Received: 9 June 2022 | Revised: 16 November 2022 | Accepted: 22 January 2023

DOI: 10.1111/obr.13557

REVIEW

OBESITY Reviews WILEY

Evolution of depressive symptoms from before to 24 months after bariatric surgery: A systematic review and meta-analysis

Robbie Woods[1,2] | Ana M. Moga[1,3,4] | Paula A. B. Ribeiro[1] | Jovana Stojanovic[1] | Kim L. Lavoie[1,5] | Simon L. Bacon[1,6]

[1]Montreal Behavioural Medicine Centre, CIUSSS du Nord-de-l'Île-de-Montréal, Montreal, Quebec, Canada

[2]Department of Psychology, Concordia University, Montreal, Quebec, Canada

[3]School of Physical and Occupational Therapy, McGill University, Montreal, Quebec, Canada

[4]Centre for Outcomes Research and Evaluation, McGill University Health Center-Research Institute, Montreal, Quebec, Canada

[5]Department of Psychology, University of Quebec at Montréal, Montreal, Quebec, Canada

[6]Department of Health, Kinesiology, and Applied Physiology, Concordia University, Montreal, Quebec, Canada

Correspondence
Simon L. Bacon, Department of Health, Applied Physiology, and Kinesiology, Concordia University, 7141 Sherbrooke St W, Montreal, Quebec H4B 1R6, Canada.
Email: simon.bacon@concordia.ca

Funding information
Canadian Institutes of Health Research (CIHR), Grant/Award Numbers: SMC-151518, UD1-170148, PJT-153424; Les Fonds du recherche du Québec: Santé, Grant/Award Numbers: 309815, 251618, 34757, 257821, 256141; J.W. McConnell Memorial Graduate Fellowships; Richard and Edith Strauss Canada Foundation Doctoral Scholarship; Canada Research Chairs Program, Grant/Award Number: 950-232522; UQAM Research Chair

Summary

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 determined 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: Forty-six studies met inclusion criteria (32,342 patients). Meta-analysis indicated a postsurgical 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.

KEYWORDS
bariatric surgery, depression, meta-analysis, systematic review

1 | 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.[1] About 19% of individuals seeking bariatric surgery have depression,[2] and depression after surgery is associated with suboptimal health outcomes,[3] including postsurgical weight-regain[4] and revisional surgeries.[5]

Depression typically improves after surgery.[6] However, these results are not always consistent,[7,8] and it is unclear what the general magnitude of change might be.[2,6,9–11] Previous reviews included

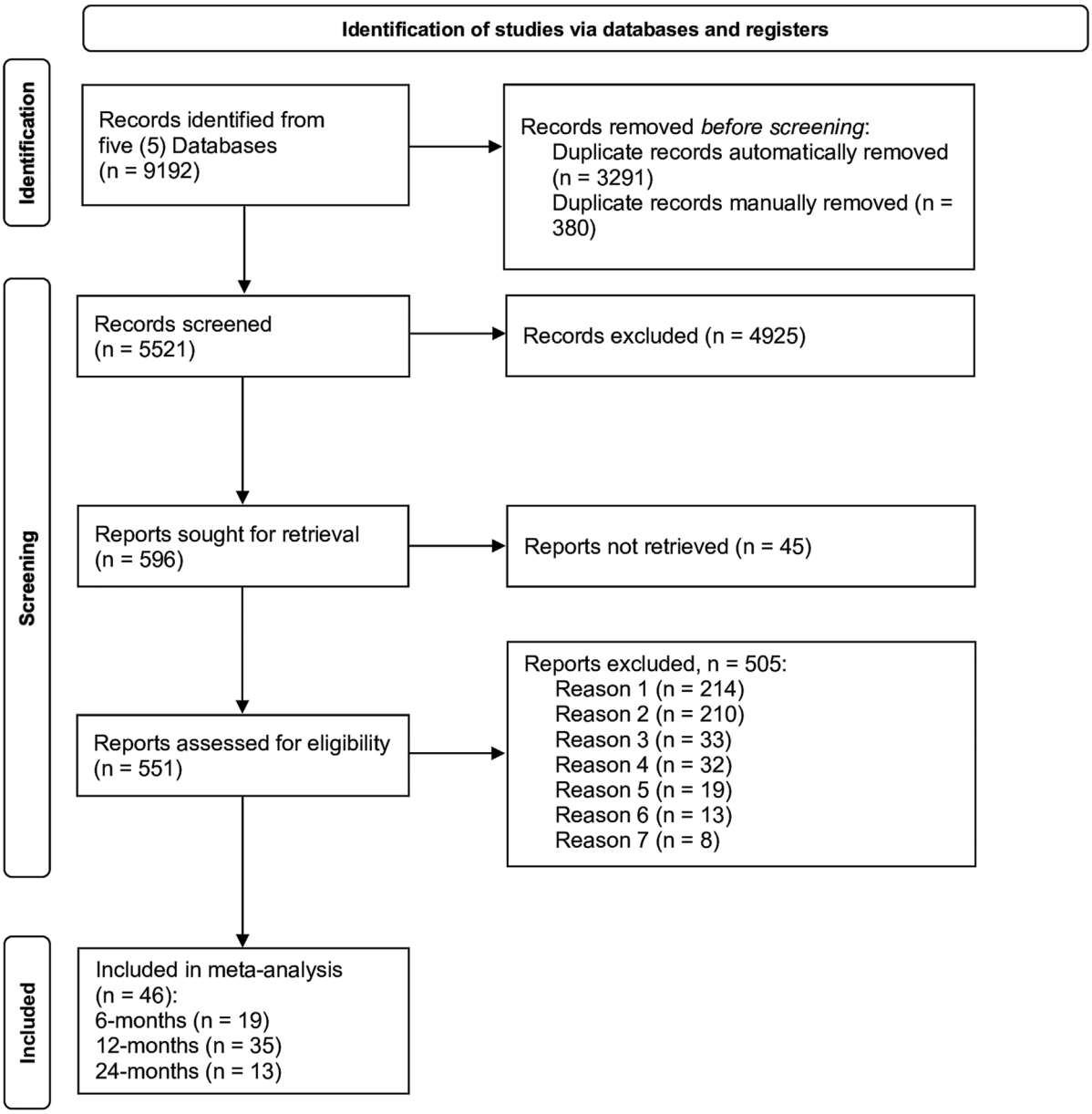

FIGURE 1 PRISMA flow diagram of literature search. Reason 1 = reported outcome (missing presurgery and/or postsurgery outcome, invalid or missing tool); Reason 2 = publication type (abstract only, review, theses, letters to editor); Reason 3 = timing of follow-up (not occurring at specific, collected 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 (case study, cross-sectional, multiple interventions without control arm).

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, and 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-ups. 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.[6] For this reason, the current investigation aimed to estimate the magnitude depressive symptom scores decreased 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.

