The evolution of depressive symptoms following bariatric surgery for purposes of substantial weight loss

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ABSTRACT

The evolution of depressive symptoms following bariatric surgery for purposes of substantial weight loss

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Depression is the most prevalent psychiatric condition among individuals seeking bariatric surgery for severe obesity (BMI ≥ 40.0 kg/m^2; 35.0 with weight-related comorbidities). Following bariatric surgery, depression prevalence and symptom severity are drastically reduced. That said, depression that persists or worsens after bariatric surgery is associated with poorer weight loss outcomes. Psychiatric conditions, e.g., depression, are routinely evaluated during a preoperative psychosocial evaluation when determining suitability for a bariatric procedure. This includes a clinical interview that may be supplemented with screening tools for assessing psychiatric symptoms, e.g., depression. Screening tools are more frequently administered after bariatric surgery in order to monitor how well individuals are adjusting after the procedure. Despite the ubiquity of depressive symptom screening tools, there is a limited understanding of their use in a bariatric population. The current dissertation sought to address the current gaps in the literature regarding depressive symptom screening tools in the bariatric population. The first study consisted of a systematic review and meta-analysis that included 46 studies that examined the evolution of depressive symptoms after individuals had undergone bariatric surgery. Results from the meta-analysis determined that the magnitude that depressive symptoms decreased was similar at 6-, 12-, and 24-months after surgery. The second study examined whether the responses to items within a common depressive symptom screening tool clustered together in a bariatric cohort. This study performed both exploratory and confirmatory factor analyses within

two groups and found a model consisting of three subscales was the most appropriate for screening depressive symptoms pre- and post-surgery. The final study examined whether reductions of depressive symptoms overall or within specific subscales were associated with weight loss outcomes. The total and subscale change-scores were tested separately in the association with percent excess-body weight loss. Only the reduction of *negative perception* features of depression was linked to greater weight loss. Taken together, these studies can inform healthcare professionals about the typical evolution of depressive symptoms up to 24 months after surgery, as well as the depressive symptoms that might be potential targets for intervention if weight loss following bariatric surgery is suboptimal.

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Chapter 1: General Introduction

Obesity is a multifactorial, noncommunicable chronic disease that is characterized by excess adiposity and having a body mass index (BMI) that exceeds 30.0 kg/m^2 (Wharton et al., 2020). Globally, the prevalence of obesity has grown exponentially in recent decades, such that one in five individuals has a BMI greater than 30.0 kg/m^2 (OECD, 2017). The prevalence of obesity is even greater in Canada, wherein one in four individuals have a BMI exceeding 30.0 kg/m^2 (OECD, 2017). This is expected to increase by 2031 such that one in three Canadians will be considered to have obesity (Bancej et al., 2015).

Obesity is a serious health condition that has a negative impact on physical and psychological health (Guh et al., 2009). Moreover, obesity increases the risk of developing metabolic (Singh et al., 2013), cardiovascular (Czernichow et al., 2011; Singh et al., 2013), and musculoskeletal diseases (Anandacoomarasamy et al., 2008), as well as the development of some cancers (Lauby-Secretan et al., 2016). Consequently, obesity is linked to poorer quality of life (Kolotkin & Andersen, 2017) and increased risk of premature death (Xu et al., 2018).

Although obesity has traditionally been viewed as a behavioural issue characterized by physical inactivity and overeating (Puhl & Heuer, 2009), more recent developments have shed light on the complex interplay between biological, psychological, and social/environmental factors that contribute to the development and maintenance of obesity (Vandenbroeck et al., 2007; Wharton et al., 2020). Many biological processes are known to contribute to the development of obesity, including: genetic heritability (Bouchard, 2021); inflammation (Crewe et al., 2017); and gut microbiome (Turnbaugh et al., 2009). Certain psychological and behavioural processes are also implicated in obesity development, including: depression (Luppino et al., 2010); perceived stress (Tenk et al., 2018); sedentary behaviour (Guo et al., 2020); and disordered eating (Grilo et al., 2020). Social and environmental factors have also been linked to obesity, i.e., peer pressure (Gwozdz et al., 2015), food advertisement (Russell et al., 2019), and low socioeconomic status (Hoebel et al., 2019). Given this, understanding the development of obesity requires an integrative lens in order to develop more effective treatments options. This may be achieved through the *biopsychosocial* model of disease (Engel, 1977; George & Engel, 1980), which suggests that chronic disease (e.g., obesity) occurs due to an interplay between biological, psychological, and social factors. Despite this, there are a limited number of interventions that address the complex interplay between these factors to achieve substantial weight loss.

Surgical interventions for obesity

Bariatric surgery is the most effective intervention for severe obesity (Buchwald et al., 2004), i.e., those within the severe class (BMI $\geq$ 40.0 kg/m^2 or BMI $\geq$ 35.0 and weight-related comorbidities; Mechanick et al., 2020; Wharton et al., 2020). In general, to be eligible for bariatric surgery, individuals should have a BMI $\geq$ 40.0 kg/m^2 or 35.0 kg/m^2 with a high-risk comorbidity (e.g., type II diabetes, cardiovascular disease, etc.; Hubbard & Hall, 1991). There are two broad categories of bariatric procedures: 'restrictive'; and 'restrictive-hypoabsorption'. Restrictive procedures reduce the size of the stomach with the aim of reducing the capacity to consume food per sitting, e.g., adjustable gastric banding, and sleeve gastrectomy. Restrictive-hypoabsorption procedures decrease the stomach size as well as diverting part of where the stomach expels food further along the small intestine in order to limit absorption of nutrients, e.g., Roux-en-Y gastric bypass, and biliopancreatic diversion with duodenal switch (Elder & Wolfe, 2007). Restrictive surgeries are recommended to those with a lower BMI and fewer weight-related comorbidities, whereas restrictive-hypoabsorptive procedures are typically reserved for individuals with a higher BMI and high-risk comorbidities (Mechanick et al., 2020).

The most common bariatric procedures performed globally are sleeve gastrectomy (46%), followed by Roux-en-Y gastric bypass (40%) and adjustable gastric banding (7%) (Angrisani et al., 2018). Of note, 7% of bariatric surgeries are revisions of previous procedures (Angrisani et al., 2018). Interestingly, pooled estimates of randomised control trials that compared bariatric procedures and weight outcomes found no significant difference between sleeve gastrectomy and Roux-en-Y gastric bypass in terms of weight loss (Kang & Le, 2017). However, observational studies have shown greater weight loss following Roux-en-Y gastric bypass when compared to sleeve gastrectomy and adjustable gastric banding (Arterburn et al., 2018). Indeed, the mean percent excess weight loss 10 years after the procedures was 60% for Roux-en-Y gastric bypass, 57% for sleeve gastrectomy, and 49% for adjustable gastric banding (O'Brien et al., 2019).

Physical Health outcomes following bariatric surgery

Bariatric surgery results in many positive physical health outcomes. Indeed, individuals lose about 28% of their preoperative weight 84 months after surgery (Courcoulas et al., 2013); however, the majority of weight loss occurs within the first 12 months (Courcoulas et al., 2013; Garvey et al., 2016). Many obesity-related comorbid conditions also improve after bariatric surgery, including reductions in type II diabetes, hypertension, and dyslipidemia (Chang et al., 2014; Elder & Wolfe, 2007) and decreased risk of mortality (Sjöström et al., 2007). Indeed, type II diabetes remitted in 72% and 36% of surgery recipients, two and 10 years (respectively) following bariatric surgery (Sjöström et al., 2004). Individuals who received bariatric surgery also experienced fewer cardiovascular incidents (Sjöström et al., 2012), and had a decreased risk of cancer (Sjöström et al., 2009). By virtue of the rapid and drastic weight loss following this procedure, individuals also show improvements in obstructive sleep apnea severity, daytime sleepiness (Wong et al., 2018), and osteoarthritis (Groen et al., 2015).

Mental Health outcomes following bariatric surgery

Bariatric surgery is effective in facilitating weight loss; however, behavioural changes after surgery play a critical role in achieving and maintaining weight loss outcomes. Considering that about 20% of individuals who receive bariatric surgery experience poor weight loss or weight regain (Christou et al., 2006), it is important to consider factors that might undermine successful weight loss outcomes. This might be particularly challenging among those living with a comorbid psychiatric condition. Indeed, there is a high prevalence of psychiatric conditions among individuals seeking bariatric surgery for weight loss (Dawes et al., 2016). Notably, between 32% and 45% of candidates for bariatric surgery present with a current major depressive episode, while the lifetime history of depression among candidates for bariatric surgery is between 23% and 63% (Alosco et al., 2015; Hayden et al., 2014; Legenbauer et al., 2011; Mitchell et al., 2012; Semanscin-Doerr et al., 2010). In contrast, the lifetime prevalence of depression in the general population is approximately 11% (Patten et al., 2016). This difference underscores the additional burden that individuals living with obesity face relative to the general population regarding depression.

At this junction it is important to differentiate the terminology when describing depression. Broadly speaking, *depression* refers to a mood disorder characterized by pervasive sadness and/or a loss of interest in activities that were previously enjoyed, as well as cognitive, affective, and somatic changes that altogether interfere with daily life (American Psychiatric Association, 2013). A depression diagnosis (e.g., major depressive episode, recurrent depressive disorder) refers to an individual meeting the diagnostic criteria (i.e., depressive symptoms, symptom duration) that are specified in the Diagnosis and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5; American Psychiatric Association, 2013) or International Classification of Diseases – Eleventh Edition (ICD-11; World Health Organization, 2022). A depression diagnosis is typically determined by a mental health professional, e.g., psychologist or psychiatrist (Fried & Nesse, 2015). In contrast, elevated depressive symptoms refer to experiencing greater frequency or severity of any depressive symptom. This is typically determined using a screening tool or psychometric questionnaire that quantify elevations using a summed-score with thresholds that classify into ranges of clinical severity (Fried & Nesse, 2015).

Prior systematic reviews (Dawes et al., 2016; Fu et al., 2021; Gill et al., 2019; Loh et al., 2021; Spirou et al., 2020) have reported substantial reductions in depressive disorder prevalence and symptom severity following bariatric surgery. These improvements can occur within weeks after bariatric surgery (Dymek et al., 2001) and can persist even 10 years after the procedure (Karlsson et al., 2007). Moreover, the magnitude that depression improves following surgery is comparable to psychological and pharmacological treatments for depression (Faulconbridge et al., 2013; Fournier et al., 2010, 2022).

While depression alone is not a contraindication for bariatric surgery (Finks et al., 2011), it has been associated with poorer postoperative outcomes when compared to individuals without a history of depression (Legatto et al., 2022; Semanscin-Doerr et al., 2010). Likewise, unresolved depression or worsening of symptoms following surgery has been linked to poorer postoperative weight outcomes, including suboptimal weight loss (Lai et al., 2021; Lier et al., 2011; Youssef et al., 2020), weight regain (Freire et al., 2021), and the need for revisional surgeries (de Gara & Karmali, 2014). Indeed, depressive symptoms and suboptimal weight loss have been attributed to lower adherence to postoperative dietary and exercise programs (Hood et al., 2016; Toussi et al., 2009).

Assessing depression in a bariatric population

In recognising the impact that psychosocial (e.g., access to social support, physical and mental quality of life) and behavioural (e.g., eating behaviours, dietary adherence, physical exercise) factors (Herpertz et al., 2004; Hindle et al., 2017; Kourounis et al., 2020) can have on postoperative outcomes, the American Association of Clinical Endocrinologists (AACE), The Obesity Society, American Society of Metabolic and Bariatric Surgery, Obesity Medicine Association, and American Society of Anesthesiologists Boards of Directors commissioned a joint statement that outlined evidence-based recommendations in an effort to standardise the clinical practice guidelines of surgical interventions for obesity (Mechanick et al., 2020). This included a formal psychosocial evaluation performed by a qualified mental health professional prior to being a candidate for bariatric surgery (Mechanick et al., 2020), including the evaluation of psychiatric conditions, health-related behaviours (e.g., substance use, smoking, physical history), and suicide risk. For the first time, these guidelines also recommend continued monitoring of the psychosocial well-being of individuals who received bariatric surgery (Mechanick et al., 2020). This includes assessing changes in lifestyle, medications that can cause weight gain, maladaptive eating habits, and psychological comorbidities. Recently, Obesity Canada and the Canadian Association of Bariatric Physicians and Surgeons (CABPS) also provided clinical practice guidelines that recommended both preoperative and postoperative psychosocial evaluations (Garneau et al., 2022; Wharton et al., 2020). However, these guidelines were less clear on which aspects are important in the follow-up assessments.

Most preoperative psychosocial evaluations involve a clinical interview that is supplemented with psychometric tests and screening tools (Fabricatore et al., 2006; Walfish et al., 2007). Clinical interviews involve structured or semi-structure scripts that are designed to assess a broad array of psychiatric disorders. Given this, clinical interviews are favoured by most psychologists (Bauchowitz et al., 2005). That said, such methods are timely and resource-demanding (e.g., require in-person administration and costly assessment protocols). Social desirability, i.e., presenting oneself in a favourable light, has also been raised as a concern when administering clinical interviews within a bariatric population. Indeed, reporting greater psychological distress may impede access to bariatric surgery (Butt et al., 2021).

Administering psychometric tests and screening tools as part of the preoperative psychosocial evaluation can help readily screen for the presence of psychological distress, and are less likely to result in underreporting of depressive symptoms (Ambwani et al., 2013). Many psychological tools used to assess psychiatric conditions have been validated in candidates for bariatric surgery (Cassin et al., 2013; Hall et al., 2013; Hayden et al., 2012). Moreover, these screening tools are typically administered at follow-up visits with bariatric teams to monitor for the presence of psychological distress. This can be particularly helpful when monitoring any changes to depressive symptoms relative to preoperative scores. There are a number of screening tools available to assess depressive symptoms, but differ in many ways. For instance, the Beck Depression Inventory (BDI) contains 21 items that assesses cognitive, affective, and somatic depressive symptoms (Beck et al., 1996). Likewise, the Hospital Anxiety and Depression Scale (HADS) contains a 7-item subscale that assesses the severity of depressive symptoms (Zigmond & Snaith, 1983). In contrast, the Patient Health Questionnaire-9 (PHQ-9) assesses the frequency in duration of nine depressive symptoms (Cassin et al., 2013). Therefore, inferences regarding changes in depressive symptom presentation following bariatric surgery will differ between measures. That is, the severity of depressive symptoms may decrease following surgery if assessed using the BDI or HADS, but these measures cannot assess whether there were changes in symptom frequency after surgery. In contrast, responses to the PHQ-9 could detect changes in the frequency of depressive symptoms; however, this measure cannot assess whether the severity of depressive symptoms changed. Moreover, the BDI includes additional items that assess various somatic depressive symptoms. However, these somatic items overlap with symptoms of obesity (Krukowski et al., 2010). Consequently, BDI scores prior to surgery might be inflated due to the physical challenges among those living with obesity (Krukowski et al., 2010).

In line with the *biopsychosocial* model, depressive symptoms are a key psychological factor that contributes to the development of obesity. While bariatric surgery facilitates substantial weight loss, depressive symptoms that either increase or persist after surgery may be an impediment to achieving weight loss goals. As psychosocial follow-up visits become integrated into postoperative clinical practice (Mechanick et al., 2020), it is important that clinicians have a clearer understanding of how depressive symptoms fluctuate after bariatric surgery measured using screening tools. In turn, this may help inform clinicians about which depressive symptoms persist or worsen postoperatively, as well as identify potential targets for psychological intervention that mitigate the development of suboptimal weight loss outcomes. To help clinicians make evidence-based decisions when assessing depressive symptoms, the objectives of this dissertation are to: (i) evaluate common screening tools when used to assess changes to depressive symptoms following bariatric surgery; (ii) evaluate the extent to which depressive symptoms change following surgery; and (iii) discuss how these objective can be integrated into clinical practice.

Chapter 2: Evolution of Depressive Symptoms from Pre- to 24 Months Post-Bariatric Surgery: A Systematic Review and Meta-Analysis

Robbie Woods, Ana M. Moga, Paula A. B. Ribeiro, Jovana Stojanovic, Kim L. Lavoie, & Simon L. Bacon. (*Revise & Resubmitted*). Evolution of Depressive Symptoms from Pre- to 24 Months Post-Bariatric Surgery: A Systematic Review and Meta-Analysis. *Obesity Reviews.*

Contributions: RW, KLL, and SLB contributed to the study concept and design. RW and PABR analyzed the data. All authors contributed to the interpretation of data. RW wrote the first draft of the report, and all authors reviewed and edited the final report. PABR, KLL, and SLB provided supervision of the study. RW and SLB have full access to all the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis.

Abstract

Aims Depression after bariatric surgery can lead to suboptimal health outcomes. However, it is unclear how depressive symptoms evolve over the 24 months after surgery. We determine the extent depressive symptoms changed up to 24 months after bariatric surgery; and how this was impacted by measurement tool and surgical procedure.

Methods We conducted a systematic review and meta-analysis, searching five databases from database inception to June 2021 for studies that prospectively measured depressive symptoms before and up to 24-months after bariatric surgery. Change-scores were converted to Hedge's *g* and analyses were performed using mixed-effects models. Subgroup analyses examined differences across time of follow-up, measurement tool, and surgical procedure.

Findings 46 studies met inclusion criteria (32,342 patients). Meta-analysis indicated a post-surgical reduction in depressive symptom scores that were significant (large effect, g=0.804; 95%CI: 0.73-0.88, I^2=95.7%). Subgroup analyses found that symptom reductions did not differ between the timing of follow-up periods, measurement tool and surgical procedure.

Conclusions Depressive symptom scores reduced substantially following surgery; comparable decreases occurred 6- through 24-months after surgery. These findings can help inform practitioners of the typical evolution of depressive symptoms following surgery and where deviations from this may require additional intervention.

