes Surg.* 2014; 24(9): 1469-1475. doi:10.1007/s11695-014-1207-0.

36. Scholtz S, Bidlake L, Morgan J, Fiennes A, El-Etar A, Lacey JH *et al.* Long-term outcomes following laparoscopic adjustable gastric banding: postoperative psychological sequelae predict outcome at 5-year follow-up. *Obes Surg.* 2007; 17(9): 1220-1225. doi:10.1007/s11695-007-9212-1.

37. Colles SL, Dixon JB, O'brien PE. Grazing and loss of control related to eating: two high-risk factors following bariatric surgery. *Obesity* 2008; 16(3): 615-622. doi:10.1038/oby.2007.101.

38. de Zwaan M, Hilbert A, Swan-Kremeier L, Simonich H, Lancaster K, Howell LM *et al.* Comprehensive interview assessment of eating behavior 18–35 months after gastric

bypass surgery for morbid obesity. *Surg Obes Relat Dis.* 2010; 6(1): 79-85. doi:10.1016/j.soard.2009.08.011.

39. Erden CS, Seyit H, Yazısız V, Türkyılmaz Uyar E, Akçakaya RÖ, Beşirli A *et al.* Binge eating disorder prevalence in bariatric surgery patients: evaluation of presurgery and postsurgery quality of life, anxiety and depression levels. *Bariatr Surg Pract Patient Care* 2016; 11(2): 61-66. doi:10.1089/bari.2015.0045.
40. Mack I, Ölschläger S, Sauer H, von Feilitzsch M, Weimer K, Junne F *et al.* Does laparoscopic sleeve gastrectomy improve depression, stress and eating behaviour? A 4-year follow-up study. *Obes Surg.* 2016; 26(12): 2967-2973. doi:10.1007/s11695-0162219-8.
41. Kofman MD, Lent MR, Swencionis C. Maladaptive eating patterns, quality of life, and weight outcomes following gastric bypass: results of an internet survey. *Obesity* 2010; 18(10): 1938-1943. doi:10.1038/oby.2010.27.
42. Hsu LK, Sullivan SP, Benotti PN. Eating disturbances and outcome of gastric bypass surgery: a pilot study. *Int J Eat Disord.* 1997; 21(4): 385-390. https://doi.org/10.1002/(SICI)1098-108X(1997)21:4<385::AID-EAT12>3.0.CO;2-Y.
43. Larsen JK, van Ramshorst B, Geenen R, Brand N, Stroebe W, van Doornen LJ. Binge eating and its relationship to outcome after laparoscopic adjustable gastric banding. *Obes Surg.* 2004; 14(8): 1111-1117. doi:10.1381/0960892041975587.
44. Luiz LB, de Souza Brito CL, Debon LM, Brandalise LN, de Azevedo JT, Monbach KD *et al.* Variation of binge eating one year after Roux-en-Y gastric bypass and its relationship with excess weight loss. *PloS One* 2016; 11(12): e0167577. https://dx.doi.org/10.1371/journal.pone.0167577.
45. Yen YC, Huang CK, Tai CM. Psychiatric aspects of bariatric surgery. *Curr Opin Psychiatry* 2014; 27(5): 374-379. doi:10.1097/YCO.0000000000000085.

46. Bocchieri LE, Meana M, Fisher BL. A review of psychosocial outcomes of surgery for morbid obesity. *J Psychosom Res.* 2002; 52(3): 155-165. http://dx.doi.org/10.1016/S0022-3999(01)00241-0.

47. Herpertz S, Kielmann R, Wolf AM, Langkafel M, Senf W, Hebebrand J. Does obesity surgery improve psychosocial functioning? A systematic review. *Int J Obes.* 2003; 27(11): 1300-1314. doi:10.1038/sj.ijo.0802410.

48. van Hout GC, Boekestein P, Fortuin FA, Pelle AJ, van Heck GL. Psychosocial functioning following bariatric surgery. *Obes Surg.* 2006; 16(6): 787-794. doi:10.1381/096089206777346808.

49. Kubik JF, Gill RS, Laffin M, Karmali S. The impact of bariatric surgery on psychological health. *J Obes.* 2013; 2013: 1-5. http://dx.doi.org/10.1155/2013/837989.

50. Jumbe S, Hamlet C, Meyrick J. Psychological aspects of bariatric surgery as a treatment for obesity. *Curr Obes Rep.* 2017; 6(1): 71-78. doi: 10.1007/s13679-017-0242-2.

51. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP *et al.* The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Med.* 2009; 6(7): e1000100. doi:10.1371/journal.pmed.1000100.

52. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry* 1961; 4(6): 561-571. doi:10.1001/archpsyc.1961.01710120031004.

53. Beck AT, Steer RA, Brown GK. *Beck Depression Inventory-II (BDI-II).* Psychological Corporation: San Antonio, Texas, 1996; 78(2): 490-498.

54. Spitzer RL, Kroenke K, Williams JB. Patient health questionnaire primary care study group. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *JAMA* 1999; 282(18): 1737-1744. doi:10.1001/jama.282.18.1737.

55. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand.* 1983; 67(6): 361-370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x.

56. Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: psychometric properties. *J Consult Clin Psychol.* 1988; 56(6): 893-897. doi:10.1037/0022-006X.56.6.893.

57. Spielberg CD, Gorsuch RL, Lushene RE, Vagg PR, Jacobs GA. *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologist Press: Palo Alto, California, 1983.

58. Gormally J, Black S, Daston S, Rardin D. The assessment of binge eating severity among obese persons. *Addict Behav.* 1982; 7(1): 47-55. http://dx.doi.org/10.1016/0306-4603(82)90024-7.

59. Hawkins II RC, Clement PF. Development and construct validation of a self-report measure of binge eating tendencies. *Addict Behav.* 1980; 5(3): 219-226. https://doi.org/10.1016/0306-4603(80)90042-8.

60. Fairburn CG, Beglin SJ. Assessment of eating disorders: Interview or self-report questionnaire? *Int J Eat Disord.* 1994; 16(4): 363-370. doi:10.1002/1098-108X(199412)16:4<363::AID-EAT2260160405>3.0.CO;2-#.

61. Spitzer RL, Devlin M, Walsh BT, Hasin D, Wing R, Marcus M *et al.* Binge eating disorder: A multisite field trial of the diagnostic criteria. *Int J Eat Disord.* 1992; 11(3): 191-203.http://dx.doi.org/10.1002/1098-108X(199204)11:3<191::AIDEAT2260110302>3.0.CO;2-S.

62. First MB, Spitzer RL, Gibbon M, Williams JB. *Structured Clinical Interview for DSM-IV-TR axis I disorders, research version, patient edition*. SCID-I/NP. New York State Psychiatric Institute: New York, 2002.