2 | METHODS

2.1 | 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[12] 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 Data S1). The Embase, PsycInfo, PubMed, Scopus, and Web of Science databases were searched from database inception to June 1, 2021 (see Data S1 for terms). 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 and longitudinal) studies or the control arm of a randomized-control intervention (i.e., unintervened group). Entries were excluded due to: (1) publication type (i.e., abstracts, unpublished literature, commentary or reviews, and book chapters); (2) not published in English or French; (3) study design (cross-sectional and 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, and 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 ($\kappa = 89\%$). Disagreements were resolved through discussion with a third reviewer (SLB). Extracted data included participant demographics (e.g., age and sex), time of follow-up, depressive symptom tool, surgical procedure, and presurgical and postsurgical 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 three attempts were made to contact authors if data were missing from articles. Risk of bias was independently assessed (RW and AMM, $\kappa = 88\%$) using a modified Joanna Briggs Institute (JBI) checklist for quasi-experimental studies,[13] with a maximum potential score of 9 points.

2.2 | Data analysis

Meta-analyses were performed when three or more studies provided available data at follow-up. Because 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% CIs). 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.[14] Forest plots reflected the magnitude depressive symptoms decreased from presurgery (independent of the tool used). The standardized mean difference (Hedge's g) was converted to an unstandardized mean-change score for each depressive symptom screening tool (Table S2). 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 two sided, and statistical significance was set to $p = 0.05$. All analyses were performed using Comprehensive Meta-Analysis (CMA) version 3.

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 presurgical BMI of 47 kg/m^2, and was comprised of mostly female patients (78%). Most studies were conducted in the United States (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[22] 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: 0.73–0.88, $I^2 = 95.7\%$). Subgroup analysis (Figure 2) indicated that decreases in depressive symptom scores following bariatric surgery were comparable across the follow-ups ($Q = 0.002$, $df = 2$, $p = 0.999$): 6 ($g = 0.806$; 95% CI: 0.66–0.96, $I^2 = 83.6\%$), 12 ($g = 0.804$; 95% CI: 0.68–0.93, $I^2 = 96.9\%$), and 24 months ($g = 0.801$; 95% CI: 0.66–0.94, $I^2 = 89.2\%$). 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). 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 at either the 6-month (Figure S2; $Q = 1.41$, $df = 1$, $p = 0.235$) or 12-month (Figure S3; $Q = 2.866$, $df = 2$, $p = 0.239$) follow-ups. However, there was an effect of symptom tool type at the 24-month follow-up (Figure S4; $Q = 9.742$, $df = 2$, $p = 0.008$). 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 with 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 S5, $Q = 1.296$, $df = 1$, $p = 0.255$) nor 12-month (Figure S6; $Q = 4.247$, $df = 2$,

TABLE 1 Study characteristics.

First author (year)	Country	Study design	Depressive symptom tool	Surgery type(s)	Baseline *N*
Alfonsson et al.[15] (2014)	Sweden	Prospective	HADS	Bypass	129
Andersen et al.[16] (2010)	Norway	Prospective	HADS	Switch	50
Assimakopoulos et al.[17] (2011)	Greece	Prospective	HADS	Sleeve, bypass, switch	59
Barzin et al.[18] (2020)	Iran	Prospective	BDI	Sleeve, bypass	685
Burgmer et al.[7] (2014)	Germany	Prospective	HADS	Band, vertical gastroplasty	148
Buser et al.[19] (2004)	USA	Prospective	BDI	Bypass	42
Buzgova et al.[20] (2016)	Czech Republic	Prospective	HADS	Sleeve, greater curvature plication	68
Castellini et al.[21] (2014)	Italy	Prospective	BDI, SCL-90	Band, bypass, switch	83
Chalut-Carpentier et al.[22] (2015)	Switzerland	Prospective	HADS	Bypass	38
Cherick et al.[23] (2019)	France	Prospective	BDI	Sleeve, bypass	36
Dixon et al.[24] (2003)	Australia	Prospective	BDI	Band	487
Dixon et al.[25] (2016)	USA	Prospective	BDI	Band	149
Efferdinger et al.[26] (2017)	Austria	Prospective	BDI	Bypass, sleeve resection	45
Emery et al.[27] (2007)	USA	Longitudinal	BDI	Bypass	13
Erden et al.[28] (2016)	Turkey	Prospective	BDI	Sleeve	51
Faulconbridge et al.[29] (2013)	USA	Prospective observational	BDI	Band, bypass	36
Felske et al.[30] (2021)	Canada	Prospective	BDI	Band, sleeve, bypass	50
Gade et al.[31] (2015)	Norway	Randomized-control trial (control)	HADS	Sleeve, bypass	38
Gaudrat et al.[32] (2021)	France	Longitudinal	HADS	Band, sleeve, bypass	80
Green et al.[33] (2004)	USA	Prospective	BDI	Bypass	65
Hancock et al.[34] (2018)	UK	Longitudinal	HADS	Band	31
Hayden et al.[35] (2011)	Australia	Prospective	BDI	Band	258
Ho et al.[36] (2018)	Canada	Retrospective	PHQ	Sleeve, bypass	365
Ivezaj and Grilo[37] (2015)	USA	Prospective	BDI	Bypass	107
Kantarovich et al.[38] (2019)	Canada	Prospective	MINI, PHQ	Sleeve, bypass	211
Kvalem et al.[39] (2020)	Norway	Prospective	HADS	Bypass	169
Leung et al.[40] (2019)	Canada	Prospective	PHQ	Sleeve, bypass	108
Lier et al.[41] (2011)	Norway	Prospective	BDI	Bypass	127
Malone et al.[42] (2004)	USA	Prospective, longitudinal	BDI	Bypass	109
Mokhber et al.[43] (2016)	Iran	Prospective	BDI	Bypass	40
Nielsen et al.[44] (2020)	Denmark	Prospective	BDI	Sleeve, bypass	40
O'Brien et al.[45] (2002)	Australia	Prospective	BDI	Band	709
Peterhansel et al.[46] (2017)	Germany	Prospective	BDI	Sleeve, bypass	154
Smith et al.[47] (2019)	USA	Prospective	PHQ	Band, sleeve, bypass, switch	21,823

TABLE 1 (Continued)