Introduction

The most effective treatment for severe obesity (BMI > 40.0 kg/m^2 or > 35.0 kg/m^2 with comorbidities) is bariatric surgery (Cadena-Obando et al., 2020). About 19% of individuals seeking bariatric surgery have depression (Dawes et al., 2016), and depression after surgery is associated with sub-optimal health outcomes (Youssef et al., 2020), including post-surgical weight-regain (Freire et al., 2021) and revisional surgeries (de Gara & Karmali, 2014).

Depression typically improves after surgery (Gill et al., 2019). However, these results are not always consistent (Burgmer et al., 2014; Sockalingam et al., 2011) and it is unclear what the general magnitude of change might be. Five systematic reviews (including three meta-analyses) have recently shown that depression decreases following surgery. These reviews included studies that assessed depression at various follow-up intervals (e.g., 1 to 120 months) and used various depression assessment measures (e.g., clinical interview, screening tools, medication usage). While informative for understanding the general prognosis of depression following surgery, these reviews provide limited utility for healthcare practitioners to understand the typical change of depressive symptoms when captured using validated screening tools and at common postoperative follow-up. This poses a challenge for practitioners when determining whether patients are deviating from the typical evolution of depression postoperatively. Most prospective studies capture depressive symptoms at regular intervals of 6-, 12-, and 24-months, postoperatively (Gill et al., 2019). For this reason, the current investigation aimed to estimate the magnitude depressive symptom scores decrease during these routine follow-up assessment periods. Specifically, we conducted a systematic review to estimate the effect bariatric surgery has on changes to depressive symptom scores within the first 24 months following surgery, and to determine whether these effects differed according to the timing of the postoperative follow-up, the depressive symptom tool used, and the type of bariatric procedure.

Methods

Search strategy and selection criteria

This meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines (Page et al., 2021), and was registered with Open Science Framework (OSF; DOI: 10.17605/OSF.IO/AXQE3). RW, PABR (systematic review specialist), SLB (senior researcher), and university librarians developed the search strategy (see Supplemental files). The Embase, PsycInfo, PubMed, Scopus, and Web of Science databases were searched from database inception to June 1st 2021. Inclusion criteria for the meta-analyses required: (1) use of a validated depressive symptom tool; (2) consist of an adult sample (18 years or older); (3) exposure to bariatric surgery; and (4) observational (i.e., prospective, longitudinal) studies or the control arm of a randomized-control intervention (i.e., un-intervened group). Entries were excluded due to: (1) publication type (i.e., abstracts, unpublished literature, commentary or reviews, book chapters); (2) not published in English or French; (3) study design (cross-sectional, no RCT control-arm that otherwise met inclusion criteria); (4) follow-up occurred within 30 days of surgery); and (5) depression assessment method (i.e., clinical interview only, medical chart code, prescription data). The number of studies that were excluded for each of these reasons is documented in Figure 1. Two reviewers (RW and AMM) independently screened all title and abstract entries, and full-text review (κ = 89%). Disagreements were resolved through discussion with a third reviewer (SLB). Extracted data included participant demographics (e.g., age, sex), time of follow-up, depressive symptom tool, surgical procedure, and pre- and post-surgical depressive symptom summary means (SD). Articles with overlapping samples were identified and the one with the largest sample size and complete data was included. Up to 3 attempts were made to contact authors if data was missing from articles. Risk of bias was independently assessed (RW and AMM, κ = 88%) using a modified Joanna Biggs Institute (JBI) checklist for quasi-experimental studies (Tufanaru et al., 2020), with a maximum potential score of 9 points.

Data Analysis

Meta-analyses were performed when three or more studies provided available data at follow-up. Since depressive symptom screening tools often differ in their scale of measurement, mean change-scores were standardized by subtracting the postsurgical mean from presurgical mean and then divided by a pooled standard deviation. This was expressed as Hedge's g (which accounts for sample size) with 95% Confidence Intervals (95% CI). Subgroup analyses were performed to examine the impact of follow-up period, symptom tool, and bariatric surgery type. Mixed-effects models were used given the anticipated heterogeneity across studies and group comparisons. Small (0.2), medium (0.5), and large (0.8) effect sizes were defined according to Cohen (1988). Forest plots reflected the magnitude depressive symptoms decreased from pre-surgery (independent of the tool used). The standardized mean difference (Hedge's g) was converted to a unstandardized mean-change score for each depressive symptom screening tool. Heterogeneity was reported as the Q-statistic and the I^2 index. Meta-regression analyses were performed using study sample characteristics and total JBI scores. All tests were 2-sided, and statistical significance was set to p = .05. All analyses were performed using Comprehensive Meta Analysis (CMA) version 3.

Results

Table 1 summarizes the study characteristics. Across the 46 studies that met inclusion for systematic review and meta-analyses (Figure 1), the overall sample consisted of 32,342 (range = 7-21,823) individuals seeking bariatric surgery. This overall sample had a mean age of 42-years-old, a mean pre-surgical BMI of 47 kg/m^2, and was comprised of mostly female patients (78%). Most studies were conducted in the USA (26.1%), Canada (13.0%), and Australia (8.7%). Most follow-up visits occurred at 12 months (n = 32), followed by 6 (n = 22), and 24 months (n = 13). Depressive symptoms were measured most commonly using the Beck Depression Inventory (BDI; 56.5%), followed by the Hospital Anxiety and Depression Scale (HADS; 30.4%), and Patient Health Questionnaire (PHQ; 13.1%). Most studies performed gastric bypass surgeries (n = 35), followed by sleeve gastrectomy (n = 21), gastric band (n = 12), and duodenal switch (n = 5).

All but one (Chalut-Carpentier et al., 2015) of the 46 studies reported improvements to depressive symptom scores following bariatric surgery. Following bariatric surgery, a large effect was observed regarding changes in depressive symptom scores (Hedge's $g = 0.804$; 95% CI: 0.73 to 0.88, $I^2 = 95.7\%$). Subgroup analysis (Figure 2) indicated that decreases in depressive symptom scores following bariatric surgery were comparable across the follow-ups ($Q = 0.002$, $df = 2$, $p = .999$): 6-months ($g = 0.806$; 95% CI: 0.66 to 0.96, $I^2 = 83.6\%$); 12-months ($g = 0.804$; 95% CI: 0.68 to 0.93, $I^2 = 96.9\%$); and 24-months ($g = 0.801$; 95% CI: 0.66 to 0.94, $I^2 = 89.2\%$). An effect of this size translates to a symptom score decrease of 6.3 (BDI range: 0 - 63), 2.8 (HADS range: 0 - 21), and 3.5 (PHQ: 0 - 27; Table 3). There was a large amount of heterogeneity for the main effect of depressive symptom score change at each follow-up.

Depressive symptom score changes were not different as a function of which depressive symptom tool was used to at either the 6-month (Figure 3; $Q = 1.41$, $df = 1$, $p = .235$) or 12-month (Figure 4; $Q = 2.866$, $df = 2$, $p = .239$) follow-ups. However, there was an effect of symptom tool type at the 24-month follow-up (Figure 5; $Q = 9.742$, $df = 2$, $p = .008$). Studies using the BDI ($g = 0.637$, 95% CI: 0.48-0.80, $I^2 = 80.6\%$) reported smaller changes in depressive symptom scores when compared to the HADS ($g = 0.899$, 95% CI: 0.54-1.26, $I^2 = 81.2\%$) and the PHQ ($g = 0.944$, 95% CI: 0.83-1.06, $I^2 = 50.1\%$).

There was no effect of bariatric surgery type on changes to depressive symptoms at neither the 6-month (Figure 6; $Q = 1.296$, $df = 1$, $p = .255$) nor 12-month (Figure 7; $Q = 4.247$, $df = 2$, $p = .120$) follow-up. There were not enough observations per surgery type to perform an analysis for the 24-month follow-up.

Simple meta-regression tests indicated that higher preoperative depressive symptom scores were associated with the observed effect size ($Q = 10.20$, $df = 1$, $p = .001$). Neither preoperative BMI ($p = .288$), sex ($p = .445$), nor age ($p = .108$) were associated with the observed effect sizes.

The mean (SD) JBI Scale score was 6.0 (1.2), range = 4-9 (Table 2 and Figure 8). Meta-regression did not find a significant association between JBI Scale score and changes to depressive symptom scores following bariatric surgery ($p = .549$). Publication bias was detected following inspection of the funnel plot (Figure 8), which was confirmed by the Egger's test (B = 3.75, 95% CI: 2.69-4.82, p > .001). The Trim-and-Fill procedure reduced the main effect from g = 0.80 (see change scores above) to g = 0.47 (BDI: 3.5; HADS: 1.5; PHQ: 1.9), with 32 studies estimated as missing (Table 3).

Discussion

We found large decreases to depressive symptom scores following bariatric surgery. Decreases in depressive symptom scores at 24 months postoperatively were comparable to 6 and 12 months after surgery. The magnitude of these effects were large and translated to an approximate decrease of 6.3 points for the BDI, 2.8 points for the HADS, and 3.5 points of the PHQ, all of which are equivalent to or surpass the minimum clinically important difference (MCID) for these tools (Bauer-Staeb et al., 2021; Kounali et al., 2020; Lemay et al., 2019). Previous systematic reviews have examined changes in depression following surgery (Dawes et al., 2016), and whether decreases to depression differed by timing of follow-up (Gill et al., 2019; Spirou et al., 2020), method of depression assessment (Loh et al., 2021), and surgery type (Fu et al., 2021). However, this is the first review to provide a quantitative estimate of the general change to depressive symptom across this post-operative period, as well as how this is impacted by these methodological considerations.

These values give clearer insight to the expected evolution of depression after undergoing bariatric surgery by providing change-scores that would be expected across the first 24 months of bariatric surgery. Depressive symptom scores that do not decrease to this magnitude could signal the need for further psychological support to mitigate other suboptimal health outcomes from developing, including increased suicidality (Gordon et al., 2019), problematic eating behaviours (White et al., 2015), suboptimal weight loss (Geerts et al., 2021), weight regain (Freire et al., 2021), and the need for revisional surgery (de Gara & Karmali, 2014).

None of the included studies formally tested psychological interventions and though it is possible that some patients received such an intervention as part of their care, it is also possible that these changes in depressive symptoms could be driven by other potential mechanisms.

Psychologically, increased body image (Behrens et al., 2021; Geller et al., 2020) and impulse control (White et al., 2010) have been associated with decreased depressive symptom scores after bariatric surgery. Likewise, improved functional mobility (King et al., 2016) and increased physical activity postoperatively (Rosenberger et al., 2011) also were linked to decreased depressive symptoms, possibly through greater cardiopulmonary fitness (Vetrovsky et al., 2021). Bariatric surgery disrupts many physiological systems that might have an antidepressant effect. Inflammatory markers (e.g., interleukin 6 [IL-6], C-reactive protein [CRP]) that are released systemically due to elevated visceral adipose tissue (Fontana et al., 2007) significantly decreases following weight loss, and in turn are associated with decreased depressive symptoms (Emery et al., 2007; Musselman et al., 2019). In recent developments, bariatric surgery has been shown to also alter the gut microbiota (increased/decreased bacterial abundance), as well as modulate various neuroendocrine and neurotransmission systems that are also associated with decreased depression (Brown et al., 2021).

In general, we found that depressive symptom scores did not differ between the BDI, HADS, and PHQ across the follow-ups. This suggests that using any one of these tools, either clinically or for research, would be reasonable. There was a small, but statistically significant difference in depressive symptom reduction at 24-months when measured using the BDI compared to the HADS and PHQ. This difference may be due to the fact that the BDI includes additional items measuring physical symptoms, which could overlap with obesity-related symptoms, which might inflate depressive symptom scores (Krukowski et al., 2010). The BDI does have recognised subscales which could help differentiate overlapping symptoms between depression and obesity (Hayes et al., 2015). However, none of these were tested in the included studies and should be explored in future research.

Decreased depressive symptom scores at 6- and 12-months did not differ by the type of bariatric procedure. This aligns with most reports of depression outcomes by surgery type (Ayloo et al., 2015; Barzin et al., 2020; Castellini et al., 2014; Strain et al., 2014). Murphy et al. (2018) observed larger decreases to depressive symptom scores initially if having undergone gastric bypass compared to gastric banding, but these differences between procedures were negligible 24-month after surgery. Considering that specific procedures are recommended according to obesity severity (Mechanick et al., 2020) and presences of other comorbidities (English & Williams, 2018) these results suggest similar favourable psychological outcomes irrespective of the type of procedure received.

Higher preoperative depressive symptom scores were associated with larger decreases to scores postoperatively, which is consistent with previous meta-analyses examining psychological and pharmacological interventions (Fournier et al., 2010, 2022), and suggests large improvements to the quality of life among those initially more impaired (Dawes et al., 2016). Despite higher preoperative depressive symptom scores being associated with larger reductions, postoperative depression values might continue to be above questionnaire thresholds that are indicative of clinical depression (Buser et al., 2004; Chalut-Carpentier et al., 2015; Hayden et al., 2011; Leung et al., 2019; Mokhber et al., 2016; O'Brien et al., 2002; Youssef et al., 2020). Therefore, individuals that continue to report elevated depression scores post-surgery should be considered for referral for depression-related treatments.

The substantial reductions in depressive symptoms within the first 24 months after surgery coincides with the rapid weight loss and improvements in many other facets of psychosocial functioning that occur within the 24-month 'honeymoon' period (de Zwaan et al., 2011; Karlsson et al., 2007). As weight begins to stabilize 24 months onwards, mental health has been shown to worsen, including increases in depressive symptoms (Gill et al., 2019), substance use (King et al., 2017), and binge-eating (Spirou et al., 2020). Given that mental health may begin to worsen following the first 24-months following surgery, it will be important that future reviews examine the changes in depressive symptoms seen over longer periods of time.

It was important for the current review to address specific gaps that remained among other recent systematic reviews that have examined depression outcomes following bariatric surgery. Notably, translating the results of the extant literature into results that could be directly applicable to clinical practice was a key issue. As such, the current review focused solely on data captured using the most common screening tools and did not examine the prevalence of depression diagnoses before and after bariatric surgery, which can only be administered by trained mental health professionals. Additionally, this review examined whether these changes varied over the common postoperative assessment periods, i.e., 6-, 12-, and 24-months after surgery. Other reviews included follow-up visits that spanned between 1 and 120 months. Given that depressive symptom scores can fluctuate postoperatively, the current study showed that this does not occur within the first 24 month after surgery. These two conceptual pieces likely contributed to the limited overlap of included studies (6% to 36% of the studies in our review were found in the other reviews).

The current review also employed a number of methods that were in line with high scientific rigor for systematic reviews. For example, we explored five databases. Except for Spirou et al. (2020) between 3 and 4 databases were searched by the other prior reviews. Screening and data extraction were performed independently by two reviews throughout the current study, whereas two reviews (Fu et al., 2021; Loh et al., 2021) did not employ such techniques. The current and three prior reviews (Dawes et al., 2016; Fu et al., 2021; Loh et al.,

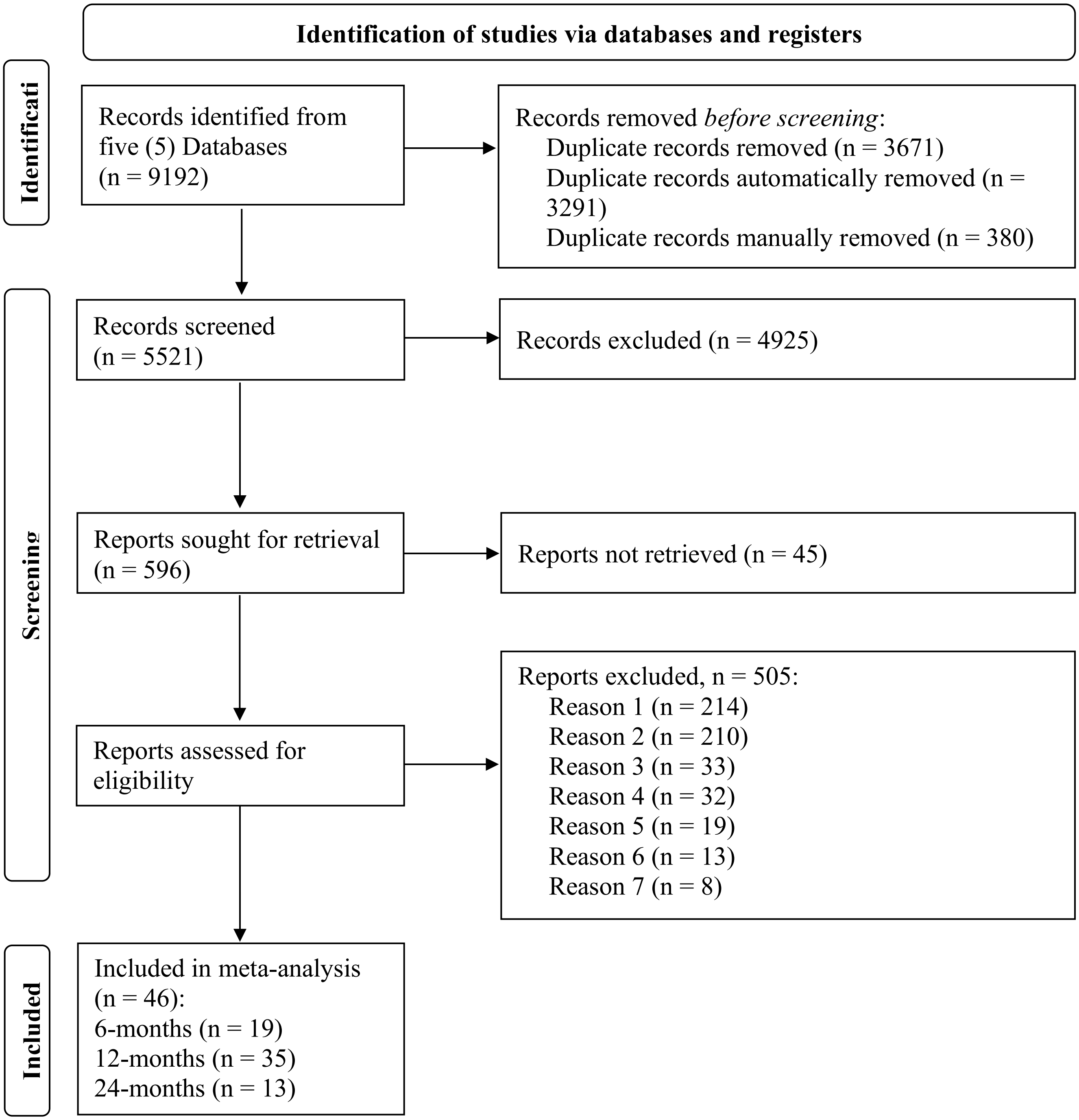
2021) performed meta-analyses, whereas two reviews did not (Gill et al., 2019; Spirou et al., 2020).