63. Fairburn CG, Cooper Z. The Eating Disorders Examination. In: Fairburn CG, Wilson GT, ed. *Binge Eating: Nature, Assessment and Treatment*. New York, NY: Guilford Press; 1993: 317-360.

64. Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E *et al.* The Mini International Neuropsychiatric Interview (MINI): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry* 1998; 59(Supplement 20): 22-33. Available from: https://www.psychiatrist.com/jcp/article/Pages/1998/v59s20/v59s2005.aspx.

65. Krukowski RA, Friedman KE, Applegate KL. The utility of the Beck Depression Inventory in a bariatric surgery population. *Obes Surg.* 2010; 20(4): 426-431. doi:10.1007/s11695-008-9717-2.

66. Karlsson J, Taft C, Ryden A, Sjöström L, Sullivan M. Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. *Int J Obes.* 2007; 31(8): 1248-1261. doi:10.1038/sj.ijo.0803573.

67. Grupski AE, Hood MM, Hall BJ, Azarbad L, Fitzpatrick SL, Corsica JA. Examining the Binge Eating Scale in screening for binge eating disorder in bariatric surgery candidates. *Obes Surg.* 2013; 23(1): 1-6. doi: 10.1007/s11695-011-0537-4.

68. National Heart, Lung, and Blood Institute. *Quality assessment tool for observational cohort and cross-sectional studies*. Bethesda: National Institutes of Health, Department of Health and Human Services, 2014. Available from: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools.

69. Guedes EP, Madeira E, Mafort TT, Madeira M, Moreira RO, Mendonca LM *et al.* Impact of a 6-month treatment with intragastric balloon on body composition and psychopathological profile in obese individuals with metabolic syndrome. *Diabetes Metab Syndr.* 2016; 8(1): 81. doi:10.1186/s13098-016-0197-6.

70. Deliopoulou K, Konsta A, Penna S, Papakostas P, Kotzampassi K. The impact of weight loss on depression status in obese individuals subjected to intragastric balloon treatment. *Obes Surg.* 2013; 23(5): 669-675. doi: 10.1007/s11695-012-0855-1.

71. Dymek MP, Le Grange D, Neven K, Alverdy J. Quality of life after gastric bypass surgery: a cross-sectional study. *Obes Res.* 2002; 10(11): 1135-1142. doi:10.1038/oby.2002.154

72. Faulconbridge LF, Wadden TA, Thomas JG, Jones-Corneille LR, Sarwer DB, Fabricatore AN. Changes in depression and quality of life in obese individuals with binge eating disorder: bariatric surgery versus lifestyle modification. *Surg Obes Relat Dis.* 2013; 9(5): 790-796. doi:10.1016/j.soard.2012.10.010.

73. Green AE, Dymek-Valentine M, Pytluk S, Le Grange D, Alverdy J. Psychosocial outcome of gastric bypass surgery for patients with and without binge eating. *Obes Surg.* 2004; 14(7): 975-985. doi:10.1381/0960892041719590.

74. Andersen JR, Aasprang A, Bergsholm P, Sletteskog N, Våge V, Natvig GK. Anxiety and depression in association with morbid obesity: changes with improved physical health after duodenal switch. *Health Qual Life Outcomes* 2010; 8(1): 52. doi:10.1186/1477-7525-8-52.

75. Ivezaj V, Grilo CM. When mood worsens after gastric bypass surgery: characterization of bariatric patients with increases in depressive symptoms following surgery. *Obes Surg.* 2015; 25(3): 423-429. doi:10.1007/s11695-014-1402-z.

76. Erden CS, Seyit H, Yazısız V, Uyar ET, Akçakaya RÖ, Alış H *et al.* Changes in sexual functions of female patients after bariatric surgery: relationship with body image, depression, and anxiety. *Bariatr Surg Pract Patient Care* 2015; 10(4): 150-155. doi:10.1089/bari.2015.0033.

77. Bužgová R, Bužga M, Holéczy P, Zonča P. Evaluation of quality of life, clinical parameters, and psychological distress after bariatric surgery: comparison of the laparoscopic sleeve gastrectomy and laparoscopic greater curvature plication. *Bariatr Surg Pract Patient Care* 2016; 11(4): 169-176. doi:10.1089/bari.2016.0022.

78. Efferdinger C, König D, Klaus A, Jagsch R. Emotion regulation and mental well-being before and six months after bariatric surgery. *Eat Weight Disord.* 2017; 22(2): 353-360. doi:10.1007/s40519-017-0379-8.

79. Malone M, Alger-Mayer S. Binge status and quality of life after gastric bypass surgery: A one-year study. *Obes Res.* 2004; 12(3): 473-481. doi:10.1038/oby.2004.53.

80. White MA, Masheb RM, Rothschild BS, Burke-Martindale CH, Grilo CM. The prognostic significance of regular binge eating in extremely obese gastric bypass patients: 12-month postoperative outcomes. *J Clin Psychiatry* 2006; 67(12): 1928-1935. http://dx.doi.org/10.4088/JCP.v67n1213.

81. Burgmer R, Petersen I, Burgmer M, de Zwaan M, Wolf AM, Herpertz S. Psychological outcome two years after restrictive bariatric surgery. *Obes Surg.* 2007; 17(6): 785-791. doi:10.1007/s11695-007-9144-9.

82. Thonney B, Pataky Z, Badel S, Bobbioni-Harsch E, Golay A. The relationship between weight loss and psychosocial functioning among bariatric surgery patients. *Am J Surg.* 2010; 199(2): 183-188. doi:10.1016/j.amjsurg.2008.12.028.

83. Assimakopoulos K, Karaivazoglou K, Panayiotopoulos S, Hyphantis T, Iconomou G, Kalfarentzos F. Bariatric surgery is associated with reduced depressive symptoms and better sexual function in obese female patients: a one-year follow-up study. *Obes Surg.* 2011; 21(3): 362-366. doi:10.5812/ircmj.24685.

84. Hayden MJ, Dixon JB, Dixon ME, Shea TL, O'Brien PE. Characterization of the improvement in depressive symptoms following bariatric surgery. *Obes Surg.* 2011; 21(3): 328-335. doi:10.1007/s11695-010-0215-y.

85. Castellini G, Godini L, Amedei SG, Faravelli C, Lucchese M, Ricca V. Psychological effects and outcome predictors of three bariatric surgery interventions: a 1-year follow-up study. *Eat Weight Disord-St.* 2014; 19(2): 217-224. doi:10.1007/s40519-014-0123-6.

86. Booth H, Khan O, Prevost AT, Reddy M, Charlton J, Gulliford MC. Impact of bariatric surgery on clinical depression. Interrupted time series study with matched controls. *J Affect Disord.* 2015; 174: 644-649. doi:10.1016/j.jad.2014.12.050.