First author (year)	Country	Study design	Depressive symptom tool	Surgery type(s)	Baseline *N*
Smith et al.[48] (2020)	USA	Retrospective	BDI	Band, bypass	2308
Sockalingam et al.[49] (2017)	Canada	Prospective	MINI, PHQ	Sleeve, bypass	156
Strain et al.[50] (2017)	USA	Prospective	BDI	Switch	275
Subramaniam et al.[51] (2018)	Malaysia	Prospective	HADS	Sleeve, bypass, anastomosis gastric bypass-mini gastric bypass	57
Tan et al.[52] (2021)	Singapore	Prospective	HADS	Sleeve, bypass	55
Thonney et al.[53] (2010)	Switzerland	Prospective	BDI, HADS	Bypass	43
Usta and Aygin[54] (2020)	Turkey	Pretest–posttest, repeated measures, randomized-control prospective (control)	BDI	Sleeve	26
Vetrovsky et al.[55] (2021)	Czech Republic	Prospective	HADS	Bypass	26
Wei et al.[56] (2020)	China	Prospective	HADS	Sleeve, bypass	25
White et al.[57] (2006)	USA	Prospective	BDI	Bypass	139
White et al.[58] (2010)	USA	Prospective	BDI	Bypass	361
Youssef et al.[3] (2020)	Canada	Prospective	PHQ	Sleeve, bypass	2268

TABLE 1 (Continued)

First author (year)	% women	Mean age (SD)	Mean baseline BMI (SD)	Follow-up timing (months)	Reported depressive symptom outcome	JBI score/9
Alfonsson et al.[15] (2014)	78.0	42.80 (10.5)	42.95 (4.0)	12	−1.4 (3.13)	7
Andersen et al.[16] (2010)	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.[17] (2011)	100.0	36.00 (.)	51.90 (9.9)	12	−2.9 (3.26)	7
Barzin et al.[18] (2020)	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.[7] (2014)	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.[19] (2004)	100.0	41.06 (10.1)	52.46 (10.1)	12	−13.1 (6.79)	4
Buzgova et al.[20] (2016)	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.[21] (2014)	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
Chalut-Carpentier et al.[22] (2015)	81.6	43.00 (9.0)	46.30 (6.8)	6	−0.2 (2.69)	5
Cherick et al.[23] (2019)	100.0	37.00 (13.0)	41.00 (7.0)	6	−4.0 (5.44)	6
Dixon et al.[24] (2003)	85.0	41.20 (9.7)	44.10 (7.4)	12	−9.9 (8.24)	6
Dixon et al.[25] (2016)	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

TABLE 1 (Continued)

First author (year)	% women	Mean age (SD)	Mean baseline BMI (SD)	Follow-up timing (months)	Reported depressive symptom outcome	JBI score/9
Efferdinger et al.[26] (2017)	76.0	44.07 (13.3)	45.59 (7.5)	6	−10.5 (10.40)	6
Emery et al.[27] (2007)	100.0	46.90 (5.7)	51.30 (6.3)	12	−9.0 (4.07)	5
Erden et al.[28] (2016)	64.7	36.92 (9.3)	47.66 (7.5)	6	−8.2 (6.37)	7
Faulconbridge et al.[29] (2013)	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.[30] (2021)	80.0	46.98 (8.6)	49.01 (10.5)	12	−5.4 (7.82)	7
Gade et al.[31] (2015)	73.7	41.20 (9.6)	43.50 (4.7)	12	−2.5 (5.35)	7
Gaudrat et al.[32] (2021)	67.5	38.33 (11.2)	44.39 (5.5)	6, 12, 24	6M: −4.1 (3.24) 12M: −3.8 (3.24) 24M: −4.3 (3.19)	6
Green et al.[33] (2004)	73.8	39.21 (9.9)	54.78 (9.9)	6	−10.3 (8.44)	5
Hancock et al.[34] (2018)		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.[35] (2011)	85.0	41.36 (9.3)	43.80 (7.9)	12	−10.8 (7.92)	9
Ho et al.[36] (2018)	80.0	44.70 (10.0)	50.10 (9.6)	12	−4.6 (5.48)	7
Ivezaj and Grilo[37] (2015)	87.9	42.66 (10.2)	51.66 (7.9)	6	−7.7 (6.70)	7
Kantarovich et al.[38] (2019)	81.9	44.86 (9.5)	48.85 (8.2)	12, 24	12M: −6.5 (5.33) 24M: −5.6 (5.45)	4
Kvalem et al.[39] (2020)	77.5	45.20 (9.3)	44.50 (5.6)	12	−2.2 (3.42)	6
Leung et al.[40] (2019)	80.6	46.21 (9.7)	48.30 (8.7)	24	−5.5 (5.45)	6
Lier et al.[41] (2011)	74.0	41.30 (10.3)	45.30 (5.2)	12	−5.0 (9.01)	5
Malone et al.[42] (2004)	81.1	45.19 (10.1)	47.74 (17.3)	12	−8.0 (7.09)	5
Mokhber et al.[43] (2016)	87.5	34.20 (11.3)	45.31 (2.6)	6	−10.0 (9.71)	6
Nielsen et al.[44] (2020)	15.0	40.00 (9.2)	45.00 (6.8)	6	−7.5 (9.96)	7
O'Brien et al.[45] (2002)	85.0	Median: 41.00 (range: 16–71)	45.00 (7.0)	24	−10.2 (12.84)	4
Peterhansel et al.[46] (2017)	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.[47] (2019)	79.8	46.71 (11.7)	47.18 (7.9)	12	−1.5 (4.1)	4
Smith et al.[48] (2020)	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.[49] (2017)	81.0	45.23 (9.3)	50.43 (8.8)	24	−4.5 (5.70)	6
Strain et al.[50] (2017)	69.8	42.70 (10.0)	53.40 (11.4)	12	−6.7 (10.16)	4
Subramaniam et al.[51] (2018)	64.9	39.40 (10.1)	45.52 (18.3)	6	−2.1 (2.54)	5

TABLE 1 (Continued)

First author (year)	% women	Mean age (SD)	Mean baseline BMI (SD)	Follow-up timing (months)	Reported depressive symptom outcome	JBI score/9
Tan et al.[52] (2021)	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.[53] (2010)	100.0	39.20 (9.2)	44.7 (2.6)	12, 24	12M: −4.0 (11.30) 24M: −4.3 (9.88)	6
Usta and Aygin[54] (2020)	80.8	36.60 (12.9)	46.70 (5.8)	6	−5.7 (5.35)	7
Vetrovsky et al.[55] (2021)	76.9	45.40 (9.0)	45.10 (7.4)	6	−3.0 (3.82)	7
Wei et al.[56] (2020)	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.[57] (2006)	89.2	42.40 (10.2)	51.70 (7.9)	12	−8.2 (6.77)	6
White et al.[58] (2010)	86.1	43.70 (10.0)	51.10 (8.3)	12, 24	12M: −6.2 (12.85) 24M: −6.4 (11.32)	5
Youssef et al.[3] (2020)	82.0	45.00 (10.5)	48.70 (8.9)	12, 24	12M (Bypass): −7.0 (5.45) 24M (Bypass): −5.9 (5.68)	5

$p = 0.120$) 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 greater observed effect sizes ($Q = 10.20$, $df = 1$, $p = 0.001$). Neither preoperative BMI ($p = 0.288$), sex ($p = 0.445$), nor age ($p = 0.108$) were associated with the observed effect sizes.