Individual Study and Review Limitations

A few limitations were evident among the articles included in this review. There was high heterogeneity across studies, which may decrease the confidence in the results seen should be interpreted with caution. That said, this might also suggest that the observed decrease in depressive symptoms is universal across bariatric settings and among different individuals undergoing surgery. Another limitation to consider among the included studies is a selection bias in favor of individuals with less severe depression. Greater symptom severity during a depressive episode is among the ineligibility criteria for those seeking bariatric surgery (Mechanick et al., 2020). In addition, those with higher depressive symptom severity are also less likely to participate in research studies and/or discontinue participation in longitudinal studies (Sockalingam et al., 2013). Therefore, the results in the current study might not apply universally to all individuals who undergo bariatric surgery. The observational study design of included articles limits the ability to make causal inferences about the impact bariatric surgery has on depressive outcomes. Only five studies reported testing the psychometric properties of the depressive symptom tool in their sample (Andersen et al., 2010; Burgmer et al., 2014; Efferdinger et al., 2017; Gade et al., 2015; Hayden et al., 2011). Without reporting this, it is unclear how reliable the symptom tools were within the diverse cultural populations. Also, most studies did not test statistical assumptions or adjust for covariates in their analyses.

There were a few limitations with this systematic review. First, we only included studies that measured depression using validated symptom measures (i.e., BDI, HADS, and PHQ) which alone, are not reliable measures of clinical depression or depressive disorders. Although appropriate for screening and research purposes, symptom measures should be used in conjunction with clinical interviews when making a formal diagnoses of depressive disorders (Stuart et al., 2014). That said, patients undergoing bariatric surgery tend to underreport psychiatric symptoms during clinical interviews out of concern of being ineligible for the surgery (Ambwani et al., 2013). Second, we focused on specific follow-up time periods and did not include studies that reported data at different follow-up times, e.g., 3 or 18 months. This was done given the lack of observations occurring at these time points but does limit our capacity to fully explore more fine-grained variations in effects across the 24-month follow-up period. However, the consistency in our results across time does mitigate some of this concern.

Depression accounts for a large proportion of psychiatric comorbidities among those seeking surgical interventions for obesity (Dawes et al., 2016). Bariatric surgery results in a large magnitude of change that translates to clinically significant improvements in depressive symptoms, with higher pre-surgical distress being associated with greater decreases post-surgery. Future research should consider exploring potential mechanisms that contribute to decreases in depressive symptoms following bariatric surgery. Identifying these mechanisms could lead to developing targeted interventions that healthcare providers can offer if surgery recipients experience smaller decreases to depression and/or if depressive symptom scores remain above levels that are indicative of depression. Identifying individuals that continue to live with depression in the postoperative period allows for early intervention, which could help mitigate increasing risk of suboptimal surgical outcomes (e.g., problematic eating, weight regain, surgical revisions) that undermines the quality of life of individuals who received bariatric surgery.



Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram Reason 1 = reported outcome (missing pre- and/or post-surgery outcome, invalid or missing questionnaire); Reason 2 = publication type (abstract only, review, theses, letters to editor); Reason 3 = timing of follow-up (not occurring at specific, collected in window); Reason 4 = overlapping samples; Reason 5 = language (no English, no French); Reason 6 = no exposure (no surgery, infrequent procedure type); Reason 7 = study design

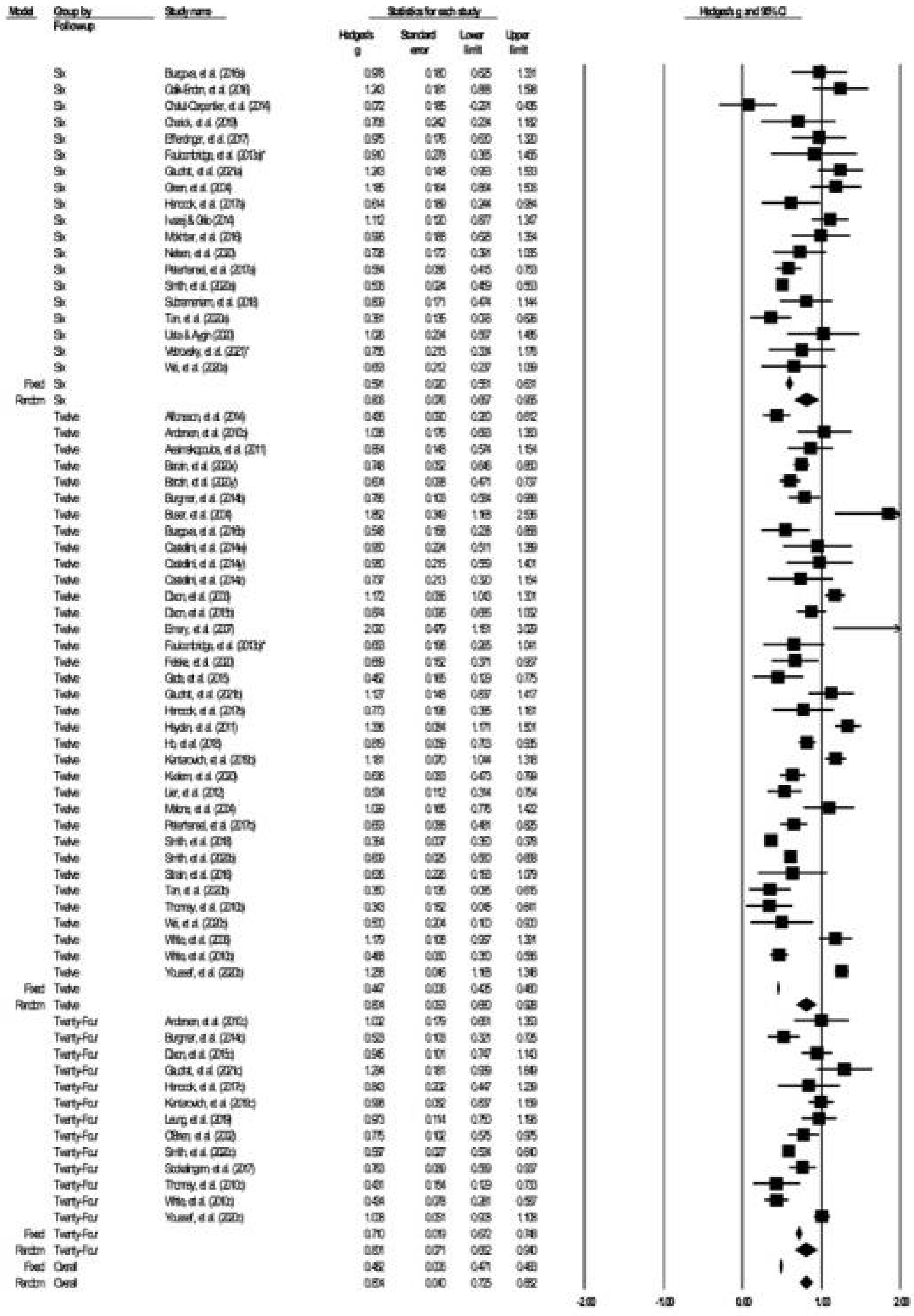
First Author (year)	Country	Study Design	Depressive Symptom Tool	Surgery Type(s):	Baseline N	% Women	Mean Age (SD)	Mean Baseline BMI (SD)	Follow-Up Timing (months)	Reported depressive symptom outcome	JBI Score/9
Alfonsson et al., 2014	Sweden	Prospective	HADS	Bypass	129	78.0	42.80 (10.5)	42.95 (4.0)	12	-1.4 (3.13)	7
Andersen et al., 2010	Norway	Prospective	HADS	Switch	50	56.0	37.90 (7.9)	51.70 (7.5)	12, 24	12M: -4.2 (3.92) 24M: -4.1 (3.97)	8
Assimakopoulos et al., 2011	Greece	Prospective	HADS	Sleeve, Bypass, Switch	59	100.0	36.00 (..)	51.90 (9.9)	12	-2.9 (3.26)	7
Barzin et al., 2020	Iran	Prospective	BDI	Sleeve, Bypass	685	84.8	38.70 (10.9)	45.10 (6.6)	12	Sleeve: -7.2 (9.40) Bypass: -6.1 (9.85)	7
Burgmer et al., 2014	Germany	Prospective	HADS	Band, Vertical Gastroplasty	148	68.2	38.80 (10.2)	50.70 (8.0)	12, 24	12M (Band): -3.0 (3.72) 24M (Band): -2.1 (3.91)	8
Buser et al., 2004	USA	Prospective	BDI	Bypass	42	100.0	41.06 (10.1)	52.46 (10.1)	6, 12	-13.1 (6.79)	4
Buzgova et al., 2016	Czech Republic	Prospective	HADS	Sleeve, Greater Curvature Plication	68	66.2	44.20 (9.6)	42.60 (5.4)	6, 12	6M (Sleeve): -3.3 (3.27) 12M (Sleeve): -2.0 (3.53)	6
Castellini et al., 2014	Italy	Prospective	BDI, SCL-90	Band, Bypass, Switch	83	89.7	43.70 (10.3)	47.96 (6.3)	12	Band: -9.3 (9.46) Bypass: -9.8 (9.66) Switch: -7.9 (10.29)	6
Celik-Erden et al., 2016	Turkey	Prospective	BDI	Sleeve	51	64.7	36.92 (9.3)	47.66 (7.5)	6	-8.2 (6.37)	7
Chalut-Carpentier et al., 2015	Switzerland	Prospective	HADS	Bypass	38	81.6	43.00 (9.0)	46.30 (6.8)	6	-0.2 (2.69)	5
Cherick et al., 2019	France	Prospective	BDI	Sleeve, Bypass	36	100.0	37.00 (13.0)	41.00 (7.0)	6	-4.0 (5.44)	6
Dixon et al., 2003	Australia	Prospective	BDI	Band	487	85.0	41.20 (9.7)	44.10 (7.4)	12	-9.9 (8.24)	6

First Author (year)	Country	Study Design	Depressive Symptom Tool	Surgery Type(s):	Baseline N	% Women	Mean Age (SD)	Mean Baseline BMI (SD)	Follow-Up Timing (months)	Reported depressive symptom outcome	JBI Score/9
Dixon et al., 2016	USA	Prospective	BDI	Band	149	90.6	Median: 40 (range:18-55)	35.40 (range: 29.8-39.9)	12, 24	12M: -5.6 (6.24) 24M: -5.8 (5.98)	6
Efferdinger et al., 2017	Austria	Prospective	BDI	Bypass, Sleeve Resection	45	76.0	44.07 (13.3)	45.59 (7.5)	6	-10.5 (10.40)	6
Emery et al., 2007	USA	Longitudinal	BDI	Bypass	13	100.0	46.90 (5.7)	51.30 (6.3)	12	-9.0 (4.07)	5
Faulconbridge et al., 2013	USA	Prospective Observational	BDI	Band, Bypass	36	72.2	47.00 (9.6)	48.90 (6.6)	6, 12	6M: -5.9 (9.07) 12M: -4.5 (6.65)	8
Felske et al., 2021	Canada	Prospective	BDI	Band, Sleeve, Bypass	50	80.0	46.98 (8.6)	49.01 (10.5)	12	-5.4 (7.82)	7
Gade et al., 2015	Norway	Randomized Control Trial (Control)	HADS	Sleeve, Bypass	38	73.7	41.20 (9.6)	43.50 (4.7)	12	-2.5 (5.35)	7
Gaudrat et al., 2021	France	Longitudinal	HADS	Band, Sleeve, Bypass	80	67.5	38.33 (11.2)	44.39 (5.5)	6, 24	6M: -4.1 (3.24) 12M: -3.8 (3.24) 24M: -4.3 (3.19)	6
Green et al., 2004	USA	Prospective	BDI	Bypass	65	73.8	39.21 (9.9)	54.78 (9.9)	6	-10.3 (8.44)	5
Hancock et al., 2018	UK	Longitudinal	HADS	Band	31	..	45.90 (7.2)	.	6, 12, 24	6M: -2.8 (4.33) 12M: -3.5 (4.32) 24M: -3.6 (4.16)	5
Hayden et al., 2011	Australia	Prospective	BDI	Band	258	85.0	41.36 (9.3)	43.80 (7.9)	12	-10.8 (7.92)	9
Ho et al., 2018	Canada	Retrospective	PHQ	Sleeve, Bypass	365	80.0	44.70 (10.0)	50.10 (9.6)	12	-4.6 (5.48)	7
Ivezaj & Grilo, 2015	USA	Prospective	BDI	Bypass	107	87.9	42.66 (10.2)	51.66 (7.9)	6, 12	-7.7 (6.70)	7
Kantarovich et al., 2019	Canada	Prospective	MINI, PHQ	Sleeve, Bypass	211	81.9	44.86 (9.5)	48.85 (8.2)	24	12M: -6.5 (5.33) 24M: -5.6 (5.45)	4

First Author (year)	Country	Study Design	Depressive Symptom Tool	Surgery Type(s):	Baseline N	% Women	Mean Age (SD)	Mean Baseline BMI (SD)	Follow-Up Timing (months)	Reported depressive symptom outcome	JBI Score/9
Kvalem et al., 2020	Norway	Prospective	HADS	Bypass	169	77.5	45.20 (9.3)	44.50 (5.6)	12	-2.2 (3.42)	6
Leung et al., 2019	Canada	Prospective	PHQ	Sleeve, Bypass	108	80.6	46.21 (9.7)	48.30 (8.7)	24	-5.5 (5.45)	6
Lier et al., 2011	Norway	Prospective	BDI	Bypass	127	74.0	41.30 (10.3)	45.30 (5.2)	12	-5.0 (9.01)	5
Malone & Alger-Mayer, 2004	USA	Prospective, Longitudinal	BDI	Bypass	109	81.1	45.19 (10.1)	47.74 (17.3)	12	-8.0 (7.09)	5
Mokhber et al., 2016	Iran	Prospective	BDI	Bypass	40	87.5	34.20 (11.3)	45.31 (2.6)	6	-10.0 (9.71)	6
Nielsen et al., 2020	Denmark	Prospective	BDI	Sleeve, Bypass	40	15.0	40.00 (9.2)	45.00 (6.8)	6	-7.5 (9.96)	7
O'Brien et al., 2019	Australia	Prospective	BDI	Band	709	85.0	Median: 41.00 (range: 16-71)	45.00 (7.0)	12, 24	-10.2 (12.84)	4
Peterhansel et al., 2017	Germany	Prospective	BDI	Sleeve, Bypass	154	69.5	46.77 (10.6)	50.11 (8.0)	6, 12	6M: -5.6 (9.30) 12M: -6.2 (9.23)	7
Smith et al., 2018	USA	Prospective	PHQ	Band, Sleeve, Bypass, Switch	21823	79.8	46.71 (11.7)	47.18 (7.9)	12	-1.5 (4.1)	4
Smith et al., 2020	USA	Retrospective	BDI	Band, Bypass	2308	78.7	45.50 (11.4)	.	6, 12, 24	6M: -3.4 (6.56) 12M: -4.2 (6.74) 24M: -4.2 (6.99)	5
Sockalingam et al., 2017	Canada	Prospective	MINI, PHQ	Sleeve, Bypass	156	81.0	45.23 (9.3)	50.43 (8.8)	12, 24	-4.5 (5.70)	6
Strain et al., 2017	USA	Prospective	BDI	Switch	275	69.8	42.70 (10.0)	53.40 (11.4)	12	-6.7 (10.16)	4
Subramaniam et al., 2018	Malaysia	Prospective	HADS	Sleeve, Bypass, Anastomosis Gastric Bypass-Mini Gastric Bypass	57	64.9	39.40 (10.1)	45.52 (18.3)	6	-2.1 (2.54)	5