87. Strain GW, Kolotkin RL, Dakin GF, Gagner M, Inabnet WB, Christos P *et al.* The effects of weight loss after bariatric surgery on health-related quality of life and depression. *Nutr Diabetes* 2014; 4(9): e132. doi:10.1038/nutd.2014.29.

88. Ribeiro GA, Giapietro HB, Belarmino LB, Salgado-Junior W. Depression, anxiety, and binge eating before and after bariatric surgery - Problems that remain. *Arq Bras Cir Dig.* 2018; 31(1): e1356. https://dx.doi.org/10.1590/0102-672020180001e1356.

89. Nickel C, Widermann C, Harms D, Leiberich PL, Tritt K, Kettler C *et al.* Patients with extreme obesity: change in mental symptoms three years after gastric banding. *Int J Psychiatry Med.* 2005; 35(2): 109-122. doi:10.2190/ANYR-WE1M-39G5-K92D.

90. Buddeberg-Fischer B, Klaghofer R, Krug L, Buddeberg C, Müller MK, Schoeb O *et al.* Physical and psychosocial outcome in morbidly obese patients with and without bariatric surgery: a 4½-year follow-up. *Obes Surg.* 2006; 16(3): 321-330. doi:10.1381/096089206776116471.

91. Nickel MK, Loew TH, Bachler E. Change in mental symptoms in extreme obesity patients after gastric banding, part II: six-year follow up. *Int J Psychiatry Med.* 2007; 37(1): 69-79. doi:10.2190/X40R-712P-8J44-0L3H.

92. Burgmer R, Legenbauer T, Müller A, de Zwaan M, Fischer C, Herpertz S. Psychological outcome 4 years after restrictive bariatric surgery. *Obes Surg.* 2014; 24(10): 1670-1678. doi:10.1007/s11695-014-1226-x.

93. Aasprang A, Andersen JR, Våge V, Kolotkin RL, Natvig GK. Five-year changes in health-related quality of life after biliopancreatic diversion with duodenal switch. *Obes Surg.* 2013; 23(10): 1662-1668. doi:10.1007/s11695-013-0994-z.

94. Mirijello A, D'Angelo C, Iaconelli A, Capristo E, Ferrulli A, Leccesi L *et al.* Social phobia and quality of life in morbidly obese patients before and after bariatric surgery. *J Affect Disord.* 2015; 179: 95-100. doi:10.1016/j.jad.2015.03.030.

95. Boan J, Kolotkin RL, Westman EC, McMahon RL, Grant JP. Binge eating, quality of life and physical activity improve after Roux-en-Y gastric bypass for morbid obesity. *Obes Surg.* 2004; 14(3): 341-348. doi:10.1381/096089204322917864.

96. Di Volo S, Bolognesi S, Goracci A, Caterini C, Castellani G, Vuol G *et al.* Binge eating disorder and bariatric surgery: a pilot study. *Eur Neuropsychopharmacol.* 2015; 25(2): S656-S657. doi:10.1016/s0924-977x(15)30934-2.

97. Wadden TA, Faulconbridge LF, Jones-Corneille LR, Sarwer DB, Fabricatore AN, Thomas JG *et al.* Binge eating disorder and the outcome of bariatric surgery at one year: a prospective, observational study. *Obesity* 2011; 19(6): 1220-1228. https://dx.doi.org/10.1038/oby.2010.336.

98. Nasirzadeh Y, Kantarovich K, Wnuk S, Okrainec A, Cassin SE, Hawa R *et al.* Binge eating, loss of control over eating, emotional eating, and night eating after bariatric surgery: results from the Toronto Bari-PSYCH cohort study. *Obes Surg.* 2018; 28(7): 2032-2039. https://dx.doi.org/10.1007/s11695-018-3137-8.

99. Chao AM, Wadden TA, Faulconbridge LF, Sarwer DB, Webb VL, Shaw JA *et al.* Binge-eating disorder and the outcome of bariatric surgery in a prospective, observational study:

two-year results. *Obesity* 2016; 24(11): 2327-2333. https://dx.doi.org/10.1002/oby.21648.

100. Legenbauer T, Petrak F, de Zwaan M, Herpertz S. Influence of depressive and eating disorders on short-and long-term course of weight after surgical and nonsurgical weight loss treatment. *Compr Psychiatry* 2011; 52(3): 301-311. doi:10.1016/j.comppsych.2010.06.012.
101. Dimidjian S, Martell CR, Herman-Dunn R, Hubley S. Behavioral activation for depression. In: Barlow DH, ed. *Clinical handbook of psychological disorders: A step-by-step treatment manual*. New York, NY: Guilford Publications; 2014: 353-393.
102. Dowlati Y, Herrmann N, Swardfager W, Liu H, Sham L, Reim EK *et al*. A meta-analysis of cytokines in major depression. *Biol Psychiatry* 2010; 67(5): 446-457. doi:10.1016/j.biopsych.2009.09.033.
103. Ellulu MS, Patimah I, Khaza'ai H, Rahmat A, Abed Y. Obesity and inflammation: the linking mechanism and the complications. *Arch Med Sci.* 2017; 13(4): 851-863. doi:10.5114/aoms.2016.58928
104. Forsythe LK, Wallace JM, Livingstone MB. Obesity and inflammation: the effects of weight loss. *Nutr Res Rev.* 2008; 21(2): 117-133. doi:10.1017/S0954422408138732.
105. Bianchi VE. Weight loss is a critical factor to reduce inflammation. *Clin Nutr ESPEN* 2018; 28: 21-35. doi:10.1016/j.clnesp.2018.08.007.
106. Köhler O, Benros ME, Nordentoft M, Farkouh ME, Iyengar RL, Mors O *et al*. Effect of anti-inflammatory treatment on depression, depressive symptoms, and adverse effects: a systematic review and meta-analysis of randomized clinical trials. *JAMA Psychiatry* 2014; 71(12): 1381-1391. doi:10.1001/jamapsychiatry.2014.1611.

107. Rosenblat JD, Kakar R, Berk M, Kessing LV, Vinberg M, Baune BT *et al*. Anti-inflammatory agents in the treatment of bipolar depression: a systematic review and meta-analysis. *Bipolar Disord.* 2016; 18(2): 89-101. doi:10.1111/bdi.12373.

108. Barlow DH. *Clinical handbook of psychological disorders: A step-by-step treatment manual*. New York, NY: Guilford Publications; 2014.

109. Powers PS, Perez A, Boyd F, Rosemurgy A. Eating pathology before and after bariatric surgery: a prospective study. *Int J Eat Disord.* 1999; 25(3): 293-300. https://doi.org/10.1002/(SICI)1098-108X(199904)25:3<293::AID-EAT7>3.0.CO;2-G.

110. Saunders R. "Grazing": a high-risk behavior. *Obes Surg.* 2004; 14(1): 98-102. doi:10.1381/096089204772787374.

111. White MA, Kalarchian MA, Masheb RM, Marcus MD, Grilo CM. Loss of control over eating predicts outcomes in bariatric surgery: a prospective 24-month follow-up study. *J Clin Psychiatry* 2010; 71(2): 175-184. doi:10.4088/JCP.08m04328blu.