The mean (SD) JBI Scale score was 6.0 (1.2), range = 4–9 (Table S1 and Figure S6). Meta-regression did not find a significant association between JBI Scale score and changes to depressive symptom scores following bariatric surgery ($p = 0.549$). Publication bias was detected following inspection of the funnel plot (Figure S1), which was confirmed by the Egger's test ($B = 3.75$, 95% CI: 2.69–4.82, $p > 0.001$). The Trim-and-Fill procedure reduced the main effect from $g = 0.80$ (see change scores above) to $g = 0.47$ (95% CI: 0.38–0.55; BDI: 3.5; HADS: 1.5; PHQ: 1.9), with 32 studies estimated as missing.

4 | DISCUSSION

We found large decreases to depressive symptom scores following bariatric surgery. Decreases in depressive symptom scores at 24 months postoperatively were comparable with 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.[59–61] Previous systematic reviews have examined changes in depression following surgery,[2] and whether decreases to depression differed by timing of follow-up,[6,9] method of depression assessment,[10] and surgery type.[11] However, this is the first review to provide a quantitative estimate of the general change to depressive symptom across this postoperative 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,[62] problematic eating behaviors,[63] suboptimal weight loss,[64] weight regain,[4] and the need for revisional surgery.[5]

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[65,66] and impulse control[58] have been associated with decreased depressive symptom scores after bariatric surgery. Likewise, improved functional mobility[67] and increased physical activity postoperatively[68] also were linked to decreased depressive symptoms, possibly through greater cardiopulmonary fitness.[55] Bariatric surgery disrupts many physiological

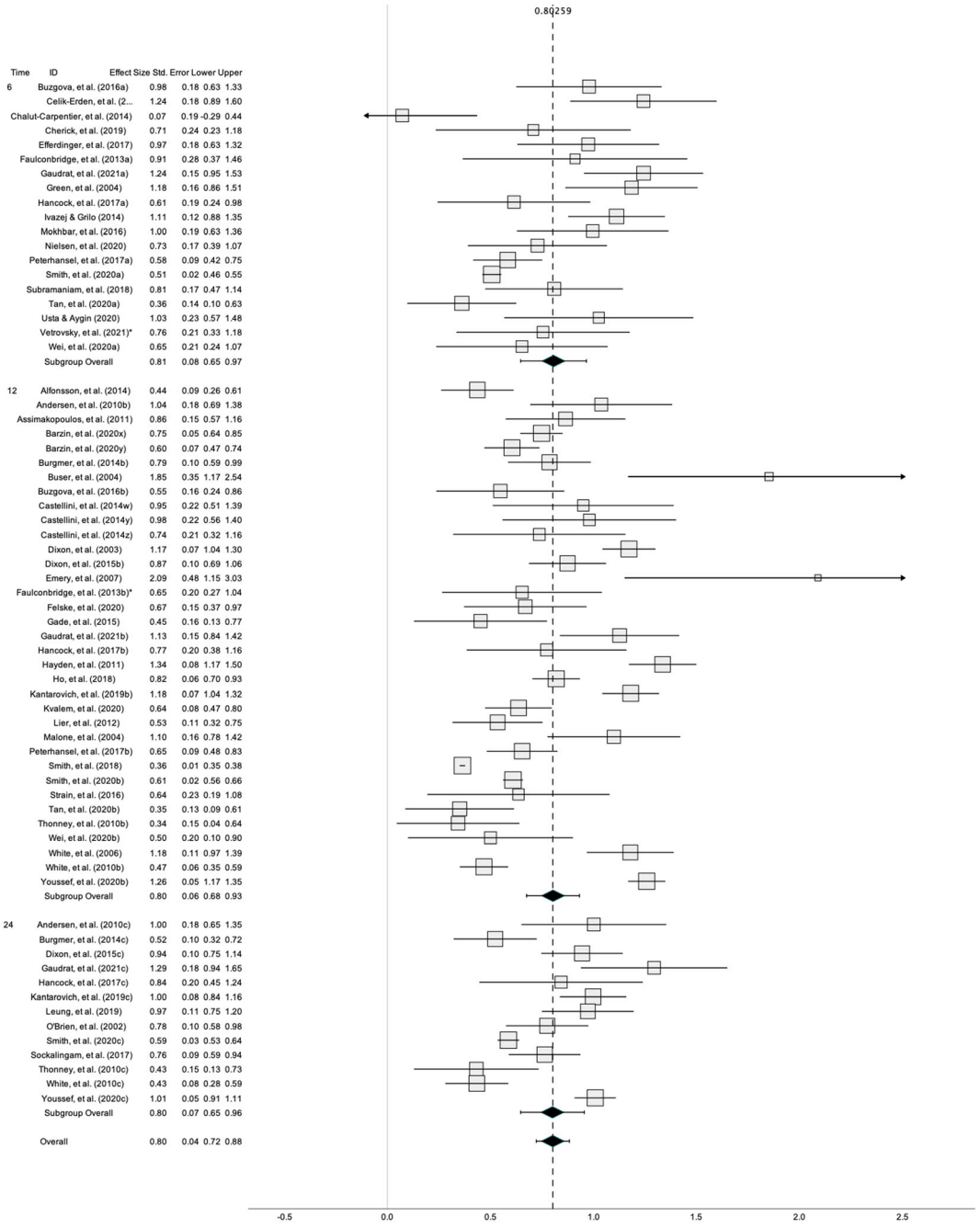

FIGURE 2 Forest plot changes to depressive symptoms following surgery at the time of follow-up. Six = 6 months; Twelve = 12 months; Twenty-Four = 24 months; CI = confidence interval. *Note*: Superscripts denote study observations with multiple follow-ups ("a" 6, "b" 12, and "c" 24 months) included in the meta-analyses and within study observation that separate depressive symptoms scores by procedure type ("w" band, "x" sleeve, "y" bypass, and "z" switch).

systems that might have an antidepressant effect. Inflammatory markers (e.g., interleukin 6 [IL-6] and C-reactive protein [CRP]) that are released systemically due to elevated visceral adipose tissue[69] significantly decreases following weight loss and in turn are associated with decreased depressive symptoms.[27,70] 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.[71]

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.[72] The BDI does have recognized subscales which could help differentiate overlapping symptoms between depression and obesity.[73] 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.[18,21,74,75] Murphy et al.[76] 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 months after surgery. Considering that specific procedures are recommended according to obesity severity[77] and presences of other comorbidities,[78] these results suggest similar favorable 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[18,35] and suggests large improvements to the quality of life among those initially more impaired.[2] 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.[3,19,22,35,40,43,45] 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.[79,80] As weight begins to stabilize 24 months onwards, mental health has been shown to worsen, including increases in depressive symptoms,[6] substance use,[81] and binge-eating.[9] 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, that is, 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).