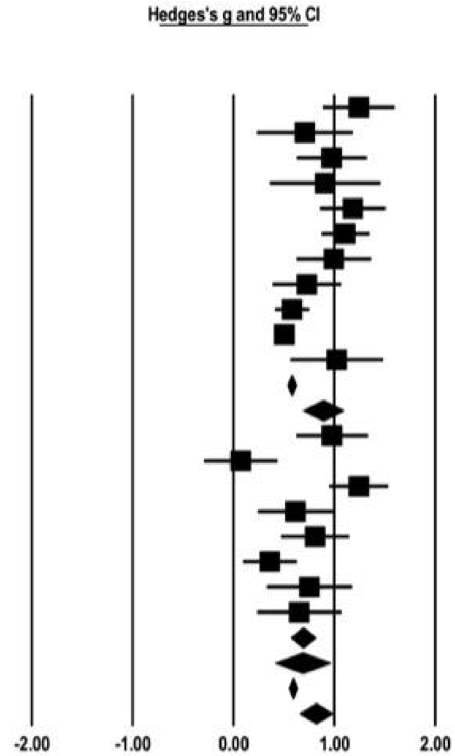
First Author (year)	Country	Study Design	Depressive Symptom Tool	Surgery Type(s):	Baseline N	% Women	Mean Age (SD)	Mean Baseline BMI (SD)	Follow-Up Timing (months)	Reported depressive symptom outcome	JBI Score/9
Tan et al., 2021	Singapore	Prospective	HADS	Sleeve, Bypass	55	63.6	44.69 (9.4)	40.92 (6.0)	6, 12	6M: -1.2 (3.12) 12M: -1.1 (3.02)	5
Thonney et al., 2010	Switzerland	Prospective	BDI, HADS	Bypass	43	100.0	39.20 (9.2)	44.7 (2.6)	24	12M: -4.0 (11.30) 24M: -4.3 (9.88)	6
Usta & Aygin, 2020	Turkey	Pretest–Posttest, Repeated-Measures, Randomized Control Prospective (Control)	BDI	Sleeve	26	80.8	36.60 (12.9)	46.70 (5.8)	6	-5.7 (5.35)	7
Vetrovsky et al., 2021	Czech Republic	Prospective	HADS	Bypass	26	76.9	45.40 (9.0)	45.10 (7.4)	6	-3.0 (3.82)	7
Wei et al., 2020	China	Prospective	HADS	Sleeve, Bypass	25	60.0	42.60 (12.2)	40.80 (7.7)	6, 12	6M: -2.3 (3.36) 12M: -1.8 (3.54)	7
White et al., 2006	USA	Prospective	BDI	Bypass	139	89.2	42.40 (10.2)	51.70 (7.9)	12	-8.2 (6.77)	6
White et al., 2010	USA	Prospective	BDI	Bypass	361	86.1	43.70 (10.0)	51.10 (8.3)	6, 12, 24	12M: -6.2 (12.85) 24M: -6.4 (11.32)	5
Youssef et al., 2020	Canada	Prospective	PHQ	Sleeve, Bypass	2268	82.0	45.00 (10.5)	48.70 (8.9)	6, 12, 24	12M (Bypass): -7.0 (5.45) 24M (Bypass): -5.9 (5.68)	5

Note. Table presents study sample characteristics. Abbreviations: Body Mass Index = BMI; Joanna Biggs Institute = JBI; Beck Depression Inventory = BDI; Hospital Anxiety and Depression Scale = HADS; Patient Health Questionnaire = PHQ; Gastric Banding = Band; Sleeve Gastrectomy = Sleeve; Gastric Bypass = Bypass; Duodenal Switch = Switch; Depression scores decrease = '↓'; Depression scores unchanged = ' - '

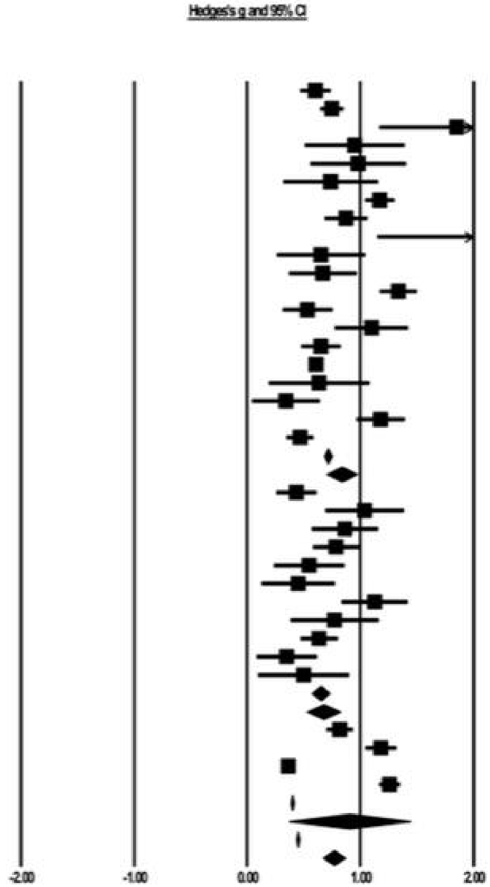


Note: Superscripts denote study observations with multiple follow-ups ('a' 6-months; 'b' 12-months; 'c' 24-months) included in the meta-analyses, and within study observation that separate depressive symptoms scores by procedure type ('w' Band; 'x' Sleeve; 'y' Bypass; 'z' Switch')

Model	Group by Questionnaire	Study name	Statistics for each study			
			Hedges's g	Standard error	Lower limit	Upper limit
	BDI	Celik-Erden, et al. (2016)	1.243	0.181	0.888	1.598
	BDI	Cherick, et al. (2019)	0.708	0.242	0.234	1.182
	BDI	Efferdinger, et al. (2017)	0.975	0.176	0.630	1.320
	BDI	Faulconbridge, et al. (2013a)*	0.910	0.278	0.365	1.455
	BDI	Green, et al. (2004)	1.185	0.164	0.864	1.506
	BDI	Ivazej, et al. (2014)	1.112	0.120	0.877	1.347
	BDI	Mokhbar, et al. (2016)	0.996	0.188	0.628	1.364
	BDI	Nielsen, et al. (2020)	0.728	0.172	0.391	1.065
	BDI	Peterhansel, et al. (2017a)	0.584	0.086	0.415	0.753
	BDI	Smith, et al. (2020a)	0.506	0.024	0.459	0.553
	BDI	Usta, et al. (2019)	1.026	0.234	0.567	1.485
Fixed	BDI		0.578	0.022	0.536	0.620
Random	BDI		0.891	0.102	0.691	1.090
	HADS	Buzgova, et al. (2016a)	0.978	0.180	0.625	1.331
	HADS	Chalut-Carpentier, et al. (2014)	0.072	0.185	-0.291	0.435
	HADS	Gaudrat, et al. (2021a)	1.243	0.148	0.953	1.533
	HADS	Hancock, et al. (2017a)	0.614	0.189	0.244	0.984
	HADS	Subramaniam, et al. (2018)	0.809	0.171	0.474	1.144
	HADS	Tan, et al. (2020a)	0.361	0.135	0.096	0.626
	HADS	Vetrovsky, et al. (2021)*	0.755	0.215	0.334	1.176
	HADS	Wei, et al. (2020a)	0.653	0.212	0.237	1.069
Fixed	HADS		0.692	0.061	0.572	0.812
Random	HADS		0.688	0.138	0.418	0.957
Fixed	Overall		0.591	0.020	0.551	0.631
Random	Overall		0.819	0.082	0.659	0.979

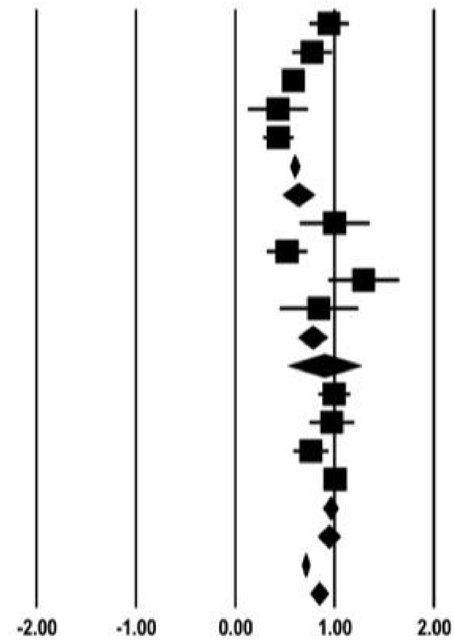


Model	Group by Questionnaire	Study name	Hedges's g	Standard error	Lower limit	Upper limit
	BDI	Barzin, et al. (2020a)	0.604	0.068	0.471	0.737
	BDI	Barzin, et al. (2020b)	0.748	0.052	0.646	0.850
	BDI	Buser, et al. (2004)	1.852	0.349	1.168	2.536
	BDI	Castellini, et al. (2014a)	0.950	0.224	0.511	1.389
	BDI	Castellini, et al. (2014b)	0.980	0.215	0.559	1.401
	BDI	Castellini, et al. (2014c)	0.737	0.213	0.320	1.154
	BDI	Dixon, et al. (2003)	1.172	0.066	1.043	1.301
	BDI	Dixon, et al. (2015)	0.874	0.096	0.686	1.062
	BDI	Emery, et al. (2007)	2.090	0.479	1.151	3.029
	BDI	Faulconbridge, et al. (2013b)*	0.653	0.198	0.265	1.041
	BDI	Felske, et al. (2020)	0.669	0.152	0.371	0.967
	BDI	Haydin, et al. (2011)	1.336	0.084	1.171	1.501
	BDI	Lier, et al. (2012)	0.534	0.112	0.314	0.754
	BDI	Malone, et al. (2004)	1.099	0.165	0.776	1.422
	BDI	Peterhansel, et al. (2017b)	0.653	0.088	0.481	0.825
	BDI	Smith, et al. (2020b)	0.609	0.025	0.560	0.658
	BDI	Strain, et al. (2016)	0.636	0.226	0.193	1.079
	BDI	Thonney, et al. (2010)	0.343	0.152	0.045	0.641
	BDI	White, et al. (2006)	1.179	0.108	0.967	1.391
	BDI	White, et al. (2010)	0.468	0.060	0.350	0.586
Fixed	BDI		0.714	0.017	0.681	0.747
Random	BDI		0.836	0.067	0.704	0.969
	HADS	Alfonsson, et al. (2014)	0.436	0.090	0.260	0.612
	HADS	Andersen, et al. (2010)	1.038	0.176	0.693	1.383
	HADS	Assimakopoulos, et al. (2011)	0.864	0.148	0.574	1.154
	HADS	Burgmer, et al. (2014)	0.786	0.103	0.584	0.988
	HADS	Burgova, et al. (2016b)	0.548	0.158	0.238	0.858
	HADS	Gade, et al. (2015)	0.452	0.165	0.129	0.775
	HADS	Gaudrat, et al. (2021b)	1.127	0.148	0.837	1.417
	HADS	Hancock, et al. (2017b)	0.773	0.198	0.385	1.161
	HADS	Kvalem, et al. (2020)	0.636	0.083	0.473	0.799
	HADS	Tan, et al. (2020b)	0.350	0.135	0.085	0.615
	HADS	Wei, et al. (2020b)	0.500	0.204	0.100	0.900
Fixed	HADS		0.650	0.039	0.574	0.726
Random	HADS		0.675	0.074	0.531	0.820
	PHQ	Ho, et al. (2018)	0.819	0.059	0.703	0.935
	PHQ	Kantarovich, et al. (2019)	1.181	0.070	1.044	1.318
	PHQ	Smith, et al. (2018)	0.364	0.007	0.350	0.378
	PHQ	Youssef, et al. (2020)	1.258	0.046	1.168	1.348
Fixed	PHQ		0.398	0.007	0.384	0.411
Random	PHQ		0.904	0.272	0.372	1.436
Fixed	Overall		0.447	0.006	0.435	0.460
Random	Overall		0.767	0.049	0.672	0.863

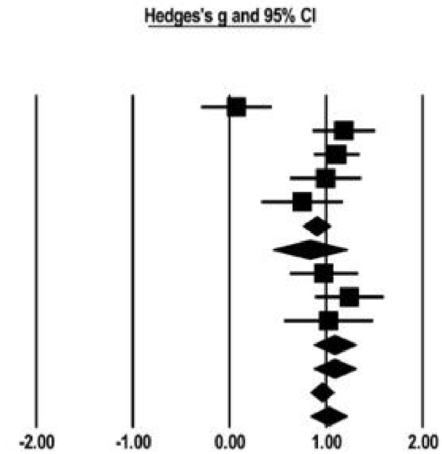


Model	Group by Questionnaire	Study name	Statistics for each study			
			Hedges's g	Standard error	Lower limit	Upper limit
	BDI	Dixon, et al. (2015c)	0.945	0.101	0.747	1.143
	BDI	O'Brien, et al. (2002)	0.775	0.102	0.575	0.975
	BDI	Smith, et al. (2020c)	0.587	0.027	0.534	0.640
	BDI	Thonney, et al. (2010c)	0.431	0.154	0.129	0.733
	BDI	White, et al. (2010c)	0.434	0.078	0.281	0.587
Fixed	BDI		0.599	0.024	0.553	0.646
Random	BDI		0.637	0.081	0.477	0.796
	HADS	Andersen, et al. (2010c)	1.002	0.179	0.651	1.353
	HADS	Burgmer, et al. (2014c)	0.523	0.103	0.321	0.725
	HADS	Gaudrat, et al. (2021c)	1.294	0.181	0.939	1.649
	HADS	Hancock, et al. (2017c)	0.843	0.202	0.447	1.239
Fixed	HADS		0.780	0.074	0.634	0.926
Random	HADS		0.899	0.186	0.535	1.263
	PHQ	Kantarovich, et al. (2019c)	0.998	0.082	0.837	1.159
	PHQ	Leung, et al. (2019)	0.973	0.114	0.750	1.196
	PHQ	Sockalingam, et al. (2017)	0.763	0.089	0.589	0.937
	PHQ	Youssef, et al. (2020c)	1.008	0.051	0.908	1.108
Fixed	PHQ		0.960	0.037	0.888	1.033
Random	PHQ		0.944	0.057	0.833	1.056
Fixed	Overall		0.710	0.019	0.672	0.748
Random	Overall		0.847	0.045	0.758	0.935

Hedges's g and 95% CI



Model	Group by Type of surgery	Study name	Statistics for each study Hedges's g	Standard error	Lower limit	Upper limit
	BYPASS	Chalut-Carpentier, et al. (2014)	0.072	0.185	-0.291	0.434
	BYPASS	Green, et al. (2004)	1.185	0.164	0.863	1.506
	BYPASS	Ivazej & Grilo (2014)	1.112	0.120	0.877	1.347
	BYPASS	Mokhbar, et al. (2016)	0.996	0.188	0.628	1.365
	BYPASS	Vetrovsky, et al. (2021)*	0.755	0.215	0.334	1.176
Fixed	BYPASS		0.904	0.073	0.760	1.048
Random	BYPASS		0.834	0.197	0.448	1.219
	SLEEVE	Buzgova, et al. (2016a)	0.978	0.180	0.626	1.331
	SLEEVE	Celik-Erden, et al. (2016)	1.243	0.180	0.890	1.595
	SLEEVE	Usta & Aygin (2020)	1.026	0.234	0.567	1.484
Fixed	SLEEVE		1.091	0.112	0.872	1.310
Random	SLEEVE		1.091	0.112	0.872	1.310
Fixed	Overall		0.960	0.061	0.840	1.080
Random	Overall		1.028	0.097	0.838	1.219



Model	Group by Type of Surgery	Study name	Hedges's g	Standard error	Lower limit	Upper limit
	BAND	Castellini, et al. (2014w)	0.950	0.224	0.511	1.390
	BAND	Dixon, et al. (2003)	1.172	0.066	1.044	1.301
	BAND	Dixon, et al. (2015b)	0.874	0.096	0.687	1.061
	BAND	Hancock, et al. (2017b)	0.773	0.198	0.385	1.161
	BAND	Hayden, et al. (2011)	1.336	0.084	1.172	1.499
Fixed	BAND		1.127	0.043	1.042	1.212
Random	BAND		1.059	0.104	0.856	1.262
	BYPASS	Alfonsson, et al. (2014)	0.436	0.090	0.260	0.612
	BYPASS	Barzin, et al. (2020y)	0.604	0.068	0.470	0.738
	BYPASS	Buser, et al. (2004)	1.852	0.349	1.169	2.536
	BYPASS	Castellini, et al. (2014y)	0.980	0.215	0.558	1.401
	BYPASS	Emery, et al. (2007)	2.090	0.479	1.152	3.028
	BYPASS	Kvalem, et al. (2020)	0.636	0.083	0.474	0.798
	BYPASS	Lier, et al. (2012)	0.534	0.112	0.316	0.753
	BYPASS	Malone, et al. (2004)	1.099	0.165	0.776	1.422
	BYPASS	Thonney, et al. (2010b)	0.343	0.152	0.045	0.641
	BYPASS	White, et al. (2006)	1.179	0.108	0.968	1.390
	BYPASS	White, et al. (2010)	0.468	0.060	0.351	0.586
Fixed	BYPASS		0.625	0.031	0.564	0.686
Random	BYPASS		0.777	0.095	0.591	0.964
	SWITCH	Andersen, et al. (2010b)	1.038	0.176	0.693	1.382
	SWITCH	Castellini, et al. (2014z)	0.737	0.213	0.319	1.155
	SWITCH	Strain, et al. (2016)	0.636	0.226	0.193	1.079
Fixed	SWITCH		0.842	0.116	0.614	1.070
Random	SWITCH		0.836	0.126	0.590	1.082
Fixed	Overall		0.796	0.025	0.748	0.844
Random	Overall		0.890	0.061	0.770	1.010