112. Meany G, Conceição E, Mitchell JE. Binge eating, binge eating disorder and loss of control eating: effects on weight outcomes after bariatric surgery. *Eur Eat Disord Rev*. 2014; 22(2): 87-91. doi:10.1002/erv.2273.

113. Brown CA, Mehler PS. Medical complications of self-induced vomiting. *Eat Disord.* 2013; 21(4): 287-294. doi:10.1080/10640266.2013.797317.

114. Tice JA, Karliner L, Walsh J, Petersen AJ, Feldman MD. Gastric banding or bypass? A systematic review comparing the two most popular bariatric procedures. *Am J Med.* 2008; 121(1): 885-893. doi:10.1016/j.amjmed.2008.05.036.

115. Opozda M, Chur-Hansen A, Wittert G. Changes in problematic and disordered eating after gastric bypass, adjustable gastric banding and vertical sleeve gastrectomy: a systematic review of pre-post studies. *Obes Rev*. 2016; 17(8): 770-792. doi:10.1111/obr.12425

116. Friedman MA, Brownell KD. Psychological correlates of obesity: moving to the next research generation. *Psychol Bull.* 1995; 117(1): 3-20. doi:10.1037//0033-2909.117.1.3.

117. Ambwani S, Boeka AG, Brown JD, Byrne TK, Budak AR, Sarwer DB, Fabricatore AN, Morey LC, O'Neil PM. Socially desirable responding by bariatric surgery candidates during psychological assessment. *Surg Obes Relat Dis.* 2013; 9(2): 300-305. doi:10.1016/j.soard.2011.06.019.

118. Lindekilde N, Gladstone BP, Lübeck M, Nielsen J, Clausen L, Vach W, Jones A. The impact of bariatric surgery on quality of life: a systematic review and meta-analysis. *Obes Rev.* 2015; 16(8): 639-651. doi:10.1111/obr.12294.

119. Beck NN, Johannsen M, Støving RK, Mehlsen M, Zachariae R. Do postoperative psychotherapeutic interventions and support groups influence weight loss following bariatric surgery? A systematic review and meta-analysis of randomized and nonrandomized trials. *Obes Surg.* 2012; 22(11): 1790-1797. doi:10.1007/s11695-012-0739-4.

120. Paul L, van der Heiden C, Hoek HW. Cognitive behavioral therapy and predictors of weight loss in bariatric surgery patients. *Curr Opin Psychiatry* 2017; 30(6): 474-479. doi:10.1097/YCO.0000000000000359

Table 1 Search terms

Bariatric surgery	Endoscopic bariatric procedure	Psychological construct
"adjustable gastric banding" OR "morbid obesity" OR "bariatric surgery" OR "surgical intervention" OR "biliopancreatic diversion" OR "gastric banding" OR "duodenal switch" OR "gastric sleeve" OR "gastrectomy" OR "sleeve gastrectomy" OR "gastroplasty" OR "sleeve gastroplasty" OR "gastric bypass"	"non-surgical intervention" OR "non-surgical procedure" OR "endoluminal" OR "laparoscopic" OR "gastric balloon" OR "intragastric balloon" OR "endoscopic bariatric" OR "endoscopic gastroplasty"	“psychological consequences" OR "psychological functioning" OR "psychological outcomes" OR "psychopathology" OR "mental health" OR "depression" OR "anxiety" OR "binge eating" OR "binge eating disorder"

Note. Search method included bariatric surgery terms OR endoscopic bariatric procedure terms AND psychological construct terms.

Table 2 Characteristics of depression studies by follow up period

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in depression symptoms (reduced, increased, same)
Dymek *et al.*[71]	80[d]	90%[d]	38.7[d]	NA	RYGB	BDI	1	Pre. vs 1 month: reduced**
	60[e]	76%[e]	39.2[e]				6	1 vs 6 months: reduced**
	93[e]	73%[e]	40.8[e]				12	6 vs 12 months: same
	83[e]	81%[e]	40.9[e]					
Faulconbridge *et al.*[72]	36	72%	47.0	NA	RYGB, LAGB	BDI-II	2	2 months: same as baseline
	49[d]	80%[d]	43.8[d]	NA			6	6 months: reduced*
				43%, 41%[d]			12	12 months: same as 6 months (surgical vs lifestyle group[d])
Deliopoulou *et al.*[70]	100	100%	35.7	NA	IB	BDI-II	3	Reduced**
				NA			6	Reduced**
Buzgova *et al.*[77]	68	66%	44.2	0%	LSG, LGCP	HADS	3	LSG: 3**, 6**, 12* months, all reduced
				0%			6	LGCP: 3, 6, 12 months, same as baseline
				0%			12	
Efferdinger *et al.*[78]	45	76%	44.1	32%	RYGB, SG	BDI-II	6	Reduced**
Erden *et al.*[76]	31	100%	41.4	24%	LSG	BDI	6	Reduced**
Erden *et al.*[39]	51	65%	36.5	11%	LSG	BDI	6	Reduced**
Green *et al.*[73]	65	74%	39.3	8%	RYGB	BDI	6	Reduced**

Table 2 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in depression symptoms (reduced, increased, same)
Guedes *et al.*[69]	50	NA	34.6	22%	IB	BDI, HADS	6	BDI: Reduced* HADS: Reduced*
Matini *et al.*[26]	67	94%	36.8	5%	GBY	SCID	6	Pre. MDD: 24% Post. MDD: 15%, same as baseline
Tae *et al.*[23]	32	100%	41.0	28%	NA	BDI	6-10	Severe/moderate (pre): 78% Severe/moderate (post) 44%, reduced*
Andersen *et al.*[74]	50	56%	37.9	6% 12%	DS	HADS	6 12	6 months: reduced** 12 months: reduced**
de Zwaan *et al.*[24]	107	70%	37.5	21% 21%	GB, GBY	SCID	6-12 24-36	6-12 months: reduced* 24-36 months: reduced**
Ivezaj *et al.*[75]	107	87%	42.7	NA	GBY	BDI	6 12	6 months: reduced** 12 months: reduced**
Mitchell *et al.*[11]	2146	79%	46.0	16% 20% 32% 34%	RYBG, LAGB, SG, GBY BDP/DS	BDI	6 12 24 36	6 months: reduced** 12 months: reduced** 24 months: reduced** 36 months: reduced** 12 months to 36 months: increased**
Assimakopoulos *et al.*[83]	59	100%	36.0[b]	2%	BPD-LL, RYGB-LL/SG	HADS	12	Reduced**
Colles *et al.*[37]	129	80%	45.2	25%	LAGB	BDI	12	Reduced**