These results are consistent with Fu et al.,[11] who performed a meta-analysis that examined changes to depressive symptoms after undergoing bariatric surgery. While the authors stratified the analyses according to the timing of follow-up (i.e., 6–12, 24, 36, 48, and 60 months), bariatric procedure, and screening tool used, no formal statistical tests in any of the subgroup analysis were reported. Unlike Fu et al.,[11] this review found that the extent for which screening tool scores decreased after surgery was smaller 24 months after surgery when depressive symptoms were assessed using the BDI compared to using the HADS or PHQ. The sensitivity analysis that was performed in this review determined that higher baseline depressive symptoms scores were associated with larger screening tool change scores after surgery, whereas Fu et al.[11] did not assess this in a sensitivity analysis. In addition, the Fu et al.[11] review concluded, after inspecting the symmetry of funnel plots, that there was no publication bias, which contrasts with the current study, which found that there was based on both funnel plot symmetry and Egger's test. Given that only a third of studies included in this review were also present in Fu et al.,[11] it is possible that differences in the databases searched, study inclusion/exclusion criteria, or the timing of publication contributed to the differing publication bias conclusions.

4.1 | 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. 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.[77] In addition, those with higher depressive symptom severity are also less likely to participate in research studies and/or discontinue participation in longitudinal studies.[82] Therefore, the results in the current study might not apply universally to all individuals who undergo bariatric surgery. The presence of publication bias further suggests these findings should be interpreted with some caution. 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.[7,16,26,31,35] 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.[83] That said, patients undergoing bariatric surgery tend to underreport psychiatric symptoms during clinical interviews out of concern of being ineligible for the surgery.[84] Second, we focused on specific follow-up time periods and did not include studies that reported data at different follow-up times, for example, 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.[2] Bariatric surgery results in a large magnitude of change that translates to clinically significant improvements in depressive symptoms, with higher presurgical 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, and surgical revisions) that undermines the quality of life of individuals who received bariatric surgery.

AUTHOR CONTRIBUTIONS

Robbie Woods, Kim L. Lavoie, and Simon L. Bacon contributed to the study concept and design. Robbie Woods and Paula A. B. Ribeiro analyzed the data. All authors contributed to the interpretation of data. Robbie Woods wrote the first draft of the report, and all authors reviewed and edited the final report. Paula A. B. Ribeiro, Kim L. Lavoie, and Simon L. Bacon provided supervision of the study. Robbie Woods and Simon L. Bacon 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.

ACKNOWLEDGMENTS

Funding for data collection was provided by operating grants from the Canadian Institutes of Health Research (CIHR) (PJT-153424 and UD1-170148). RW received research support from Les Fonds du recherche du Québec: Santé (256141) and J.W. McConnell Memorial Graduate Fellowships. AMM received research support from FRQS (257821) and Richard and Edith Strauss Canada Foundation Doctoral Scholarship. KLL was supported by a Canada Research Chairs Program (Tier 1: 950-232522), a UQAM Research Chair, and a FRQS Senior Research Award (34757). SLB was supported by a CIHR-SPOR Mentoring Chair (SMC-151518) and FRQS Chair's (251618 and 309815).

CONFLICT OF INTEREST

RW, AMM, PABR, and JS have no conflicts of interest to report. KLL has served on the advisory board for Schering-Plough, Takeda, AbbVie, Almirall, Janssen, GSK, Astellas, Novartis, Boehringer Ingelheim (BI), and Sojecci Inc. and received sponsorship for investigator-generated research grants from GSK and AbbVie, speaker fees from GSK, Astra-Zeneca, Astellas, Novartis, BI, Takeda, Janssen, AbbVie, Merck, Bayer, Pfizer, and Air Liquide and support for educational materials from Merck, none of which are related to the current article. SLB has received investigator-initiated educational funding from Moderna for the development of vaccine hesitancy educational training modules, consultancy fees from Respiplus for the development of behavior change continuing education modules, speaker fees from Respiplus, and has served on advisory boards for Bayer, Sanofi, Respiplus, and Sojecci Inc., none of which are related to the current article.

ORCID

Robbie Woods https://orcid.org/0000-0001-9012-1380
Simon L. Bacon https://orcid.org/0000-0001-7075-0358

REFERENCES

1. Cadena-Obando D, Ramírez-Rentería C, Ferreira-Hermosillo A, et al. Are there really any predictive factors for a successful weight loss after bariatric surgery? *BMC Endocr Disord*. 2020;20(1):20. doi:10.1186/s12902-020-0499-4
2. Dawes AJ, Maggard-Gibbons M, Maher AR, et al. Mental health conditions among patients seeking and undergoing bariatric surgery: a meta-analysis. *JAMA*. 2016;315(2):150-163. doi:10.1001/jama.2015.18118
3. Youssef A, Keown-Stoneman C, Maunder R, et al. Differences in physical and mental health-related quality of life outcomes 3 years after bariatric surgery: a group-based trajectory analysis. *Surg Obes Relat Dis*. 2020;16(11):1837-1849. doi:10.1016/j.soard.2020.06.014
4. Freire CC, Zanella MT, Segal A, Arasaki CH, Matos MIR, Carneiro G. Associations between binge eating, depressive symptoms and anxiety and weight regain after Roux-en-Y gastric bypass surgery. *Eat Weight Disord*. 2021;26(1):191-199. doi:10.1007/s40519-019-00839-w
5. de Gara CJ, Karmali S. The anatomy of a weight recidivism and revision bariatric surgical clinic. *Gastroenterol Res Pr*. 2014;2014:721095. doi:10.1155/2014/721095
6. Gill H, Kang S, Lee Y, et al. The long-term effect of bariatric surgery on depression and anxiety. *J Affect Disord*. 2019;246:886-894. doi:10.1016/j.jad.2018.12.113
7. Burgmer R, Legenbauer T, Muller A, de Zwaan M, Fischer C, Herpertz S. Psychological outcome 4 years after restrictive bariatric surgery. *Obes Surg*. 2014;24(10):1670-1678. doi:10.1007/s11695-014-1226-x
8. Sockalingam S, Wnuk S, Strimas R, Hawa R, Okrainec A. The association between attachment avoidance and quality of life in bariatric surgery candidates. *Obes Facts*. 2011;4(6):456-460. doi:10.1159/000335345
9. Spirou D, Raman J, Smith E. Psychological outcomes following surgical and endoscopic bariatric procedures: a systematic review. *Obes Rev*. 2020;21(6):e12998. doi:10.1111/obr.12998
10. Loh HH, Francis B, Lim LL, Lim QH, Yee A, Loh HS. Improvement in mood symptoms after post-bariatric surgery among people with obesity: a systematic review and meta-analysis. *Diabetes Metab Res Rev*. 2021;37(8):e3458. doi:10.1002/dmrr.3458
11. Fu R, Zhang Y, Yu K, Mao D, Su H. Bariatric surgery alleviates depression in obese patients: a systematic review and meta-analysis. *Obes Res Clin Pr*. 2021;16(1):10-16. doi:10.1016/j.orcp.2021.11.002

12. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Int J Surg*. 2021;88:105906. doi:10.1016/j.ijsu.2021.105906
13. Tufanaru C, Munn Z, Aromataris E, Campbell J, Hopp L. Chapter 3: systematic reviews of effectiveness. *JBI*. 2020;2020:71-133. doi:10.46658/JBIRM-17-03
14. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Lawrence Erlbaum Associates; 1988.
15. Alfonsson S, Sundbom M, Ghaderi A. Is age a better predictor of weight loss one year after gastric bypass than symptoms of disordered eating, depression, adult ADHD and alcohol consumption? *Eat Behav*. 2014;15(4):644-647. doi:10.1016/j.eatbeh.2014.08.024
16. Andersen JR, Aasprang A, Bergsholm P, Sletteskog N, Vage V, Natvig GK. Anxiety and depression in association with morbid obesity: changes with improved physical health after duodenal switch. *Health Qual Life Outcomes*. 2010;8(1):52. doi:10.1186/1477-7525-8-52
17. Assimakopoulos K, Karaivazoglou K, Panayiotopoulos S, Hyphantis T, Iconomou G, Kalfarentzos F. Bariatric surgery is associated with reduced depressive symptoms and better sexual function in obese female patients: a one-year follow-up study. *Obes Surg*. 2011;21(3):362-366. doi:10.1007/s11695-010-0303-z
18. Barzin M, Khalaj A, Tasdighi E, et al. Sleeve gastrectomy vs gastric bypass in improvement of depressive symptoms following one year from bariatric surgery, Tehran Obesity Treatment Study (TOTS). *Obes Res Clin Pr*. 2020;14(1):73-79. doi:10.1016/j.orcp.2019.11.002
19. Buser A, Dymek-Valentine M, Hilburger J, Alverdy J. Outcome following gastric bypass surgery: impact of past sexual abuse. *Obes Surg*. 2004;14(2):170-174. doi:10.1381/096089204322857519
20. Buzgova R, Buzga M, Holeczy P, Zonča P. Evaluation of quality of life, clinical parameters, and psychological distress after bariatric surgery: comparison of the laparoscopic sleeve gastrectomy and laparoscopic greater curvature plication. *Bariatr Surg Pract Patient Care*. 2016;11(4):169-176. doi:10.1089/bari.2016.0022
21. Castellini G, Godini L, Amedei SG, Faravelli C, Lucchese M, Ricca V. Psychological effects and outcome predictors of three bariatric surgery interventions: a 1-year follow-up study. *Eat Weight Disord*. 2014;19(2):217-224. doi:10.1007/s40519-014-0123-6
22. Chalut-Carpentier A, Pataky Z, Golay A, Bobbioni-Harsch E. Involvement of dietary fatty acids in multiple biological and psychological functions, in morbidly obese subjects. *Obes Surg*. 2015;25(6):1031-1038. doi:10.1007/s11695-014-1471-z
23. Cherick F, Te V, Anty R, et al. Bariatric surgery significantly improves the quality of sexual life and self-esteem in morbidly obese women. *Obes Surg*. 2019;29(5):1576-1582. doi:10.1007/s11695-019-03733-7
24. Dixon JB, Dixon ME, O'Brien PE. Depression in association with severe obesity: changes with weight loss. *Arch Intern Med*. 2003;163(17):2058-2065. doi:10.1001/archinte.163.17.2058
25. Dixon JB, Eaton LL, Vincent V, Michaelson R. LAP-BAND for BMI 30-40: 5-year health outcomes from the multicenter pivotal study. *Int J Obes (Lond)*. 2016;40(2):291-298. doi:10.1038/ijo.2015.156
26. Efferdinger C, Konig D, Klaus A, Jagsch R. Emotion regulation and mental well-being before and six months after bariatric surgery. *Eat Weight Disord*. 2017;22(2):353-360. doi:10.1007/s40519-017-0379-8
27. Emery CF, Fondow MD, Schneider CM, et al. Gastric bypass surgery is associated with reduced inflammation and less depression: a preliminary investigation. *Obes Surg*. 2007;17(6):759-763. doi:10.1007/s11695-007-9140-0
28. Erden SC, Seyit H, Yazısız V, et al. Binge eating disorder prevalence in bariatric surgery candidates, evaluation of presurgery and postsurgery quality of life, anxiety and depression levels. *Bariatr Surg Pract Patient Care*. 2016;11(2):61-66. doi:10.1089/bari.2015.0045
29. Faulconbridge LF, Wadden TA, Thomas JG, Jones-Corneille LR, Sarwer DB, Fabricatore AN. Changes in depression and quality of life in obese individuals with binge eating disorder: bariatric surgery versus lifestyle modification. *Surg Obes Relat Dis*. 2013;9(5):790-796. doi:10.1016/j.soard.2012.10.010
30. Felske AN, Williamson TM, Scurrey SRM, Telfer JA, Campbell TS, Rash JA. The influence of weight-related self-esteem and symptoms of depression on shape and weight concerns and weight-loss 12 months after bariatric surgery. *Obes Surg*. 2021;31(3):1062-1072. doi:10.1007/s11695-020-05097-9
31. Gade H, Friborg O, Rosenvinge JH, Smastuen MC, Hjelmesaeth J. The impact of a preoperative cognitive Behavioural therapy (CBT) on dysfunctional eating behaviours, affective symptoms and body weight 1 year after bariatric surgery: a randomised controlled trial. *Obes Surg*. 2015;25(11):2112-2119. doi:10.1007/s11695-015-1673-z
32. Gaudrat B, Florent V, Andrieux S, Rousseau A. "I want to lose weight and it has to be fair": predictors of satisfaction after bariatric surgery. *Obes Surg*. 2021;31(2):763-772. doi:10.1007/s11695-020-05069-z
33. Green AE, Dymek-Valentine M, Pytluk S, Le Grange D, Alverdy J. Psychosocial outcome of gastric bypass surgery for patients with and without binge eating. *Obes Surg*. 2004;14(7):975-985. doi:10.1381/0960892041719590
34. Hancock J, Jackson S, Johnson AB. The long-term psychological impact of disclosing (or not) laparoscopic adjustable gastric banding surgery. *Bariatr Surg Pract Patient Care*. 2018;13(3):128-136. doi:10.1089/bari.2017.0045
35. Hayden MJ, Dixon JB, Dixon ME, Shea TL, O'Brien PE. Characterization of the improvement in depressive symptoms following bariatric surgery. *Obes Surg*. 2011;21(3):328-335. doi:10.1007/s11695-010-0215-y
36. Ho K, Hawa R, Wnuk S, Okrainec A, Jackson T, Sockalingam S. The psychosocial effects of perioperative complications after bariatric surgery. *Psychosomatics*. 2018;59(5):452-463. doi:10.1016/j.psym.2018.03.005
37. Ivezaj V, Grilo CM. When mood worsens after gastric bypass surgery: characterization of bariatric patients with increases in depressive symptoms following surgery. *Obes Surg*. 2015;25(3):423-429. doi:10.1007/s11695-014-1402-z
38. Kantarovich K, Wnuk S, Cassin S, Hawa R, Sockalingam S. Employment outcomes 2 years after bariatric surgery: relationship to quality of life and psychosocial predictors. *Obes Surg*. 2019;29(9):2854-2861. doi:10.1007/s11695-019-03905-5
39. Kvalem IL, Bardstu S, Bergh I, Nordvik T, Sogg S, Mala T. Associations between perceived somatic symptoms and mental health after Roux-en-Y gastric bypass: a 3-year prospective cohort study. *Surg Obes Relat Dis*. 2020;16(5):626-632. doi:10.1016/j.soard.2019.12.018
40. Leung SE, Wnuk S, Jackson T, Cassin SE, Hawa R, Sockalingam S. Prospective study of attachment as a predictor of binge eating, emotional eating and weight loss two years after bariatric surgery. *Nutrients*. 2019;11(7):1625. doi:10.3390/nu11071625
41. Lier HO, Biringer E, Hove O, Stubhaug B, Tangen T. Quality of life among patients undergoing bariatric surgery: associations with mental health—a 1 year follow-up study of bariatric surgery patients. *Health Qual Life Outcomes*. 2011;9(1):79. doi:10.1186/1477-7525-9-79
42. Malone M, Alger-Mayer S. Binge status and quality of life after gastric bypass surgery: a one-year study. *Obes Res*. 2004;12(3):473-481. doi:10.1038/oby.2004.53
43. Mokhber N, Shaghayegh H, Talebi M, Tavassoli A. Comparison of levels of depression in patients with excessive obesity before and after gastric bypass surgery. *Ann Bariatr Surg*. 2016;5(4):100-110. doi:10.17795/minsurgery-34947
44. Nielsen MS, Christensen BJ, Schmidt JB, et al. Predictors of weight loss after bariatric surgery—a cross-disciplinary approach combining