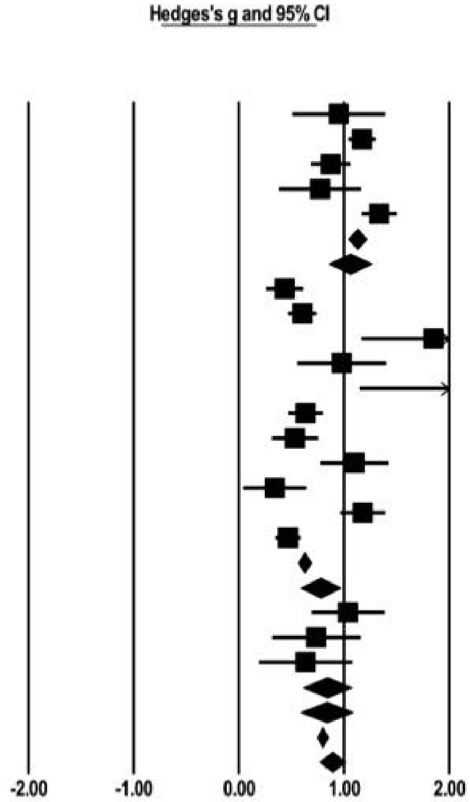


Table 2: *JBI Critical Appraisal Checklist for quasi-experimental studies.*

First Author(s), year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score/9
Alfonsson et al., 2014	Y	Y	Y	N	Y	Y	Y	N	Y	7
Andersen et al., 2010	Y	Y	Y	N	Y	Y	Y	Y	Y	8
Assimakopoulos et al., 2011	Y	Y	Y	N	Y	Y	Y	N	Y	7
Barzin et al., 2020	Y	Y	Y	N	Y	Y	Y	N	Y	7
Burgmer et al., 2014	Y	Y	Y	N	Y	Y	Y	Y	Y	8
Buser et al., 2004	N	Y	Y	N	Y	Y	N	N	N	4
Buzgova et al., 2016	Y	Y	Y	N	Y	Y	Y	N	N	6
Castellini et al., 2014	Y	Y	Y	N	Y	Y	N	N	Y	6
Erden et al., 2016	Y	Y	Y	N	Y	Y	Y	N	Y	7
Chalut-Carpentier et al., 2015	N	Y	Y	N	Y	N	Y	N	Y	5
Cherick et al., 2019	Y	Y	Y	N	Y	N	Y	N	Y	6
Dixon et al., 2003	Y	Y	Y	N	Y	N	Y	N	Y	6
Dixon et al., 2016	N	Y	Y	N	Y	Y	Y	N	Y	6
Efferdinger et al., 2017	N	Y	Y	N	Y	N	Y	Y	Y	6
Emery et al., 2007	Y	Y	Y	N	Y	N	Y	N	N	5
Faulconbridge et al., 2013	Y	Y	Y	Y	Y	Y	Y	N	Y	8
Felske et al., 2021	Y	Y	Y	N	Y	Y	Y	N	Y	7
Gade et al., 2015	Y	Y	N	N	Y	Y	Y	Y	Y	7
Gaudrat et al., 2021	Y	Y	Y	N	Y	Y	Y	N	N	6

First Author(s), year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score/9
Green et al., 2004	Y	Y	Y	N	Y	Y	N	N	N	5
Hancock et al., 2018	N	Y	Y	N	Y	Y	Y	N	N	5
Hayden et al., 2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Ho et al., 2018	Y	Y	Y	N	Y	Y	Y	N	Y	7
Ivezaj & Grilo, 2015	Y	Y	Y	N	Y	Y	Y	N	Y	7
Kantarovich et al., 2019	N	Y	Y	N	Y	N	N	N	Y	4
Kvalem et al., 2020	Y	Y	Y	N	Y	N	Y	N	Y	6
Leung et al., 2019	N	Y	Y	N	Y	Y	Y	N	Y	6
Lier et al., 2011	N	Y	N	N	Y	Y	Y	N	Y	5
Malone & Alger-Mayer, 2004	Y	Y	Y	N	Y	N	Y	N	N	5
Mokhber et al., 2016	Y	Y	Y	N	Y	Y	Y	N	N	6
Nielsen et al., 2020	Y	Y	Y	N	Y	Y	Y	N	Y	7
O'Brien et al., 2019	Y	Y	N	N	Y	N	Y	N	N	4
Peterhansel et al., 2017	Y	Y	Y	N	Y	Y	Y	N	Y	7
Smith et al., 2018	N	Y	N	N	Y	N	Y	N	Y	4
Smith et al., 2020	Y	Y	N	N	Y	N	Y	N	Y	5
Sockalingam et al., 2017	Y	Y	Y	N	Y	N	Y	N	Y	6
Strain et al., 2017	Y	Y	N	N	Y	N	N	N	Y	4
Subramaniam et al., 2018	N	Y	Y	N	Y	N	Y	N	Y	5
Tan et al., 2021	Y	Y	Y	N	Y	N	Y	N	N	5

First Author(s), year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score/9
Thonney et al., 2010	Y	Y	Y	N	Y	Y	Y	N	N	6
Usta & Aygin, 2020	Y	Y	Y	N	Y	Y	Y	N	Y	7
Vetrovsky et al., 2021	Y	Y	Y	N	Y	Y	Y	N	Y	7
Wei et al., 2020	Y	Y	Y	Y	Y	Y	Y	N	N	7
White et al., 2006	Y	Y	Y	N	Y	Y	Y	N	N	6
White et al., 2010	N	Y	Y	N	Y	N	Y	N	Y	5
Youssef et al., 2020	N	Y	Y	N	Y	N	Y	N	Y	5
Percentage (%)	73.9%	100.0%	87.0%	6.5%	100.0%	63.0%	89.1%	10.9%	71.7%	

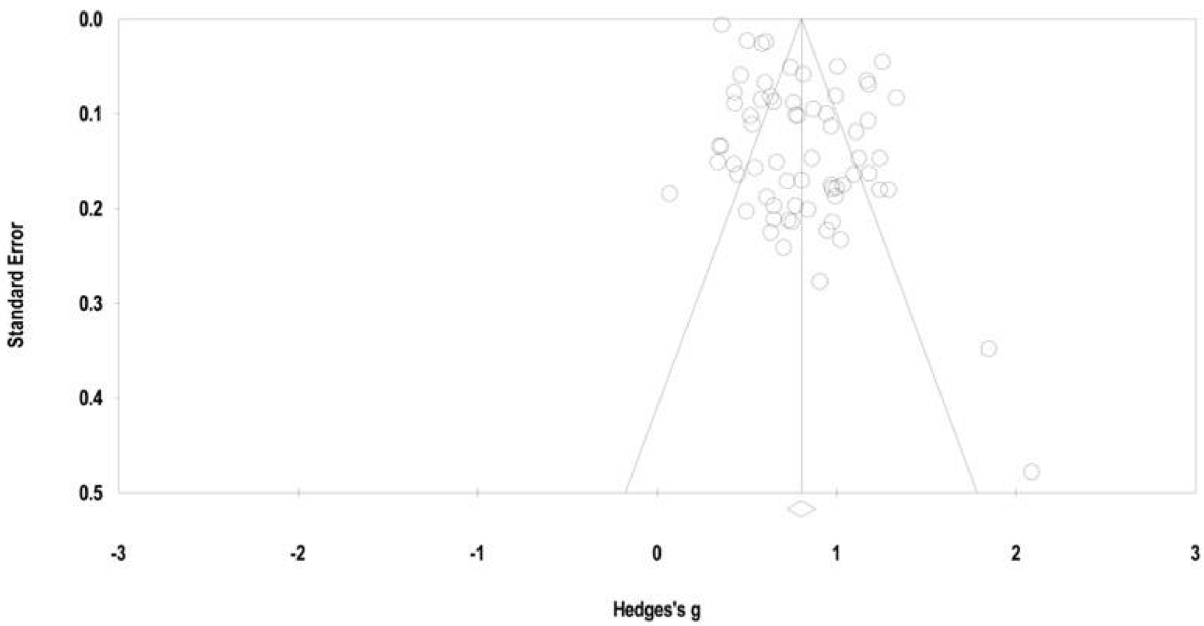
Note. Abbreviation: Y, yes; N, no.

JBI Question
Q1: Is it clear in the study what is the ‘cause’ and what is the ‘effect’?
Q2: Were the participants included in any comparisons similar?
Q3: Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?
Q4: Was there a control group?
Q5: Were there multiple measurements of the outcome both pre and post the intervention/exposure?
Q6: Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?
Q7: Were the outcomes of participants included in any comparisons measured in the same way?
Q8: Were outcomes measured in a reliable way?

Table 3: *Estimated screening tool change-scores using the overall pooled effect (Hedge's g and standard error [SE]) and after adjusting for publication bias (Trim-and-Fill method). Calculated change-score using the median sample size according to the depressive symptom screening tool used in the study.*

Tool		*Mean Change*	*SD Difference*	*N*	*g*	*SE*
BDI	Meta-Analysis	-6.25	7.58	247	0.80	0.08
	Trim and Fill	-3.35	7.58	247	0.43	0.07
HADS	Meta-Analysis	-2.75	3.34	75	0.80	0.13
	Trim and Fill	-1.50	3.34	75	0.44	0.12
PHQ	Meta-Analysis	-3.50	4.26	250	0.80	0.08
	Trim and Fill	-1.90	4.26	250	0.43	0.08

Note. BDI (Beck Depression Inventory), HADS (Hospital Anxiety and Depression Scale), PHQ (Patient Health Questionnaire)


0.0
0.1
0.2
0.3
0.4
0.5
Standard Error
-3
-2
-1
0
1
2
3
Hedges's g

Chapter 3: The factor structure and stability of the Beck Depression Inventory-II (BDI-II) in a population undergoing bariatric surgery

Authors: Robbie Woods, Kim L. Lavoie, Simon L. Bacon, & for the REBORN Team. (2022). The factor structure and stability of the Beck Depression Inventory-II (BDI-II) in a population undergoing bariatric surgery. *Obesity Surgery*. https://doi.org/10.1007/s11695-022-06277-5

Contributions: RW and BLS have full access to all the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. KLL and SLB conceived and carried out the study. RW and SLB conceived the research question. RW carried out data analysis. All authors were involved in writing the manuscript and had final approval of the submitted and published version.

Abstract

Purpose: Depression is a multifaceted psychiatric condition that has been associated with suboptimal weight loss following bariatric surgery. Previous variations of Beck Depression Inventory-Second Edition (BDI-II) subscales been proposed, including those identified within bariatric populations; however, it is unclear whether the BDI-II items contained within these subscales would remain consistent after the procedure considering the physical and lifestyle changes that occur following bariatric surgery.

Materials and Methods: A two-step analytic approach that comprised of exploratory (EFA) and confirmatory factor analyses (CFA) that aimed to identify a stable factor structure using pre- and 6-month post-surgical BDI-II responses. Baseline BDI-II responses of 149 patients (Group 1) were used to identify an initial EFA model. Five BDI-II models underwent CFA using BDI-II responses of a comparable pre-surgical group (Group 2; n=142), and 6-month post-surgical data from Group 1.

Results: EFA generated a two-factor solution. Of the five CFA models performed, the three-factor model that was initially identified by Hayes (2015) among patients undergoing bariatric surgery demonstrated superior fit across time and between groups.

Conclusions: Although the EFA initially identified a two-factor model, CFA determined that a previously defined three-factor model reliably fit both pre- and post-surgical BDI-II responses. This study supports using the Hayes (2015) subscales when monitoring pre- and post-bariatric surgery facets of depression specific to this population. Being able to accurately and reliably monitor depressive symptoms of patients that are undergoing bariatric surgery will allow for the provision and monitoring of targeted interventions aimed at improving their mental and physical health outcomes.

Key Points

- The Hayes (2015) three-factor model demonstrated superior fit when compared to all other competing models in the baseline and postoperative BDI-II responses across two groups.
- The three BDI-II subscales measure negative perceptions, cognitive dysregulation, and diminished vigor.
- These subscales could more readily identify facets of depression and streamline patient care by delivering targeted and personalized treatments

Introduction

Depression is the most prevalent psychiatric conditions among individuals seeking bariatric surgery (Dawes et al., 2016). Although depression typically improves after surgery (Akan et al., 2018; de Zwaan et al., 2011), 15% of individuals who undergo bariatric surgery show either no improvements or a worsening of depressive symptoms (Ivezaj & Grilo, 2015). Also, depressive symptoms tend to gradually increase again after surgery (Aasprang et al., 2013; Mitchell et al., 2014); thus increasing the risk for weight regain (Freire et al., 2021) and need for revisional surgery (de Gara & Karmali, 2014).

Clinical interviews are the recommended method for determining the presences of psychiatric conditions (e.g. depression) as part of the suitability assessment for bariatric surgery (Mechanick et al., 2020). While mental health professionals prefer using clinical interviews as part of the bariatric surgery suitability assessment (Fabricatore et al., 2006), this method is lengthy (Mitchell et al., 2010) and prone to underreporting of psychiatric symptoms (Ambwani et al., 2013). Alternatively, bariatric centres have adopted self-report screening tools given their ease of use for patients (Erford et al., 2016). Notably, the 21-item Beck Depression Inventory (BDI; Beck et al., 1961, 1996) is the most common self-report screening tool to assess depressive symptoms in this population (Livhits et al., 2012).

Depression is a highly heterogeneous psychiatric disorder (Zimmerman et al., 2015), where symptoms might cluster together in different ways depending on the nature of the chronic disease populations and be differentially associated with health outcomes (Gaspersz et al., 2018; Lamers et al., 2010). This has led to the development of subscales within depression screening tools. Two- and three-factor BDI-II subscales have previously been identified using exploratory factor analysis (EFA) across different populations (Arnau et al., 2001; Buckley et al., 2001). Hall

(2013) identified a three-factor model (Buckley et al., 2001) using a confirmatory factor analysis (CFA) approach without first exploring whether symptoms uniquely clusters together. Hayes et al. (2015) identified a three-factor solution (negative perceptions, diminished vigor, and cognitive dysregulation) by first performing an EFA using BDI-II responses of one bariatric sample, and then applied a CFA in a second bariatric sample. However, the study did not compare this three-factor structure to other models previously published.

The BDI-II includes several items that measure symptoms that obesity and depression share (Hayden et al., 2014; Luppino et al., 2010). Therefore, the rapid weight loss that follows bariatric surgery may impact symptom endorsement between pre- and post-surgery assessments, and undermine the reliability of specific BDI-II subscales. This study sought to address this by identifying a factor structure (EFA) using baseline BDI-II responses of individuals awaiting bariatric surgery. The stability of this EFA was then evaluated and compared with previous BDI-II structure models by performing CFA on the 6-month post-surgical BDI-II responses of the same group along with a comparable group of individuals waiting to receive bariatric surgery, to determine factor stability across the pre- and post-surgical periods.

Methods

Participants & Procedure

Between 2015 and 2018, individuals attending their pre-bariatric surgery visit were approached to participate in the *Research on bariatric care for obesity treatment* (REBORN) longitudinal cohort study (REB #2015-1176) which aimed to identify psychological and behavioural sequalae of individuals undergoing bariatric surgery. After providing informed consent, participants completed questionnaires prior to surgery (baseline) and 6-months post-surgery. Only individuals ≥18 years and undergoing their first bariatric surgery were included.

Individuals that completed the questionnaire in English or had a body mass index (BMI) < 30.0 were excluded from the current analyses (n = 26). The sample was categorized into two groups: Group 1 (n = 149) consisted of individuals that provided complete data on the BDI-II at baseline and 6-months after their bariatric surgery (i.e., sleeve gastrectomy); and Group 2 consisted of individuals (n = 142) that provided complete BDI-II data only at baseline.

Measures

Demographics: Participants completed self-reported questionnaires that included age, sex, weight, and height. BMI was calculated from weight and height.

Beck Depression Inventory – Second Edition (BDI-II): This 21-item tool assessed severity of depressive symptoms within the past two weeks (Beck et al., 1996). Items were measured using a four-point scale, ranging from '0' reflecting no endorsement of symptoms (e.g., "I do not feel like a failure") to '3' reflects high endorsement of the specified symptom (e.g., "I feel I am a total failure as a person"). Scores were summed (range 0-63), with higher scores indicative of higher depressive symptoms. The BDI-II has good internal consistency (Cronbach α = .89; Erford et al., 2016) and excellent internal consistency (α > .90) within populations undergoing bariatric surgery (Hall et al., 2013; Hayes et al., 2015).

Factor Analyses.

The analytic strategy of the current study was completed in two steps (see Figure 1), and summarized below. All analyses were conducted using SAS Studio.

Exploratory Factor Analysis (EFA)

Group 1's presurgical data underwent EFA using Principal Axis Factoring (PAF) with an oblique rotation. Factor retention was determined using five criteria in descending order of priority: (i) Eigenvalues ≥ 1; (ii) examination of scree plot; (iii) Eigenvalues > 95th percentile

Eigenvalues estimated in the parallel analysis; (iv) theoretical consideration; and (v) items loading ≥ three or more per factor. Factor loadings < .32 were suppressed (Tabachnick & Fidell, 2012).

Confirmatory Factor Analysis (CFA)

Five CFAs (see Table 1) were performed on Group 1's 6-month post-surgical data, and Group 2's baseline data. These models included a unidimensional model (Beck et al., 1961), three 2-factor models (Beck et al., 1996) including the model identified in the EFA (labelled as REBORN-2), and a 3-factor model (Hayes et al., 2015). Maximum likelihood was used to estimate the sample parameters. Model fit was evaluated according to five indices: Yuan-Bentler chi-square (χ^2) statistic, standardized root-mean-square residual (SRMR ≤ .08), and root-mean-square error of approximation (RMSEA ≤ .08; Steiger, 1990), Comparative Fit Index (CFI ≥ .95; Bentler, 1990), and Tucker-Lewis Fit Index (TLI ≥ .95; Bentler, 1990). Bayesian information criterion (BIC) was used to compare fit across models, with lower values indicating superior model fit (Raftery, 1995). Error covariance between BDI-II items was determined using the Lagrange Multiplier test. Internal consistencies for individual factors were assessed using Cronbach's α.

Results

Group 1 was significantly older and had lower baseline BDI-II scores than Group 2 (Table 2). Group 1 mostly self-identified as white (91%), followed by identifying as Black (2%), Hispanic (1%), with the remaining sample identifying as 'Other' (6%). Group 2 was predominantly White (85%), followed by Black (6%), and Hispanic (2%), while the remaining identified as 'Other' (9%). The groups did not differ in ethnicity, $\chi^2 = 3.12$, $p = .373$. BMI significantly decreased in Group 1 from baseline (M = 47.4, SD = 11.3) to 6-months following bariatric surgery (M = 35.9, SD = 6.7; *t* [141] = 31.44, $p < .001$). BDI-II scores decreased significant from baseline (M = 12.4, SD = 7.7) to 6-months following surgery (M = 7.1, SD = 6.6, *t* [148] = 9.92, $p < .001$).

Exploratory Factor Analysis

Inspection of Eigenvalues and scree plot, and parallel analysis (Figure 2) suggested a two-factor solution. After restricting to two factors, items #16, #17, and #18 were excluded after not meeting the minimum item loading criterion (see Table 3). The first factor (labelled 'Cognitive') contained 11 items, and the second factor ('Somatic-Affective') contained 7 items. Item #12 loaded equally onto both factors, but was place into the Somatic-Affective factor given the similar item loading pattern of the Beck (Beck et al., 1996) two-factor model. The Cognitive (α = .81) and Somatic-Affective factors (α = .76) had acceptable internal consistency, and were moderately correlated, $r = .57$ ($p < .001$).