Table 2 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in depression symptoms (reduced, increased, same)
Castellini *et al.*[85]	83	90%	45.3	8%	LAGB, RYGB, BPD	BDI	12	LAGB group: reduced* RYBG group: reduced* BPD group: reduced*
Hayden *et al.*[84]	191 67	84% 88%	41.8 40.0	NA	LAGB	BDI scale (I, II, III)	12	Background group: I, II, III, reduced** Elevated BDI group: I, II, III, reduced**
Lier *et al.*[25]	127	74%	41.3	31%	LRYGB	MINI, SCID, BDI-II	12	MDD diagnosis: same as baseline BDI symptoms: reduced**
Malone *et al.*[79]	109	84%	45.0	49%	GBY	BDI	12	Non-BE group: reduced* Moderate BE group: reduced* Severe BE group: reduced*
White *et al.*[80]	139	89%	42.4	2%	GBY	BDI	12	Reduced**
Thonney *et al.*[82]	43	100%	39.2	NA	GBY	BDI-II, HADS	12 24	12 months: BDI-II: reduced* 24 months: BDI-II: reduced* 12 months: HADS: reduced* 24 months: HADS: reduced*
Dixon *et al.*[12]	487	85%	41.2	23% 48% 69% 72%	LAGB	BDI	12 24 36 48	Reduced* Reduced* Reduced* Reduced*

Table 2 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in depression symptoms (reduced, increased, same)
Booth *et al.*[86]	3045, 3045[d]	79% 83%[d]	45.9 44.3[d]	0, 18, 37, 54, 69, 81, 88 (%)	LAGB, GBY, SG	Clinical diagnosis	12, 24, 36, 48, 60, 72, 84	12**, 24**, 36* months: all reduced* 48, 60, 72, 84 months: same as baseline
Burgmer *et al.*[81,92]	148	68%	38.8	20% 31% 32%	VG, GB	HADS	14[a] 25[a] 50[a]	14 months: reduced** 25 months: reduced** 50 months: reduced**
Ribeiro *et al.*[88]	281	83%	40.7	NA	RYGB	BDI	23 24-59 60	23 months: reduced** 24-59 months: reduced** 60 months: reduced* 23 months to 60 months: increased*
Hayden *et al.*[35]	204	82%	45.2	26%	LAGB	SCID	24	Pre. MDD diagnosis: 18% Post. MDD diagnosis: 6%, reduced*
Kalarchian *et al.*[27]	165	81%	46.0[b]	22% 35%	RYGB, LAGB	SCID	24 36	Pre. MDD diagnosis: 7% 24 months post: 7%, same as baseline 36 months post: 9%, same as baseline
Strain *et al.*[87]	105	72%	43.5	NA	RYGB, BDP/DS	BDI	25[a]	All groups reduced**
Nickel *et al.*[89,91]	21 29[d]	100% 100%[d]	38.0 39.5[d]	12%	LAGB, SG, GB	HADS	36, 48, 60, 72	36*, 48*, 60*, 72* months: all reduced (GB group vs non-surgical group[d])

Table 2 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in depression symptoms (reduced, increased, same)
Buddeburg-Fisher *et al.*[90]	94[e]	75%[e]	43.5[e]	29%	LAGB, RYGB	HADS	38	Reduced**
Mack *et al.*[40]	75	64%	45.2	NA	LSG	PHQ-9	48[a]	Reduced*
Aasprang *et al.*[93]	50	56%	37.8	12%	BPD/DS	HADS	60	Baseline to 60 months: reduced** 12 months to 60 months: increased*
Scholtz *et al.*[36]	29	97%	39.0	22%	LAGB	SCID	60	Pre. MDD diagnosis: 17% Post. MDD diagnosis: 28%, same as baseline
Schowalter *et al.*[13]	248	81%	38.5	40% 28%[d]	GB	BDI	67[a] 86[ad]	GB group: reduced** Non-surgery group[d]: same as baseline GB vs non-surgical group: reduced*
Karlsson *et al.*[66]	655 621	NA 58%	47.0 48.4	23%, 27%	GB, VBG, GBY	HADS	120	Surgical group: reduced** Conventional group: reduced*

Note. Mean age (years) and female percentage (%) is preoperative value unless otherwise specified. All percentages (%) are rounded to one decimal place. Drop out was calculated as a percentage of the number of participants who underwent surgery and provided baseline data, relative to the number who underwent surgery and did not provide postoperative data. NA = data/information not available; Pre. = preoperative; Post. = postoperative; MDD = major depressive disorder; BDI = beck depression inventory; BDI-II: beck depression inventory-II; HADS = hospital anxiety depression scale; PHQ-9 = patient health questionnaire-9; SCID = structured clinical interview for diagnostic and statistical manual of mental disorders-fourth edition; MINI = mini international neuropsychiatric interview; DS = duodenal switch; GB = gastric banding; VG = vertical gastroplasty; BPD = biliopancreatic diversion; BPD/DS = biliopancreatic diversion with duodenal switch; GBY = gastric bypass; LAGB = laparoscopic adjustable gastric banding; SG = sleeve gastrectomy; RYGB = Roux-en-Y gastric bypass; LSG = laparoscopic sleeve gastrectomy; LGCP: laparoscopic greater curvature plication; BPD-LL: biliopancreatic diversion with Roux-en-Y reconstruction; RYGB-LL: Roux-en-Y gastric bypass with long limb; VBG = vertical banded gastroplasty; IB = intragastric balloon. [a]Average value. [b]Median value. [d]Control group data. [e]Post-surgery data.
* $p < .05$. ** $p < .001$.

Table 3 Characteristics of anxiety studies by follow up period

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in anxiety symptoms (reduced, increased, same)
Buzgova *et al.*[77]	68	66%	44.2	0% 0% 0%	LSG, LGCP	HADS	3 6 12	LSG: 3**, 6**, 12* months, all reduced LGCP: 3, 6, 12 months, same as baseline
Erden *et al.*[76]	31	100%	41.4	24%	LSG	BAI	6	Reduced**
Erden *et al.*[39]	51	65%	36.5	11%	LSG	BAI	6	Reduced**
Guedes *et al.*[69]	50	NA	34.6	22%	IB	HADS	6	Reduced*
Matini *et al.*[26]	67	94%	36.8	5%	GBY	SCID	6	Pre. GAD: 25% Post. GAD: 36%, same as baseline
Tae *et al.*[23]	32	100%	41.0	28%	NA	STAI	6-10	Severe/moderate (pre): 87% Severe/moderate (post): 57%, reduced*
Andersen *et al.*[74]	50	56%	37.9	6% 12%	DS	HADS	6 12	6 months: reduced** 12 months: reduced**
de Zwaan *et al.*[24]	107	70%	37.5	21% 21%	GB, GBY	SCID	6-12 24-36	6-12 month: same as baseline 24-36 months: same as baseline
Assimakopoulos *et al.*[83]	59	100%	36.0[b]	2%	BPD-LL, RYGB-LL/SG	HADS	12	Same as baseline
Castellini *et al.*[85]	83	90%	45.3	8%	LAGB, RYGB, BPD	STAI	12	LAGB group: reduced* RYBG group: reduced* BPD group: reduced*