physiological, social, and psychological measures. *Int J Obes (Lond)*. 2020;44(11):2291-2302. doi:10.1038/s41366-020-0576-9
45. O'Brien PE, Dixon JB, Brown W, et al. The laparoscopic adjustable gastric band (Lap-Band): a prospective study of medium-term effects on weight, health and quality of life. *Obes Surg*. 2002;12(5):652-660. doi:10.1381/096089202321019639
46. Peterhansel C, Nagl M, Wagner B, Dietrich A, Kersting A. Predictors of changes in health-related quality of life 6 and 12 months after a bariatric procedure. *Obes Surg*. 2017;27(8):2120-2128. doi:10.1007/s11695-017-2617-6
47. Smith ME, Lee JS, Bonham A, et al. Effect of new persistent opioid use on physiologic and psychologic outcomes following bariatric surgery. *Surg Endosc*. 2019;33(8):2649-2656. doi:10.1007/s00464-018-6542-0
48. Smith KE, Mason TB, Cao L, et al. Trajectories of depressive symptoms and relationships with weight loss in the seven years after bariatric surgery. *Obes Res Clin Pr*. 2020;14(5):456-461. doi:10.1016/j.orcp.2020.08.007
49. Sockalingam S, Hawa R, Wnuk S, et al. Psychosocial predictors of quality of life and weight loss two years after bariatric surgery: results from the Toronto Bari-PSYCH study. *Gen Hosp Psychiatry*. 2017;47:7-13. doi:10.1016/j.genhosppsych.2017.04.005
50. Strain GW, Torghabeh MH, Gagner M, et al. The impact of biliopancreatic diversion with duodenal switch (BPD/DS) over 9 years. *Obes Surg*. 2017;27(3):787-794. doi:10.1007/s11695-016-2371-1
51. Subramaniam K, Low WY, Lau PC, et al. Eating behaviour predicts weight loss six months after bariatric surgery: a longitudinal study. *Nutrients*. 2018;10(11):1616. doi:10.3390/nu10111616
52. Tan SYT, Tham KW, Ganguly S, et al. The impact of bariatric surgery compared to medical therapy on health-related quality of life in subjects with obesity and type 2 diabetes mellitus. *Obes Surg*. 2021;31(2):829-837. doi:10.1007/s11695-020-05038-6
53. Thonney B, Pataky Z, Badel S, Bobbioni-Harsch E, Golay A. The relationship between weight loss and psychosocial functioning among bariatric surgery patients. *Am J Surg*. 2010;199(2):183-188. doi:10.1016/j.amjsurg.2008.12.028
54. Usta E, Aygin D. Prospective randomized trial on effects of structured training and counseling on depression, body image, and quality of life. *Bariatr Surg Pract Patient Care*. 2020;15(2):55-62. doi:10.1089/bari.2019.0028
55. Vetrovsky T, Fortova T, Conesa-Ros E, et al. Increased cardiopulmonary fitness is associated with a greater reduction in depression among people who underwent bariatric surgery. *Int J Env Res Public Health*. 2021;18(5):2508. doi:10.3390/ijerph18052508
56. Wei Y, Wu T, Tong DKH, et al. Improvement in patient-reported outcomes in Chinese adults after bariatric surgery: 1-year follow-up of a prospective cohort. *Surg Obes Relat Dis*. 2020;16(10):1563-1572. doi:10.1016/j.soard.2020.04.050
57. White MA, Masheb RM, Rothschild BS, Burke-Martindale CH, Grilo CM. The prognostic significance of regular binge eating in extremely obese gastric bypass patients: 12-month postoperative outcomes. *J Clin Psychiatry*. 2006;67(12):1928-1935. doi:10.4088/jcp.v67n1213
58. White MA, Kalarchian MA, Masheb RM, Marcus MD, Grilo CM. Loss of control over eating predicts outcomes in bariatric surgery patients: a prospective, 24-month follow-up study. *J Clin Psychiatry*. 2010;71(2):175-184. doi:10.4088/JCP.08m04328blu
59. Lemay KR, Tulloch HE, Pipe AL, Reed JL. Establishing the minimal clinically important difference for the Hospital Anxiety and Depression Scale in patients with cardiovascular disease. *J Cardiopulm Rehabil Prev*. 2019;39(6):E6-E11. doi:10.1097/HCR.0000000000000379
60. Bauer-Staeb C, Kounali DZ, Welton NJ, et al. Baseline-dependent minimal clinically important difference (MCID) for depression and anxiety: a patient-centred approach. *J Clin Epidemiol*. 2021;45(15):3269-3279. doi:10.1017/S0033291715001270
61. Kounali D, Button KS, Lewis G, et al. How much change is enough? Evidence from a longitudinal study on depression in UK primary care. *Psychol Med*. 2022;52(10):1875-1882.
62. Gordon KH, King WC, White GE, et al. A longitudinal examination of suicide-related thoughts and behaviors among bariatric surgery patients. *Surg Obes Relat Dis*. 2019;15(2):269-278. doi:10.1016/j.soard.2018.12.001
63. White MA, Kalarchian MA, Levine MD, Masheb RM, Marcus MD, Grilo CM. Prognostic significance of depressive symptoms on weight loss and psychosocial outcomes following gastric bypass surgery: a prospective 24-month follow-up study. *Obes Surg*. 2015;25(10):1909-1916. doi:10.1007/s11695-015-1631-9
64. Geerts MM, van den Berg EM, van Riel L, Peen J, Goudriaan AE, Dekker JJM. Behavioral and psychological factors associated with suboptimal weight loss in post-bariatric surgery patients. *Eat Weight Disord*. 2021;26(3):963-972. doi:10.1007/s40519-020-00930-7
65. Behrens SC, Lenhard K, Junne F, et al. Effects of bariatric surgery on depression: role of body image. *Obes Surg*. 2021;31(4):1864-1868. doi:10.1007/s11695-020-05057-3
66. Geller S, Dahan S, Levy S, Goldzweig G, Hamdan S, Abu-Abeid S. Body image and emotional eating as predictors of psychological distress following bariatric surgery. *Obes Surg*. 2020;30(4):1417-1423. doi:10.1007/s11695-019-04309-1
67. King WC, Chen JY, Belle SH, et al. Change in pain and physical function following bariatric surgery for severe obesity. *JAMA*. 2016;315(13):1362-1371. doi:10.1001/jama.2016.3010
68. Rosenberger PH, Henderson KE, White MA, Masheb RM, Grilo CM. Physical activity in gastric bypass patients: associations with weight loss and psychosocial functioning at 12-month follow-up. *Obes Surg*. 2011;21(10):1564-1569. doi:10.1007/s11695-010-0283-z
69. Fontana L, Eagon JC, Trujillo ME, Scherer PE, Klein S. Visceral fat adipokine secretion is associated with systemic inflammation in obese humans. *Diabetes*. 2007;56(4):1010-1013. doi:10.2337/db06-1656
70. Musselman D, Shenvi N, Manatunga A, Miller AH, Lin E, Gletsu-Miller N. The effects of roux en y gastric bypass surgery on neurobehavioral symptom domains associated with severe obesity. *Physiol Behav*. 2019;204:86-92. doi:10.1016/j.physbeh.2019.02.013
71. Brown RM, Guerrero-Hreins E, Brown WA, le Roux CW, Sumithran P. Potential gut–brain mechanisms behind adverse mental health outcomes of bariatric surgery. *Nat Rev Endocrinol*. 2021;17(9):549-559. doi:10.1038/s41574-021-00520-2
72. Krukowski RA, Friedman KE, Applegate KL. The utility of the Beck Depression Inventory in a bariatric surgery population. *Obes Surg*. 2010;20(4):426-431. doi:10.1007/s11695-008-9717-2
73. Hayes S, Stoeckel N, Napolitano MA, et al. Examination of the Beck Depression Inventory-II factor structure among bariatric surgery candidates. *Obes Surg*. 2015;25(7):1155-1160. doi:10.1007/s11695-014-1506-5
74. Ayloo S, Thompson K, Choudhury N, Sheriffdeen R. Correlation between the Beck Depression Inventory and bariatric surgical procedures. *Surg Obes Relat Dis*. 2015;11(3):637-642. doi:10.1016/j.soard.2014.11.005
75. Strain GW, Kolotkin RL, Dakin GF, et al. The effects of weight loss after bariatric surgery on health-related quality of life and depression. *Nutr Diabetes*. 2014;4(9):e132. doi:10.1038/nutd.2014.29
76. Murphy R, Clarke MG, Evennett NJ, et al. Laparoscopic sleeve gastrectomy versus banded Roux-en-Y gastric bypass for diabetes and obesity: a prospective randomised double-blind trial. *Obes Surg*. 2018;28(2):293-302. doi:10.1007/s11695-017-2872-6
77. Mechanick JI, Apovian C, Brethauer S, et al. Clinical Practice Guidelines for the Perioperative Nutrition, Metabolic, and Nonsurgical Support of Patients Undergoing Bariatric Procedures - 2019 Update: Cosponsored by American Association of Clinical Endocrinologists/American College of Endocrinology, The Obesity Society, American Society for Metabolic and Bariatric Surgery, Obesity Medicine