Confirmatory Factor Analysis

Fit statistics can be seen in Table 4. Modifications to Group 1 post-surgical and Group 2 baseline BDI-II responses models can be found in the supplemental material. Among Group 1 post-surgical responses, the Hayes et al. (2015) three-factor model demonstrated superior fit compared to the other four models according to the lower BIC values. Similarly, the Hayes et al. (2015) model had the lowest BIC value when compared across all models using Group 2 baseline BDI-II responses.

Subsequently, the REBORN-2 and Hayes et al. (2015) models underwent CFA to determine which model demonstrated superior fit using Group 1's baseline. Both models were comparable across model fit indices; however, the Hayes et al. (2015) model demonstrated superior fit according to the lower BIC value when compared with REBORN-2 model. Separate tables were provided to present for both groups the factor correlations (Table 5) and internal consistencies (Table 6).

Discussion

With increasing demand for surgical interventions to aid in weight loss, as well as higher incidence of depressive symptoms among those seeking surgery, healthcare practitioners rely heavily on depressive symptoms measures to monitor mental health outcomes over the course of the treatment process. Therefore, the purpose of the current study was to identify a consistent BDI-II model that would retain a factor structure before and 6 months after individuals undergone bariatric surgery. While a two-factor solution, titled REBORN-2, emerged from the initial EFA, the three-factor Hayes et al. (2015) model demonstrated superior fit over REBORN-2 when we conducted our pre- and post-surgical CFAs. This model was initially derived from an EFA using BDI-II responses of a large cohort of patients awaiting bariatric surgery, and subsequently confirmed in a second bariatric cohort (Hayes et al., 2015). The 'negative perceptions' subscale includes items that assess negative thoughts about oneself and the future, and negative valenced emotions (Hayes et al., 2015). The 'cognitive dysregulation' subscale measures the executive function impairments that occur in depression, while the 'diminished vigor' subscale is proposed to measure symptoms that historically load onto a somatic factor. Of note, the Hayes (2015) model performed consistently across the surgical procedure, suggesting that the subscale structure is robust enough to be employed at any point of the surgical timeline.

Mounting evidence has highlighted the importance of assessing depressive symptoms before and after bariatric surgery (Karlsson et al., 2007; Livhits et al., 2012; Scholtz et al., 2007). Higher depressive symptoms postoperatively was linked to weight regain (de Zwaan et al., 2011; Scholtz et al., 2007) and poorer adherence to post-surgical health behaviours (Colles et al., 2007). However, the heterogeneity of depressive symptoms (Zimmerman et al., 2015) and competing BDI-II subscales (Arnau et al., 2001; Beck et al., 1996; Buckley et al., 2001) pose a challenge when attempting to measuring the most appropriate depressive features for this unique population. Importantly, the use of subscales could highlight elevated facets of depression that might require targeted and personalize treatment, thus streamlining patient care. For instance, elevated cognitive dysregulation scores might signal difficulties in impulsive control that preclude maladaptive coping mechanisms, e.g., alcohol misuse (Miller-Matero et al., 2021; Smith et al., 2018), as well as suicidal and self-harming behaviours (Castaneda et al., 2019; Peterhansel et al., 2013). Therefore, clinicians could offer patients interventions designed to improve emotion-regulation and impulse-control strategies.

The anhedonic symptoms included in diminished vigor subscale are linked to weight recidivism following surgery (Castaneda et al., 2019). Therefore, the diminished vigor subscale might signal for clinicians to encourage patients to identify and participate in pleasurable activities (i.e., behavioural activation) that encourage more adaptive behaviours.

Elevated negative perceptions scores, which reflect pessimistic and punitive cognitions, could prompt treatments targeting distorted thought processes (e.g., *discounting the positive* improvements in health status following weight loss despite still being within the obese BMI class). This could help direct interventions that aim to challenge or navigate around negative perceptions through cognitive reframing (e.g., directing attention to ending reliance on medications for diabetes control following surgically-induced weight loss) that otherwise undermine the capacity for patients to adopt post-surgical lifestyle changes associated with maintaining a healthy weight (e.g., continued adherence to dietary and physical activity recommendations).

A number of depressive symptoms, largely physical symptoms, captured in the BDI-II are absent from the Hayes et al. (2015) model. Given the mutual relation between physical symptoms of depression and obesity (Luppino et al., 2010), endorsing these BDI-II items might be in response to the obesity rather than due to psychological disturbances. This underscores the potential limits of only using total BDI-II scores, especially when they are not paired with validated structured interviews (e.g., SCID) and how the development of validated sub-scales may further enhance the tracking of depression in these populations.

This study has some limitations that require consideration when interpreting the results. First, the current study was potentially under-powered; some have recommended that the ratio of sample to items entered in models to be 20:1 (MacCallum et al., 2001), but the current study had a ratio of 7:1. That said, smaller sample sizes are considered acceptable when a measure is highly reliable (e.g., internal consistency). Since the BDI-II responses in groups 1 and 2 demonstrated high internal consistency, the smaller sample sizes were deemed acceptable. There was high attrition in the current study (48.8%). This is consistent with previous studies with behavioural (Ponzo et al., 2021) and surgical interventions (Brode et al., 2018; Diamant et al., 2014; Taylor et al., 2018) for weight loss. Although the factor structure was consistent across time for Group 1, it is unclear whether the same would occur over time for Group 2. The number of modifications applied to the models increase the risk of overfitting and increase chances of type I error (Pitt & Myung, 2002). That said, even after modifications were applied to all models per groups, the Hayes et al. (2015) three-factor model consistently remained the best fitting model. The current sample largely consisted of women; however, the sample reflects a similar prevalence of women to men undergoing bariatric surgery. We did not conduct a psychiatric interview as part of the study, so we did not have a depression diagnosis in order determine the sensitivity and specificity of possible cut-off scores for the BDI-II and possible subscale cut-off scores. Another limitation of the current study was that the samples were not ethnically diverse and comprised mostly of individuals who identified as being white. Therefore, future studies should consider assessing the factor structure and its stability in samples that are larger and ethnically more diverse. Furthermore, because of the predominance of individuals who were white, we were not able to establish if the factor structure was consistent across different ethnicities, this should also be explored in future studies. Despite some limitations, this study also had a number of important strengths. This included study samples with complete pre- and post-surgical data, along with a comparative pre-surgical group. Another strength of the study was the inclusion of both the EFA and CFA analytic strategies of previous study groups that aimed to identify an appropriate factor structure in a bariatric population. That said, the current study was novel by extending the evaluation of the BDI-II factor structure beyond pre-surgical assessments by replicating the same analytic strategy to 6-month post-surgical assessments.

The BDI-II is among the most common self-report screening tools to assess depressive symptoms among individuals undergoing bariatric surgery. The consistency of the Hayes et al. (2015) model across all datasets, which included both pre- and post-surgical data, suggest the appropriateness of these sub-scales (i.e., negative perception, cognitive dysregulation, and diminished vigor) across the bariatric surgery continuum. While current guidelines do not specifically recommend screening depressive symptoms as part of the suitability assessment for bariatric surgery, increased symptom endorsement is associated with suboptimal surgical outcomes. As such, identifying subscales that are specific to depression in this population might help clinicians and researchers identify, develop, and deliver targeted interventions to mitigate sub-optimal outcomes of patients that undergo bariatric surgery.

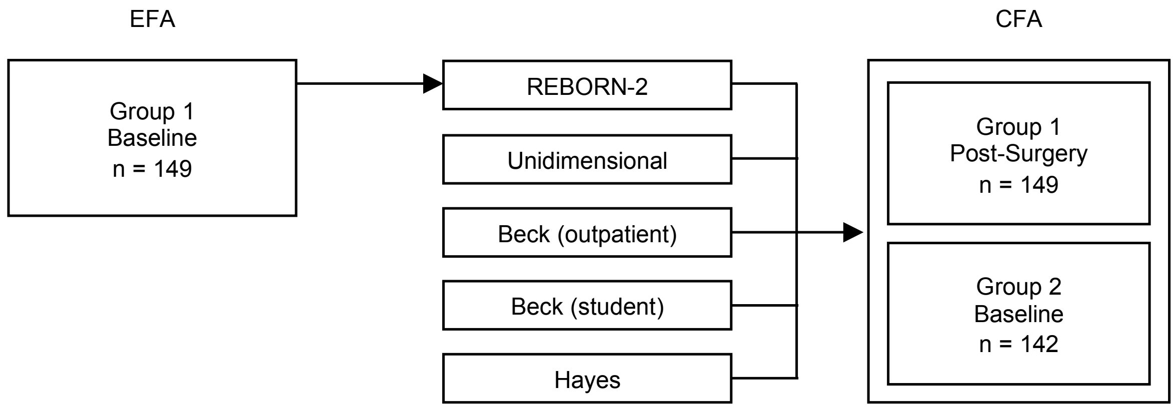

EFA
CFA
Group 1
Baseline
n = 149
REBORN-2
Unidimensional
Beck (outpatient)
Beck (student)
Hayes
Group 1
Post-Surgery
n = 149
Group 2
Baseline
n = 142

Table 1. *Item mapping for the CFA using the BDI-II.*

Items	CFA Models				
	Uni-dimensional	Beck (outpatient)	Beck (student)	REBORN-2	Hayes 2015
1. Sadness	D	C	CA	C	NP
2. Pessimism	D	C	CA	C	NP
3. Past Failure	D	C	CA	C	NP
4. Loss of Pleasure	D	SA	CA	SA	
5. Guilty Feelings	D	C	CA	C	NP
6. Punishment	D	C	CA	C	NP
7. Self-Dislike	D	C	CA	C	NP
8. Self-Criticalness	D	C	CA	C	NP
9. Suicidal thoughts and wishes	D	C	CA	C	
10. Crying	D	SA	CA	C	
11. Agitation	D	SA	CA	C	CD
12. Loss of interest	D	SA	CA	SA	
13. Indecisiveness	D	SA	CA	SA	CD
14. Worthlessness	D	C	CA	SA	NP
15. Lack of Energy	D	SA	S	SA	DV
16. Change in Sleep Pattern	D	SA	S		
17. Irritability	D	SA	CA		CD
18. Change in Appetite	D	SA	S	SA	
19. Concentration	D	SA	S	SA	CD
20. Tiredness or Fatigue	D	SA	S	SA	DV
21. Loss of Interest in Sex	D	SA	CA	SA	DV

Note. D = single factor of Depression, C = Cognitive, S = Somatic, A = Affective, NP = Negative Perceptions, DV = Diminished Vigor, CD = Cognitive Dysregulation

Table 2. *Baseline sample characteristics (i.e., percent female, age, self-reported BMI, and BDI-II scores) of Groups 1 and 2.*

	Group 1	Group 2	Between group comparisons
	N = 149	N = 142	
Female (%)	79.20%	84.50%	$\chi^2 = 1.38$
Age (M ± SD)	47.44 ± 11.32	43.04 ± 11.36	t (289) = 3.31***
Baseline BDI-II (M ± SD)	12.42 ± 7.73	15.54 ± 10.09	t (289) = 2.97**
Baseline BMI (M ± SD)	47.96 ± 7.46	48.12 ± 7.17	t (289) = -0.19

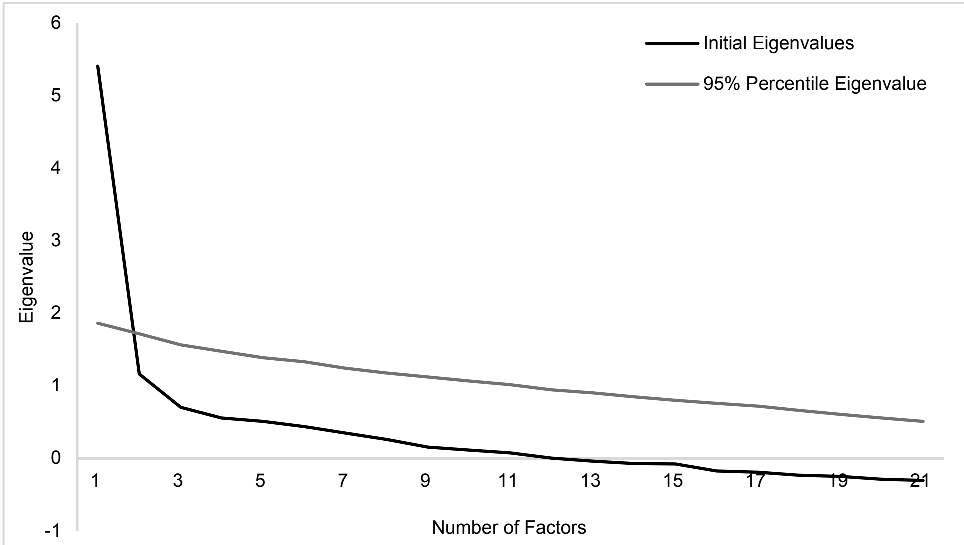
Note. *** $p < .001$, ** $p < .01$

Table 3. *BDI-II item mean (M), standard deviation (SD.) with factor loadings from pattern matrix and communalities*

Items	M	Std Dev.	Cognitive	Somatic-Affective	h^2
1. Sadness	0.34	0.53	0.45		0.48
2. Pessimism	0.35	0.58	0.62		0.43
3. Past Failure	0.64	0.76	0.52		0.36
4. Loss of Pleasure	0.59	0.65		0.42	0.49
5. Guilty Feelings	0.73	0.70	0.72		0.48
6. Punishment	0.26	0.62	0.39		0.27
7. Self-Dislike	0.81	0.95	0.48		0.38
8. Self-Criticalness	0.62	0.72	0.56		0.48
9. Suicidal thoughts and wishes	0.15	0.36	0.52		0.30
10. Crying	0.39	0.76	0.45		0.30
11. Agitation	0.34	0.53	0.44		0.32
12. Loss of interest	0.47	0.62	0.40	0.37	0.51
13. Indecisiveness	0.33	0.6		0.45	0.39
14. Worthlessness	0.37	0.69	0.57		0.52
15. Loss of Energy	1.13	0.72		0.60	0.42
16. Change in Sleep Pattern	1.04	0.90			0.22
17. Irritability	0.57	0.76			0.35
18. Change in Appetite	0.95	1.04			0.19
19. Concentration	0.58	0.71		0.65	0.43
20. Tiredness or Fatigue	0.82	0.7		0.64	0.50
21. Loss of Interest in Sex	0.95	1.01		0.51	0.29

Table 4. *Identification of the Best Fitting BDI-II among Group 1 (n = 149) baseline and post-surgical responses, and Group 2 (n = 142) baseline responses.*

Sample	Model	Y-B χ^2	*df*	*p*-value	CFI	TLI	RMSEA	SRMR	BIC
Group 1, post	Uni-dimensional	363.34	186	<.001	0.819	0.795	0.081	0.074	593.52
	Beck (outpatient)	343.42	184	<.001	0.839	0.816	0.077	0.071	578.60
	Beck (student)	351.00	184	<.001	0.831	0.807	0.078	0.071	586.19
	REBORN-2	262.88	131	<.001	0.850	0.824	0.082	0.070	463.04
	Hayes	169.26	84	<.001	0.884	0.855	0.083	0.064	349.41
Group 2	Uni-dimensional	334.81	183	<.001	0.860	0.839	0.077	0.069	579.69
	Beck (outpatient)	310.12	182	<.001	0.881	0.863	0.071	0.065	552.96
	Beck (student)	317.85	182	<.001	0.874	0.855	0.073	0.066	560.68
	REBORN-2	217.40	129	<.001	0.905	0.888	0.070	0.063	425.55
	Hayes	117.77	83	0.005	0.946	0.930	0.056	0.058	306.09
Group 1, pre	REBORN-2	162.24	113	0.001	0.918	0.902	0.055	0.065	363.40
	Hayes	123.01	84	0.004	0.928	0.909	0.056	0.066	303.16



Initial Eigenvalues
95% Percentile Eigenvalue
Eigenvalue
Number of Factors
6
5
4
3
2
1
0
-1
1
3
5
7
9
11
13
15
17
19
21

Table 5. *Correlation matrix of Hayes 3-factor subscales for Group 1 (baseline and post-surgery) and Group 2 (baseline).*

Group 1, Baseline	1	2
1. Negative Perception	-	
2. Diminished Vigor	0.37	-
3. Cognitive Dysregulation	0.54	0.49
Group 1, Post Surgery		
1. Negative Perception	-	
2. Diminished Vigor	0.3	-
3. Cognitive Dysregulation	0.62	0.43
Group 2, Baseline		
1. Negative Perception	-	
2. Diminished Vigor	0.44	-
3. Cognitive Dysregulation	0.55	0.52

Table 6. *Internal consistency (Cronbach's alpha) of BDI-II total and Hayes 3-factor.*

	Group 1		**Group 2**
	Baseline	Post-Surgery	Baseline
BDI-II Total	0.85	0.87	0.90
Negative Perception	0.80	0.84	0.83
Diminished Vigor	0.63	0.62	0.72
Cognitive Dysregulation	0.52	0.67	0.64

Chapter 4: Depressive feature improvements and weight loss outcomes following bariatric surgery: Results from the Research on bariatric care for obesity treatment (REBORN) longitudinal cohort study

Woods, R., … for the REBORN Study Team. (*In preparation*). Depressive feature improvements and weight loss outcomes following bariatric surgery: Results from the Research on bariatric care for obesity treatment (REBORN) longitudinal cohort study. *International Journal of Obesity*.

Contributions: RW and SLB have full access to all the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. KLL and SLB conceived and carried out the study. RW and SLB conceived the research question. RW and TBP carried out data analysis. All authors were involved in writing the manuscript and had final approval of the submitted and published version.