Table 3 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in anxiety symptoms (reduced, increased, same)
Lier *et al.*[25]	127	74%	41.3	31%	LRYGB	MINI, SCID, BAI	12	Anxiety disorder diagnosis: reduced* BAI symptoms: same as baseline
Thonney *et al.*[82]	43	100%	39.2	NA	GBY	HADS	12 24	12 months: reduced* 24 months: reduced*
Burgmer *et al.*[81,92]	148	68%	38.8	20% 31% 32%	VG, GB	HADS	14[a] 25[a] 50[a]	14 months: reduced** 25 months: same as baseline 50 months: same as baseline
Ribeiro *et al.*[88]	281	83%	40.7	NA	RYGB	BAI	23 24-59 60	Pre. to 23 months: reduced** Pre. to 24-59 months: reduced* Pre. to 60 months: same as baseline 23 months to 60 months: increased* 24-59 months to 60 months: increased*
Hayden *et al.*[35]	204	82%	45.2	26%	LAGB	SCID	24	Pre. anxiety disorder: 15% Post. anxiety disorder: 4%, reduced**
Kalarchian *et al.*[27]	165	81%	46.0[b]	22% 35%	RYGB, LAGB	SCID	24 36	Pre. anxiety disorder diagnosis: 17% 24 months post: 12%, same as baseline 36 months post: 8%, reduced*
Nickel *et al.*[89,91]	21 29[d]	100% 100%[d]	38.0 39.5[d]	12%	GB	HADS	36, 48, 60, 72	36*, 48*, 60*, 72* months: all reduced (GB group vs. non-surgical group[d])

Table 3 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in anxiety symptoms (reduced, increased, same)
Buddeburg-Fisher *et al.*[90]	94[e]	75%[e]	43.5[e]	29%	LAGB, RYGB	HADS	38	Same as baseline
Mirijello *et al.*[94]	20	50%	44.0	13%	BPD	STAI	44[a]	State Anxiety: same as baseline
	26	85%	41.3					Trait Anxiety: same as baseline
	50[d]	80%[d]	35.5[d]					(surgical group vs. non-surgical group)
Aasprang *et al.*[93]	50	56%	37.8	12%	BPD/DS	HADS	60	Same as baseline
Karlsson *et al.*[66]	655	NA	47.0	23%	GB, VBG,	HADS	120	Surgical group: reduced**
	621	58%	48.4	27%	GBY			Conventional group: reduced**

Note. Mean age (years) and female percentage (%) is preoperative value unless otherwise specified. All percentages (%) are rounded to one decimal place. Drop out was calculated as a percentage of the number of participants who underwent surgery and provided baseline data, relative to the number who underwent surgery and did not provide postoperative data. NA = data/information not available; Pre. = preoperative; Post. = postoperative; HADS = hospital anxiety depression scale; BAI: beck anxiety inventory; STAI = state-trait anxiety inventory; SCID = structured clinical interview for diagnostic and statistical manual of mental disorders-fourth edition; MINI = mini international neuropsychiatric interview; DS = duodenal switch; GB = gastric banding; VG = vertical gastroplasty; BPD = biliopancreatic diversion; BPD/DS = biliopancreatic diversion with duodenal switch; GBY = gastric bypass; LAGB = laparoscopic adjustable gastric banding; SG = sleeve gastrectomy; RYGB = Roux-en-Y gastric bypass; LRYGB = laparoscopic Roux-en-Y gastric bypass; LSG = laparoscopic sleeve gastrectomy; LGCP: laparoscopic greater curvature plication; BPD-LL: biliopancreatic diversion with Roux-en-Y reconstruction; RYGB-LL: Roux-en-Y gastric bypass with long limb; VBG = vertical banded gastroplasty; IB = intragastric balloon.
[a]Average value. [b]Median value. [d]Control group data. [e]Post-surgery data.
* $p < .05$. ** $p < .001$.

Table 4 Characteristics of binge eating studies by follow up period

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in binge eating symptoms (reduced, increased, same)
Boan *et al.*[95]	40	85%	41.0	NA	RYGB	BES	6	Reduced**
Di Volo *et al.*[96]	27	78%	43.0	NA	SG, GBY	BSQ	6	Reduced*
Erden *et al.*[39]	51	65%	36.5	11%	LSG	SCID	6	Pre. BED: 35% Post. BED: 0% (sig not indicated)
Larsen *et al.*[43]	250	88%	39.6	NA	LAGB	BES	8-24 25-68	8-24 months: reduced* 25-68 months: reduced*
Castellini *et al.*[85]	83	90%	45.3	8%	LAGB RYGB BPD	BES	12	LAGB group: reduced* RYBG group: reduced** BPD group: reduced*
Colles *et al.*[37]	129	80%	45.2	25%	LAGB	QEWP-R	12	Pre. BED: 14% Post. BED: 3%, reduced*
Luiz *et al.*[44]	132	80%	38.3	NA	RYGB	BES	12	Reduced**
Malone *et al.*[79]	109	84%	45.0	49%	GBY	BES	12	Non-BE group: reduced** Moderate BE group: reduced** Severe BE group: reduced**
White *et al.*[80]	139	89%	42.4	2%	GBY	EDE-Q	12	Pre. BED: 10%; weekly BE: 24% Post. BED 0%; weekly BE: 0.7% (sig not indicated)

Table 4 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in binge eating symptoms (reduced, increased, same)
Wadden *et al.*[98]	59[d]	83%[d]	43.8[d]	36%[d]	RYGB, LAGB	EDE	12	Pre. BED: 100%
and Chao *et al.*[99]	36	72%	47.0	41%				Post. BED: 8% (surgery), 14% (lifestyle[d])
	49[d]	80%[d]	43.8[d]	18%[d]				(sig not indicated)
				55%[d]			24	Pre. BED: 100%
				52%				Post. BED: 13% (surgery), 14% (lifestyle[d])
				43%[d]				(sig not indicated)
Nasirzadeh *et al.*[97]	844	81%	45.0	Overall:	RYGB, SG	BES	12	12 months: reduced*
				36%			24	24 months: reduced*
							36	36 months: reduced*
de Zwaan *et al.*[38]	59	85%	44.5[e]	32%	RYGB	QEWP	18-35	Pre. BED: 29%
						EDE		Post. BED: 3% (sig not indicated)
Ribeiro *et al.*[88]	281	83%	40.7	NA	RYGB	BES	23	23 months: reduced**
							24-59	24-59 months: reduced**
							60	60 months: same as baseline
								23 months to 60 months: increased*
Hayden *et al.*[35]	204	82%	45.2	26%	LAGB	SCID	24	Pre. BED: 14%
								Post. BED: 5%
Kalarchian *et al.*[27]	165	81%	46.0[b]	22%	RYGB, LAGB	SCID	24	Pre. BED: 6%
				35%			36	24 months post: 1% (sig not indicated)
								36 months post: 3% (sig not indicated)