Association, and American Society of Anesthesiologists. *Obes Silver Spring*. 2020;28(4):O1-O58. doi:10.1002/oby.22719
78. English WJ, Williams DB. Metabolic and bariatric surgery: an effective treatment option for obesity and cardiovascular disease. *Prog Cardiovasc Dis*. 2018;61(2):253-269. doi:10.1016/j.pcad.2018.06.003
79. de Zwaan M, Enderle J, Wagner S, et al. Anxiety and depression in bariatric surgery patients: a prospective, follow-up study using structured clinical interviews. *J Affect Disord*. 2011;133(1-2):61-68. doi:10.1016/j.jad.2011.03.025
80. Karlsson J, Taft C, Rydén A, Sjöström L, Sullivan M. Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. *Int J Obes (Lond)*. 2007;31(8):1248-1261. doi:10.1038/sj.ijo.0803573
81. King WC, Chen JY, Courcoulas AP, et al. Alcohol and other substance use after bariatric surgery: prospective evidence from a US multicenter cohort study. *Surg Obes Relat Dis*. 2017;13(8):1392-1402. doi:10.1016/j.soard.2017.03.021
82. Sockalingam S, Cassin S, Crawford S, et al. Psychiatric predictors of surgery non-completion following suitability assessment for bariatric surgery. *Obes Surg*. 2013;23(2):205-211. doi:10.1007/s11695-012-0762-5
83. Stuart AL, Pasco JA, Jacka FN, Brennan SL, Berk M, Williams LJ. Comparison of self-report and structured clinical interview in the identification of depression. *Compr Psychiatry*. 2014;55(4):866-869. doi:10.1016/j.comppsych.2013.12.019
84. Ambwani S, Boeka AG, Brown JD, et al. Socially desirable responding by bariatric surgery candidates during psychological assessment. *Surg Obes Relat Dis*. 2013;9(2):300-305. doi:10.1016/j.soard.2011.06.019

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Woods R, Moga AM, Ribeiro PAB, Stojanovic J, Lavoie KL, Bacon SL. Evolution of depressive symptoms from before to 24 months after bariatric surgery: A systematic review and meta-analysis. *Obesity Reviews*. 2023; e13557. doi:10.1111/obr.13557