Abstract

Objective: Although improvements in depressive symptoms following bariatric surgery are linked to greater weight loss, it is unclear whether this relation is a result of improvements in certain depressive features. This study examined whether overall improvements of depressive symptoms or specific depressive features after bariatric surgery were linked to weight loss.

Method: The study sample consisted of 145 individuals who underwent bariatric surgery, and provided complete Beck Depression Inventory – Second Edition (BDI-II) responses and weight data at baseline and 6-month postoperatively. Three bariatric-specific BDI-II subscales (negative perception, cognitive dysregulation, diminished vigor) were calculated.

Results: Change in total BDI-II scores trended towards significance in the association with percent excess body weight-loss 6-months following surgery, after adjusting for covariates (B = -0.17, p = .058). Larger improvement in negative perception after having undergone bariatric surgery were associated with greater weight loss (B = -0.23, p = .004). Neither changes in cognitive dysregulation (B = -0.09, p = .334) or diminished vigor (B = -0.01, p = .899) were unrelated to weight loss.

Conclusions: Only improvements in negative perception scores were linked to better weight loss 6-months following bariatric surgery, while improvements in cognitive dysregulation and diminished vigor were not associated with weight loss. Though more work is needed, these findings highlight potential treatment targets for psychological interventions if depressive symptoms and suboptimal weight loss persists following bariatric surgery.

Introduction

Depression is the most prevalent psychiatric condition among individuals seeking bariatric surgery (Dawes et al., 2016). Prospective studies have generally observed a reduction in depressive symptoms following bariatric surgery (de Zwaan et al., 2011; Woods et al., Revise and Resubmit). These reductions have been observed up to 10 years post-surgery (Karlsson et al., 2007). That said, about 15% of individuals receiving a bariatric procedure showed either no improvements or worsening of depressive symptoms (Ivezaj & Grilo, 2015), and although depressive symptoms might significantly reduce right after bariatric surgery, symptoms have been shown to gradually increase over time (Mitchell et al., 2014).

Depression is a heterogeneous psychiatric condition with 227 combinations of DSM-5 diagnostic symptoms that could result in a major depressive episode diagnosis (Zimmerman et al., 2015). In addition, depressive symptoms have been shown to cluster together differently depending on the chronic disease populations (Huang & Chen, 2015) and these clusters may be associated with specific health outcomes (Khambaty et al., 2014). In patients undergoing bariatric surgery, items within the Beck Depression Inventory – Second Edition [BDI-II]) (Beck et al., 1996), which is the most widely administered self-reported depressive symptom measure in bariatric centres (Livhits et al., 2012), have been shown to cluster into three features of depression (i.e., negative perceptions, cognitive dysregulation, diminished vigor; Hayes et al., 2015; Woods et al., 2022).

Depression prior to surgery increases the likelihood of suboptimal weight loss outcomes (Kalarchian et al., 2008; Legatto et al., 2022; Semanscin-Doerr et al., 2010) and larger improvements in depressive symptoms following bariatric surgery have been associated with greater weight loss (Burgmer et al., 2014; de Zwaan et al., 2011; Mitchell et al., 2014). However, it is unclear whether overall or dimension-specific depressive symptoms are reduced and if these are related to weight loss outcomes. Therefore, the purpose of this study was to examine whether larger reductions in depressive symptoms overall or symptoms pertaining to certain depressive features are associated with greater reductions in weight among individuals who have undergone bariatric surgery.

Methods

Participants & Procedure

Between 2015 and 2018, individuals attending their pre-bariatric surgery visit were approached to participate in the REBORN (*Research on bariatric care for obesity treatment*, https://mbmc-cmcm.ca/project/optimizing-bariatric-care/, https://osf.io/qcsrt/) longitudinal cohort study (REB #2015-1176) which aims to identify psychological and behavioral sequalae of individuals undergoing bariatric surgery. After providing informed consent, participants completed questionnaires prior to surgery (baseline) and 6-months post-surgery. Only individuals ≥18 years, scheduled to undergo a primary bariatric surgery, who completed both baseline and 6-month follow-up assessments were included in the current report.

Measures

Demographics and anthropometrics: Participants completed self-reported questionnaires that included age, sex, weight, and height. Body mass index (BMI) was calculated by dividing self-reported weight (kg) by height-squared (m^2). Percent excess body weight loss (%EBWL) was calculated by taking the difference between initial and final BMI, dividing it by the difference between initial BMI and the upper limit of a 'normal', and then multiplying the product by 100 to convert into a percentage. A BMI of 25.0 kg/m^2 was used as the normal level (Dixon et al., 2005).

Beck Depression Inventory – Second Edition (BDI-II): This 21-item tool assesses severity of depressive symptoms within the past two weeks (Beck et al., 1996). Items are measured using a four-point scale, ranging from '0' reflecting no endorsement of symptoms (e.g., "I do not feel like a failure") to '3' reflects high endorsement of the specified symptom (e.g., "I feel I am a total failure as a person"). Scores are summed (range 0-63), with higher scores indicative of higher depressive symptoms. The internal consistency (Cronbach α) of the baseline BDI-II total scores in our sample was excellent (α = 85), while the subscales ranged from good (Cognitive Dysregulation α = .52) to excellent (Negative Perceptions α = .80).

Statistical Analyses

All analyses were performed using IBM SPSS Statistics (Version 28). Comparisons between pre- and post-surgical variables were assessed using paired-sample t-tests. BDI-II total and subscale change-scores were calculated by subtracting baseline scores from 6-month follow-up scores. First, separate multivariate regression analyses assessed whether BDI-II total and subscale scores (independent variables) were associated with %EBWL (dependent variable). Second, multivariate regression analyses separately assessed the association whether changes in total and subscale depressive symptoms (independent variables) were associated with %EBWL (dependent variable) when adjusted for baseline BDI-II scores (total and subscale). All multivariate regression analyses were adjusted for baseline BMI, age, and sex.

Results

The sample consisted of 145 participants that underwent bariatric surgery. The sample consisted mostly of women (80%), with a mean age of 47.6 (11.1) years old. The sample mostly identified as White (91%), with only a small proportion identified as Black (2%) or Hispanic (1%), with the remaining sample indicated their ethnicity not being listed (6%). BMI significantly decreased from 48.2 (7.5) at baseline to 35.8 (6.5) at 6-months post-surgery, with a mean %EBWL of 56.2% (17.4). Total BDI and subscale scores at baseline and 6-months (Table 1) significantly decreased. The largest effect was observed in the diminished vigor subscale (Hedge's g = 0.94 [95% CI: 0.74, 1.13]), followed by negative perceptions (Hedge's g = 0.62 [95% CI: 0.44, 0.80]), and then cognitive dysregulation subscales (Hedge's g = 0.39 [95% CI: 0.22, 0.55]).

Baseline depressive symptoms and weight outcomes

Four individual multivariate regression models assessed the association between baseline BDI-II total and subscale scores, and %EBWL. After adjusting for covariates (baseline BMI, sex, age), baseline BDI-II total (B = -0.05, p = .542, 95% CI: -0.43, 0.23), negative perception (B = -0.09, p = .221, 95% CI: -1.14, 0.27), cognitive dysregulation (B = 0.12, p = .110, 95% CI: -0.26, 2.49), and diminished vigor scores (B = -0.09, p = .213, 95% CI: -2.36, 0.53) were not significantly associated with %EBWL.

Change in depressive symptoms and weight outcomes

In the multivariate regression, there was a trend in the association with BDI-II total change-score and %EBWL, such that larger decreases in BDI-II total scores were associate with greater %EBWL (B = -0.17, p = .058, 95% CI: -0.92, 0.02) when adjusting for baseline BDI-II total scores, baseline BMI, age, and sex.

The negative perception subscale change-scores were associated with %EBWL, such that larger decreases in the BDI-II subscale score was associate with greater %EBWL (B = -0.23, p = .004, 95% CI: -2.35, -0.37) in the adjusting model. The adjusted multivariate analysis that examined cognitive dysregulation subscale change-score and %EWL found no association (B = -0.09, p = .334, 95% CI: -2.55, 0.88). Similarly, the adjusted multivariate analysis that examined diminished vigor subscale change-score and %EBWL found that changes in the diminished vigor subscale were not associated with %EBWL (B = -0.01, p = .899, 95% CI: -1.88, 1.66).

Discussion

The present findings indicate that at baseline total and subscale depressive symptom scores were not associated with post-surgical weight outcomes, despite this being seen in previous studies (Kalarchian et al., 2008; Legatto et al., 2022; Semanscin-Doerr et al., 2010). Improvements in total depressive symptoms 6-months after having undergone bariatric surgery were also not significantly related to weight loss. However, greater improvements in negative perceptions 6-months after surgery were associated with greater weight loss, while changes in cognitive dysregulation or diminished vigor features were unrelated to weight loss. Although previous studies have found decreases in depressive symptoms scores following bariatric surgery were correlated with greater weight loss (Burgmer et al., 2014), our findings suggest that this association is more nuanced. That is, decreases in negative perceptions following bariatric surgery is closely linked to weight loss, and suggests that having fewer pessimistic and punitive cognitions following surgery may be a key psychological driver for better weight loss outcomes. Similarly, improved self-esteem (Hout, 2005) and body satisfaction (Hrabosky et al., 2006) have also been shown to be associated with better weight loss outcomes. This further asserts the perspective that favourable changes in psychosocial functioning after surgery may be tied to more optimal postoperative weight loss outcomes.

Neither baseline nor changes to cognitive dysregulation or diminished vigor were linked to weight loss outcomes after surgery. Hayes et al. (2015) indicated that cognitive dysregulation reflects symptoms that might undermine longer-term behavioural weight management. Since bariatric procedures induce dietary restriction, the relationship between cognitive dysregulation symptoms and weight outcomes may not be evident until weight begins to normalise and requires additional behavioural changes to sustain weight loss, i.e., beyond the 6-month follow-up seen in the current study. Baseline and change-scores on the diminished vigor subscale were also unrelated with weight loss. Diminished vigor contains BDI-II items that are typically categorised as somatic symptoms (Hayes et al., 2015), which have been associated with a general elevation in BMI (Marijnissen et al., 2011). There are no studies to date, that we know of, that have examined baseline or changes in the somatic depressive symptom subscale and weight outcomes post-surgery. However, reports have shown mixed results in the association between individual components within the diminished vigor subscale and weight outcomes after surgery. For example, some reports have found that a decreased lack of energy following surgery was associated with greater weight loss (Sarwer et al., 2010); however, others have observed no association between these kinds of depressive symptoms and weight loss (Schumacher et al., 2021; Strain et al., 2014). A similar pattern of discrepancies was observed for tiredness/fatigue and interest in sex in relation to weight outcomes. That is, changes to either tiredness/fatigue or interest in sex after bariatric surgery were related to weight outcomes (Sarwer et al., 2010), whereas other studies found a lack of association on either depressive symptoms and changes in weight (Schumacher et al., 2021; Strain et al., 2014). Given this, future studies should consider exploring potential moderating factors, e.g., presence of obesity-related comorbid conditions that exacerbate somatic symptoms, which may explain the inconsistencies in these findings.

The results of this study should be viewed in light of the study limitations. For instance, the results are only associations which precludes any causal inferences. This study included weight and depressive symptom assessments up to 6-months post-surgery. It is unclear whether other depressive features might be associated with weight outcomes at follow-up assessments beyond 6-months post-surgery. Participants self-reported weight at baseline and at follow-up visits. While there was sufficient reliability of self-reported and measured weight in this cohort (Ben-Porat et al., Submitted) and elsewhere (Christian et al., 2013) this may still be a limitation in the current study. Medications (e.g., antidepressants) were not assessed in the current study. While there appears to be no difference between individuals receiving pharmacological treatment for depression to those who did not in the association between depressive symptom score-change and weight loss (Dixon et al., 2003) following bariatric surgery, certain medications may impact specific depressive features rather than depression overall (Dunlop et al., 2018; Fournier et al., 2013). Given this, future studies should explore whether the association between improvements in individual depressive features and weight loss outcomes differs as a function of antidepressant use. There were also strengths in the current study. Depressive symptoms were assessed using a validated measure, including subscales that were validated in bariatric samples (Hayes et al., 2015; Woods et al., 2022). In addition, the sample was well characterised, allowing us to adjust for important clinical and sociodemographic variables. Lastly, the current study utilised a prospective-observational study design that extended up to 6-months post-surgery.

Our findings provide valuable insights into the link between depressive symptoms and weight loss after having undergone bariatric surgery. Specifically, the association between BDI-II total change-scores and post-surgical weight loss may largely be a result of greater changes in negative perception features. It is also important to note that changes in this subscale, rather than baseline levels, were associated with surgical weight loss. Collectively, this data indicates that changes in depressive features are not equally linked with great weight loss outcomes following bariatric surgery. As such, monitoring negative perceptions following bariatric surgery may help identify individuals who might require additional support, i.e., those who show limited changes in this subscale. Cognitive-behavioural therapy (CBT) is a theoretical framework that aims to identify and challenge negative or distorted perceptions for depression (Beck, 1979). Providing interventions from a licensed mental health professional that target negative perceptions, e.g., distorted cognitions and low affect, could help mitigate the development and maintenance of these depressive features that are associated with suboptimal weight loss and undermine the postoperative well-being of individuals who have undergone bariatric surgery. Future studies need to explore the potential benefits of this kind of approach in this sub-population of individuals undergoing bariatric surgery.

Table 1: *Summary values of BMI and BDI-II total and subscale scores for baseline and 6 months post-surgery*

	Baseline M (SD)	**6M Post-Surgery M (SD)**	**Mean Diff. (SD)**	***t* (*df*)**
BMI	48.2 (7.5)	35.8 (6.6)	-12.4 (4.1)	36.7 (144)***
Total BDI Score	12.6 (7.8)	7.1 (6.6)	-5.5 (6.7)	9.9 (144)***
Negative Perception	4.1 (3.7)	2.3 (3.3)	-1.8 (2.9)	7.5 (144)***
Cognitive Dysregulation	1.9 (1.8)	1.1 (1.6)	-0.7 (1.9)	4.7 (144)***
Diminished Vigor	2.9 (1.8)	1.1 (1.5)	-1.8 (1.9)	11.3 (144)***

Note. *** $p < .001$

Chapter 5: General Discussion

A rising demand for bariatric surgery has brought to light the high prevalence of psychiatric conditions, most notably depression, among individuals seeking surgical interventions for weight loss. This is concerning considering that psychiatric conditions increase the risk of suboptimal postoperative outcomes (Mechanick et al., 2020). Indeed, individuals with a prior diagnosis of depression typically lose less weight than those without a prior depression diagnosis (de Zwaan et al., 2011). While surgery-induced weight loss is strongly associated with a decrease in depression prevalence and symptom severity after receiving a bariatric procedure (Dawes et al., 2016), these benefits are often short-lived (Gill et al., 2019). In fact, depressive symptoms that persist or worsen postoperatively have been linked to weight recidivism (Odom et al., 2010) and need for revisional surgeries (de Gara & Karmali, 2014).

Current clinical practice guidelines stipulate that a psychosocial evaluation is needed when determining candidacy for bariatric surgery (Mechanick et al., 2020). This psychosocial evaluation is intended to identify potential contraindications that might undermine weight loss following surgery, including poorly controlled psychiatric conditions and substance abuse (Mechanick et al., 2020; Wharton et al., 2020). However, only recently have clinical practice guidelines mentioned the importance of performing psychosocial evaluations postoperatively when weight loss is suboptimal (Mechanick et al., 2020). Indeed, problematic psychosocial and behavioural factors that persist or worsen postoperatively are associated with poorer weight outcomes. That said, the current practice guidelines only provide recommendations for how to conduct preoperative evaluations, i.e., clinical interviews (Mechanick et al., 2020). Specifically, clinical interviews are regarded as the 'gold standard' in psychological assessment; however, this requires a significant amount of resources. Clinical interviews are typically supplemented with screening tools as part of the pre- and post-operative psychosocial evaluations, which is generally more cost-effective (Spirou et al., 2020). For instance, screening tools outnumbered clinical interviews in studies that prospectively measured the prevalence and severity of depression after having undergone bariatric surgery (Dawes et al., 2016). Despite depressive symptoms being strongly linked to suboptimal weight outcomes after bariatric surgery and the popularity of administering screening tools in pre- and post-operative assessments, a notable gap in the literature remains in how clinicians should interpret the evolution of depressive symptoms following surgery, as well as what symptoms may be more pertinent to consider in the context of weight outcomes. Therefore, the purpose of this dissertation was to bridge the gap between research and clinical practice by examining the use of screening tools to monitor depressive symptoms within the bariatric population. Specifically, the objectives of this dissertation were to: (i) evaluate the extent to which depressive symptoms change following surgery; (ii) to evaluate common screening tools when used to assess depressive symptoms before and after bariatric surgery; and (iii) discuss the clinical implication that these objectives may have on weight outcomes.

Substantial decrease of depressive symptoms after surgery

The findings of this dissertation demonstrate that there is a large decrease of depressive symptoms after bariatric surgery. Indeed, this was supported in the meta-analysis that was performed in Study 1 (Chapter 2) that included 46 studies that administered screening tools to assess depressive symptoms before and after bariatric surgery. Specifically, the pooled effect across all 46 studies, as well as when studies were stratified by the timing of the post-surgical follow-up visit (i.e., 6-, 12-, and 24-months) was statistically large and considered clinically significant per respective screening tool. This was most pronounced among studies reporting higher preoperative depressive symptom scores. Substantial decreases of depressive symptoms after bariatric surgery were further supported in studies 2 (Chapter 3) and 3 (Chapter 4). That is, scores on the BDI-II significantly decreased 6 months after bariatric surgery. These findings are consistent with previous systematic reviews that have assessed improvements in depression following bariatric surgery (Dawes et al., 2016; Fu et al., 2021; Gill et al., 2019; Loh et al., 2021; Spirou et al., 2020), as well as other areas of psychological health, including binge-eating (Morseth et al., 2016; Spirou et al., 2020; Wadden et al., 2011), anxiety (Gill et al., 2019; Spirou et al., 2020), and quality of life (Driscoll et al., 2016; Raaijmakers et al., 2017).