Table 4 (continued)

Study	Sample size	Female (%)	Mean age (years)	Drop out (%)	Surgery type	Outcome measure	Follow up (months)	Change in binge eating symptoms (reduced, increased, same)
Buddeburg-Fisher *et al.*[90]	94[e]	75%[e]	43.5[e]	29%	LAGB, RYGB	BSQ	38	Reduced**
Mack *et al.*[40]	75	64%	45.2	NA	LSG	EDE	48[a]	Pre. BED: 13% Post. BED: 2% (sig not indicated)
Scholtz *et al.*[36]	29	97%	39.0	22%	LAGB	EDE	60	Pre. BED: 17% Post. BED: 10%, same as baseline

Note. Mean age (years) and female percentage (%) is preoperative value unless otherwise specified. All percentages (%) are rounded to one decimal place. Drop out was calculated as a percentage of the number of participants who underwent surgery and provided baseline data, relative to the number who underwent surgery and did not provide postoperative data. NA = data/information not available; Pre. = preoperative; Post. = postoperative; Sig not indicated = significant value was not reported in study; BED = binge eating disorder; BES = binge eating scale; BSQ = binge scale questionnaire; QEWP = questionnaire on eating and weight patterns; QEWP-R = questionnaire on eating and weight patterns-revised; EDE: eating disorder examination; EDE-Q: eating disorder examination questionnaire; SCID = structured clinical interview for diagnostic and statistical manual of mental disorders-fourth edition; BPD = biliopancreatic diversion; GBY = gastric bypass; LAGB = laparoscopic adjustable gastric banding; SG = sleeve gastrectomy; RYGB = Roux-en-Y gastric bypass; LSG = laparoscopic sleeve gastrectomy;
[a]Average value. [b]Median value. [d]Control group data. [e]Post-surgery data.
* $p < .05$. ** $p < .001$.

Table 5 Assessment measures

Psychological outcome	Assessment measure	Number of studies
Depression	BDI	17
	BDI-II	5
	HADS	12
	SCID	6
	MINI	1
	PHQ-9	1
	Clinical diagnosis	1
Anxiety	HADS	12
	BAI	4
	SCID	5
	STAI	3
	MINI	1
Binge Eating	BES	7
	BSQ	2
	QEWP	1
	QEWP-R	1
	SCID	3
	EDE-Q	1
	EDE	5

Note. BDI = beck depression inventory; BDI-II: beck depression inventory-II; HADS = hospital anxiety depression scale; PHQ-9 = patient health questionnaire-9; SCID = structured clinical interview for diagnostic and statistical manual of mental disorders-fourth edition; MINI = mini international neuropsychiatric interview; BAI: beck anxiety inventory; STAI = state-trait anxiety inventory; BES = binge eating scale; BSQ = binge scale questionnaire; QEWP = questionnaire on eating and weight patterns; QEWP-R = questionnaire on eating and weight patterns-revised; EDE: eating disorder examination; EDE-Q: eating disorder examination questionnaire

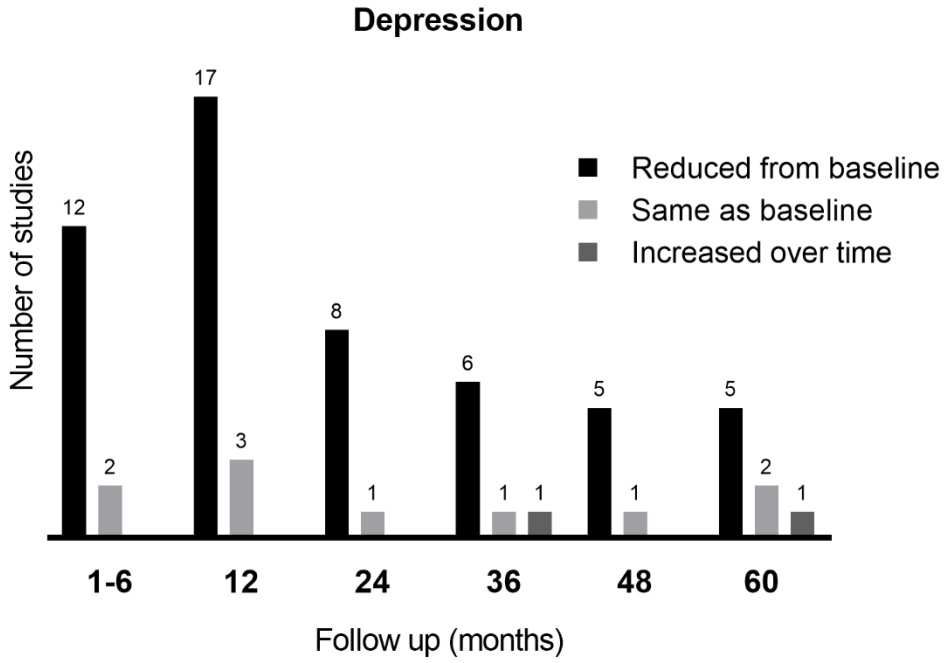

Figure 1 Summary of studies examining depression outcomes compared to baseline. Note: studies reporting a significant increase from one post-treatment timepoint to another were included in the figure.

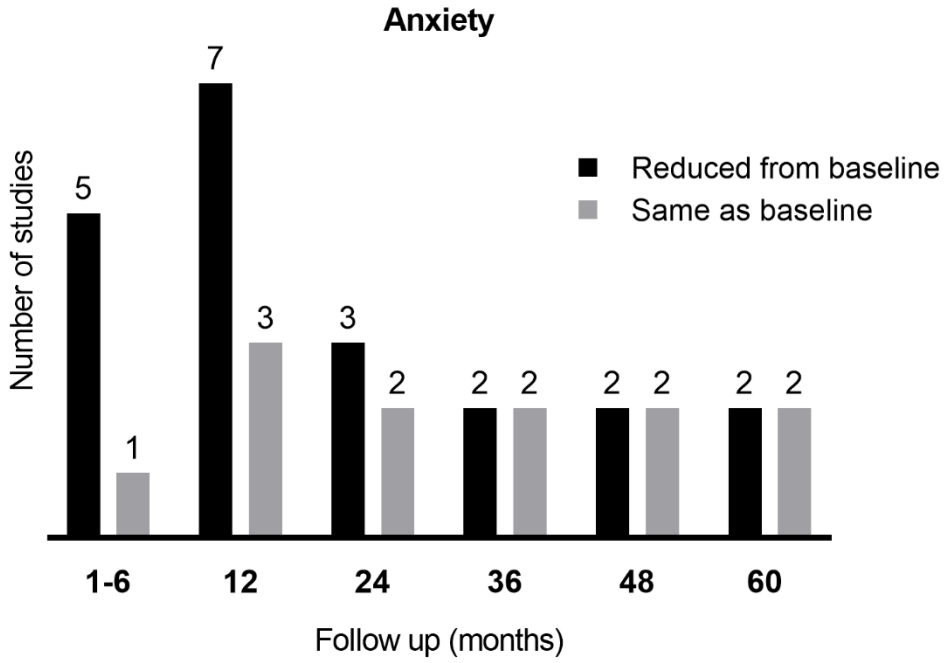

Figure 2 Summary of studies examining anxiety outcomes compared to baseline.