These findings are consistent with the timeframe in which depressive symptoms were assessed postoperatively. That is, Study 1 found that the magnitude by which depressive symptoms decreased did not differ between follow-up assessments, i.e., 6-, 12-, and 24-months, which encapsulates the '*honeymoon period*' that many individuals who have undergone bariatric surgery experience. Moreover, the results of Studies 2 and 3 were consistent with Study 1 (Chapter 2) in the magnitude depressive symptoms decreased 6 months after surgery. Considering the majority of weight loss occurs within the first 12-months of surgery after which weight appears to stabilize (Courcoulas et al., 2013; Garvey et al., 2016), the psychological benefits seem to persist for at least another 12 months. However, beyond this postoperative period, i.e., > 24 months post-surgery, depressive symptoms have been shown to worsen (Gill et al., 2019). This coincides with the timing for which weight loss requires greater adherence to lifestyle changes and physical activity programming. A similar pattern of short-term gains followed by a gradual decline in psychosocial health has also been seen in binge-eating (Spirou et al., 2020) and substance use (King et al., 2017). The exceptions to this pattern are self-injurious behaviours (Bhatti et al., 2016) and suicidality (Tindle et al., 2010), which are more prevalent during the first 36 months after surgery. Additionally, both of these studies noted that a large proportion of individuals who engaged in self-injurious behaviours and suicidality had prior psychiatric diagnoses (Bhatti et al., 2016) and suicidality (Tindle et al., 2010). Since suicidal ideation and thoughts of self-harm are among the symptoms of depression, this further demonstrates the heterogeneity of depressive symptoms which may be differentially impacted by bariatric surgery. Nevertheless, the findings of Studies 1 to 3 established the progression of depressive symptoms after bariatric surgery when measured using screening tools. Healthcare professionals could integrate these findings when monitoring depressive symptoms postoperatively, and to better identify which individuals may be deviating from this pattern.

Using screening tools to monitoring depressive symptoms after surgery

This dissertation provided further insight into the utility of screening tools for depressive symptoms that are used in the bariatric population. Study 1 (Chapter 2) determined that the Beck Depression Inventory (BDI), Hospital Anxiety and Depression Scale (HADS), and Patient Health Questionnaire (PHQ) are the most common screening tools used in bariatric centres. Moreover, this study determined that the magnitude depressive symptoms decreased (i.e., *responsiveness to change*) was similar across the three screening tools at *most* follow-up visits. This is consistent with prior studies that evaluated the *responsiveness to change* across depressive symptom screening tools (Cameron et al., 2008; Titov et al., 2011). Indeed, the three depressive symptom screening tools assessed in this study correlate strongly with one another (Cameron et al., 2008; Dum et al., 2008; Hepner et al., 2009; Lisspers et al., 1997) despite differing in their scope of assessing depression. For instance, the PHQ was designed for the purposes of diagnostic accuracy (i.e., symptom frequency) rather than the severity of depressive symptoms (Gilbody et al., 2007), while the BDI and HADS assess the severity of depressive symptoms (Dreber et al., 2015).

In Study 1, there was one exception among the screening tools when depressive symptoms were assessed 24 months after surgery; there was a smaller decrease of depressive symptom scores after surgery in studies using the BDI when compared to studies using the HADS and PHQ. This difference in magnitude between screening tools could be attributed to the BDI including multiple items that measure a somatic symptom (e.g., 'loss of energy', 'tiredness or fatigue') whereas the other measures (i.e., HADS and PHQ) limit this symptom to a single item. In turn, BDI scores might be inflated when administered in a bariatric population (Krukowski et al., 2010). The results of Study 1 suggest that this may occur at least 24 months after surgery. Moreover, endorsing certain somatic items could be confused with physical complaints due to living with severe obesity (e.g., fatigue, lack of energy) or attributed to bariatric surgery (e.g., weight fluctuations, change in appetite). Given the impact surgery has on food intake, weight status, and energy expenditure, this could result in inflated BDI scores after bariatric surgery. For instance, endorsing items that measure changes in appetite or weight loss after surgery may contribute to higher BDI scores. For these reasons, certain BDI items have been removed when administering these screening tools within bariatric settings to mitigate the likelihood of inflated scores (Hayden et al., 2011; Smith et al., 2018, 2020). This also highlights the limitations of screening tools for the purposes of monitoring the progression of depressive symptoms within the bariatric population. However, given screening tool scores approximate depression severity, certain symptoms scores may worsen postoperatively despite overall other symptoms improving. Consequently, overlooking the worsening of certain depressive symptoms limits the opportunity to identify and address specific aspects of psychological distress that could result in suboptimal post-surgical outcomes.

The additional somatic items that are included in the BDI raises the issue of what is considered *depression*, particularly within a bariatric population. Indeed, a diagnosis of depression infers a unidimensional condition, wherein all symptoms described in the DSM-5 all share a single underlying aetiology (van Loo et al., 2012), as well as prognosis and responsiveness to treatments (Wanders et al., 2016). However, the presentations of depression can be highly variable, with 227 symptom combinations that could meet the DSM-5 diagnostic criteria (Zimmerman et al., 2015). Indeed, current diagnostic manuals, i.e., DSM-5 (American Psychiatric Association, 2013) include depression subtypes that are characterised by the expression of cognitive, affective, and somatic features. That said, a systematic review that explored the dimensionality of depression in clinical samples concluded that were was lack of consistent depressive subtypes across the 20 individual studies (van Loo et al., 2012). These inconsistencies in determining the dimensionality of depression have limited the capacity to identify potential underlying mechanisms, as well as potential targets for intervention.

For these reasons, the purpose of Study 2 (Chapter 3) was to identify clusters of depressive symptoms within a bariatric cohort. It was important that the pattern of depressive symptoms clusters retain their structure before and after bariatric surgery to ensure the subscales reliably measured the same dimensions of depression, as well as ensure that the subscales were appropriate for monitoring psychosocial progress following surgery. Study 2 evaluated responses of the BDI-II within a large Canadian bariatric cohort. Responses to the BDI-II, among a sample of patients' pre-bariatric surgery, underwent EFA and generated a two-factor solution

(Cognitive, Somatic-Affective), termed REBORN-2. This factor structure was compared to four other models using 6-month post-surgical responses to the BDI-II of the same group, as well as a comparative pre-surgical bariatric group. Comparisons between CFA models suggested that a three-factor model identified by Hayes et al. (2015) demonstrated superior fit than all other models tested in both groups. Lastly, this three-factor structure underwent CFA using the baseline responses of the initial group and provided further support of appropriateness of this model in a bariatric sample. Since the (Hayes et al., 2015) three-factor model demonstrated superior fit relative to the other models, it was retained. This model comprised of three dimensions of depression, including 'negative perceptions', 'cognitive dysregulation', and 'diminished vigor'. The consistency across samples and from pre- to post-surgery does suggest a stable structure of depressive symptoms in the bariatric population, which is multidimensional.

Integrating Findings into Clinical Practice

The American Association of Clinical Endocrinologists (AACE), the Obesity Society, and American Society for Metabolic & Bariatric Surgery (ASMBS) jointly published guidelines to include a preoperative psychosocial evaluation prior to undergoing bariatric surgery in an effort to mitigate poor adjustment to life after surgery (Mechanick et al., 2020). This includes administering a clinical interview to evaluate various domains of psychosocial functioning that are deemed critical for determining candidacy for bariatric surgery, including: reasons for seeking surgery; diet and weight history; lifestyle changes necessary pre- and postoperatively; social support networks; and past and present psychiatric disorders (Snyder, 2009). Moreover, included within the most recent guidelines was the recommendation to continue monitoring post-surgery the psychosocial and behavioural factors that are important to helping successfully achieve weight loss (Mechanick et al., 2020). Most mental health professionals tasked with performing a preoperative psychosocial evaluation will typically administer a clinical interview, as well as a combination of validated screening measures (Fabricatore et al., 2006; Walfish et al., 2007b). However, validated screening tools are often employed during postoperative visits to briefly assess how well patients adjusting following the bariatric procedure (Dawes et al., 2016), to identify those who might require greater psychological support.

Monitoring depressive symptoms before and after bariatric surgery

Depressive symptoms that persist or worsen postoperatively can undermine the quality of life of patients (Ivezaj & Grilo, 2015). Therefore, it is important for clinicians to continue to carefully monitor depressive symptoms to ensure that patients who receive bariatric surgery are adjusting well following their procedure. The findings of this dissertation may help facilitate this by providing insights into how depressive symptoms typically progress postoperatively, across three common screening tools (Study 1). In turn, clinicians may integrate these findings into practice when monitoring the changes to depressive symptoms following bariatric surgery. For patients with elevated scores, clinicians will be able to evaluate whether changes in depressive symptom scores are typical of that screening tool in this population. Moreover, this could help clinicians identify if a patient reports smaller changes than would be expected, and in this case would be potential candidate for intervention. It should be noted that the current practice guidelines suggest monitoring psychological well-being (e.g., depressive symptoms) after surgery in cases of minimal weight loss or weight regain (Mechanick et al., 2020). Nevertheless, the rise of suicidal ideation *regardless* of weight status (Wnuk et al., 2020) underscores how important it is to continue monitoring how well patients adjust after bariatric surgery and to provide the psychological support, if needed.

Including subscales when screening

Findings from this dissertation demonstrated that depression is a multidimensional psychological condition within the bariatric population (Hayes et al., 2015). These findings may be helpful as part of psychological assessments to measure more precisely the important dimensions of depression present in the bariatric population. At present, a notable challenge for mental health professionals is the reliance on inaccurate psychological tools for screening psychological symptoms during psychological assessment in specific populations. Though very popular in the bariatric surgery setting, the symptoms included in the BDI are heterogenous and include additional somatic symptoms that might inflate depressive symptom scores due to the presence of weight-related comorbid medical conditions (Krukowski et al., 2010). Therefore, adapting the BDI-II scoring to include subscales may help to identify potentially important depressive features among candidates for bariatric surgery that are at a higher risk for suboptimal weight outcomes. Indeed, Study 3 established that improvements in only a subset of depressive symptoms was associated with greater weight loss after bariatric surgery. That is, decreased endorsement of BDI-II items within 'negative perceptions' dimension was associated with greater %EBWL 6-months after bariatric surgery. There was no association with baseline BDI-II total or subscale scores, nor change-scores for the BDI-II total and the remaining subscales (i.e., cognitive dysregulation, diminished vigor), with weight outcomes. Greater post-operative improvements in depressive symptoms were associated with larger weight loss outcomes (Burgmer et al., 2014; de Zwaan et al., 2011; Mitchell et al., 2014). However, the findings of Study 3 suggest that this may be driven by reductions in negative perceptions, e.g., punitive and pessimistic thoughts. Indeed, similar to the reduction in the negative perceptions dimension of depression, decreased body image dissatisfaction (Guisado et al., 2002; Kinzl et al., 2011) and increased self-esteem (Felske et al., 2021) were associated with greater weight loss outcomes after bariatric surgery in other studies. In such cases where the severity of a depressive dimension is elevated, clinicians may be able to refer the patient for additional psychological testing, as well as developing a psychological treatment plan that would optimise the structure and nature of the treatment as well as post-surgical outcomes.

Identifying targets for potential psychological interventions

These findings may also be incorporated into assessing for potential targets of psychotherapeutic interventions for the treatment of depression in the context of bariatric surgery and weight loss. Notably, the findings of studies 2 (Chapter 3) and 3 (Chapter 4) align with the constructs found within Cognitive-Behavioural Therapy (CBT), which is an effective treatment for treatment of depression (Cuijpers et al., 2021) and weight loss (Jacob et al., 2018). For instance, CBT for obesity may address negative or maladaptive cognitions that relate to an overestimation that weight loss will drastically improve mood in post-surgery or unmet expectations about weight loss through Socratic dialogue and behavioural experiments.

The fact that we found that a specific subscale was 'unique' in being associated with weight outcomes could be effective at developing potential psychotherapeutic targets (e.g., cognitive distortions) that are addressed using CBT-specific interventions. Additionally, these subscales could be helpful in assessing the responsiveness of the interventions. For instance, clinicians could administer the BDI-II prior to each CBT session and review each Hayes et al. (2015) subscale. Inspecting the negative perception subscale could help inform whether specific cognitive interventions (e.g., cognitive restructure) were effective at attenuating maladaptive and dysfunctional. Indeed, the *Canadian Psychological Association (CPA) Task for on Evidence-Based Practice of Psychological Treatments* specified that symptom monitoring is considered an integral part when delivering evidence-based psychological interventions for depression (Dozois et al., 2014). Therefore, integrating these BDI-II subscales into psychological treatment could ensure clinicians are able to monitor the effectiveness of psychological interventions.

Strengths & Limitations

Overall, there are a number of novel contributions this dissertation provides in regard to monitoring the progression of depressive symptoms after bariatric surgery. Given the mounting evidence that has demonstrated favourable psychological outcomes after bariatric surgery (Dawes et al., 2016; Fu et al., 2021; Gill et al., 2019; Loh et al., 2021; Spirou et al., 2020), the current dissertation fills a gap between research and clinical practice. That is, clinicians can reference what is considered a change-score typical of common screening tools when monitoring the progression of depressive symptoms following bariatric surgery. Additionally, Study 1 largely comprised of prospective-observation study designs, while Studies 2 and 3 were sampled from a community bariatric centre. Therefore, the findings are likely representative of the bariatric population. Also, the dissertation validated a previous report that depression is multidimensional (Hayes et al., 2015). Considering most studies assume that depression is a unidimensional psychiatric condition by only analysing the overall decrease of depressive symptoms, the current findings suggest that only a subset of depressive symptoms are linked to favourable weight loss outcomes.

As noted throughout, the purpose of this dissertation was to examine the use of validated screening tools in the bariatric population. Although the accuracy and performance of these tools have been well studied in both research and clinical contexts (Maurer et al., 2018; P. Miller et al., 2021; von Glischinski et al., 2019; Wu et al., 2021), their purpose is restricted to screening and not to establish a diagnosis. Diagnoses can only be determined using the diagnostic criteria recognized by professional associations (i.e., American Psychiatric Association; World Health Organization). Validated clinical interviews (e.g., SCID-5) are regarded as the ‘gold standard’ given their accuracy in classifying psychiatric diagnoses (Thombs et al., 2018). Therefore, the findings within these studies are limited to the screening of depressive symptoms. That is, the change in depressive symptom severity (e.g., BDI, HADS) or diagnostic accuracy (e.g., PHQ) following bariatric surgery. Additionally, there are some limitations in regard to the BDI-II subscales identified in Study 2 and 3. First, these subscales have not been validated (i.e., construct, concurrent, and discriminant validity). Second, there are no cut-off scores that indicate a clinical threshold. Thus, future research should consider exploring the utility of these subscales in clinical practice. Another limitation is that the findings from Study 2 and 3 were generated from the same sample. Consequently, this may limit the generalisability of the findings. Replication of study results should be considered at a later point to determine if these results extend beyond the REBORN study cohort. That said, Study 2 validated in two subsamples a factor structure that was previously identified in two consecutive bariatric samples (Hayes et al., 2015). Additionally, Study 2’s findings showed that this three-factor structure remained stable after surgery (Woods et al., 2022). An additional limitation in both studies was the reliance of self-reported anthropomorphic measurements (i.e., height and weight). Although a sensitivity analysis was performed in this sample on the level of agreement between measured and self-reported height and weight (Ben-Porat et al., Submitted), the level of agreement was not perfect.

The findings presented in this dissertation show that bariatric surgery impacts a key psychological driver of obesity. That is, depressive symptoms decrease after bariatric. In turn, this decrease is related to greater weight loss. This aligns with the *biopsychosocial* framework of chronic disease (Engel, 1977; George & Engel, 1980) as well as the current understanding that obesity is multifactorial (Wharton et al., 2020). Treatments (e.g., bariatric surgery) aimed at substantial weight loss disrupt many biological, psychological and social drivers involved in development and maintenance. As detailed in Study 1, there are a number of potential mechanisms linking changes to depressive symptoms following bariatric surgery (i.e., psychological, immunological, neuroendocrine). From a biological perspective, excess adipose tissue found in obesity elicits systemic inflammation (Gregor & Hotamisligil, 2011), the latter of which has also been shown to induce depressive-like symptoms (Miller et al., 2002). After bariatric surgery, weight loss was associated with decreased inflammatory markers and affective states (Capuron et al., 2011). Bariatric surgery has also been associated with alterations in psychosocial support. For instance, social support is believed to increase after surgery (Conceição et al., 2020) and greater access to social support prior to surgery is linked to greater weight loss outcome after the procedure (Ray et al., 2003). Also, those reporting higher social support and less depressive symptoms after surgery experienced greater weight loss (Conceição et al., 2020). Given the many pathways, future studies should explore mechanisms that link changes in depressive symptoms after surgery and weight outcomes.

Conclusions

Overall, the findings from this dissertation provide novel and valuable insights into the course of depressive symptoms following bariatric surgery. That is, individuals that have undergone bariatric surgery demonstrate substantial and clinically meaningful improvements on screening measures for depressive symptoms within 24 months of their procedure. This is in light of mounting evidence showing that the benefits of bariatric surgery on psychological outcomes (e.g., depressive symptoms) are short-lived (Gill et al., 2019). Psychiatric conditions, such as depression, therefore begin to worsen about 24 months after bariatric surgery (Gill et al., 2019). Moreover, depression within the bariatric population comprises of three dimensions, of which, only a reduction in the ‘negative perceptions’ dimension is associated with better weight loss outcomes. The findings may be incorporated into clinical practice by helping clinicians more accurately assess for potential signs of psychological distress. This may also provide opportunities for early interventions and mitigate suboptimal postoperative outcomes.

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