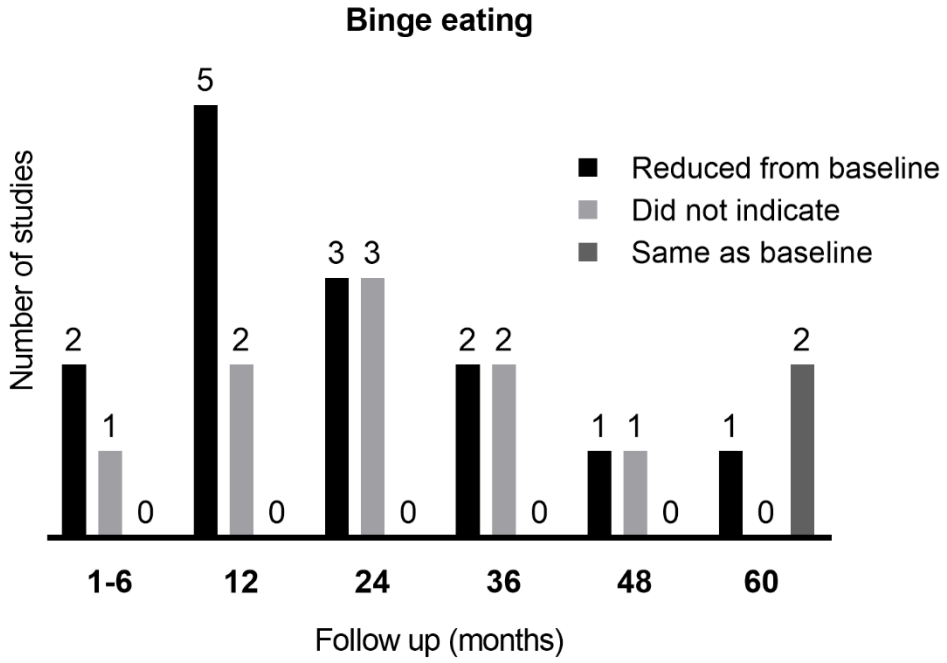

Figure 3 Summary of studies examining binge eating outcomes compared to baseline. Note: some studies did not indicate whether changes from baseline were statistically significant.

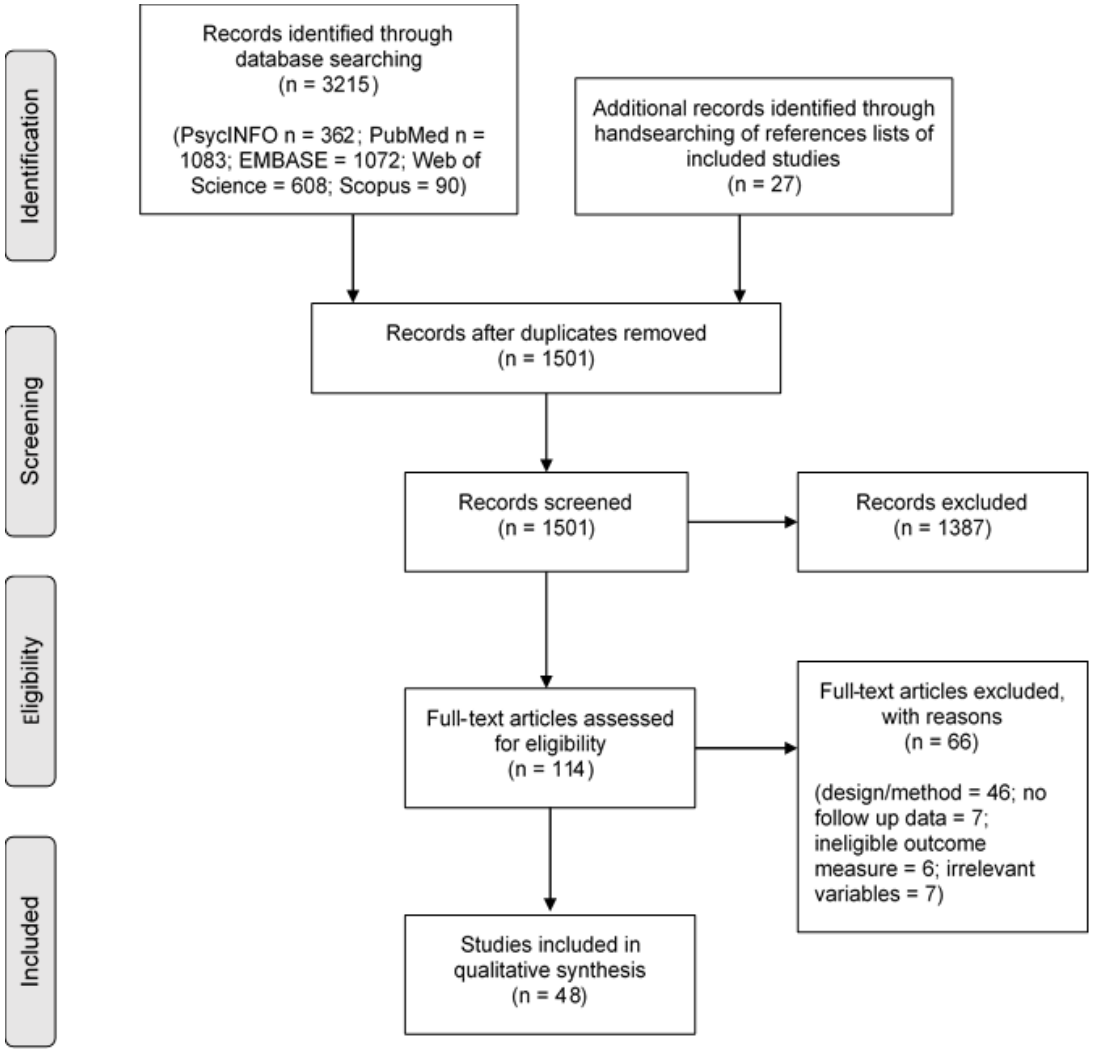

Figure 4 PRISMA flowchart of the study selection process.