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Jacobs, A.; Monpellier, V.M.; Torensma, B.; Antoniou, E.E.; Janssen, I.M.C.; Tollenaar, R.A.E.M.; Jansen, A.T.M.

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REVIEW

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Influence of mental and behavioral factors on weight loss after bariatric surgery: A systematic review and meta-analysis

Anne Jacobs[1,2] | Valerie M. Monpellier[1] | Bart Torensma[3] | Evangelia E. Antoniou[4] | Ignace M. C. Janssen[1] | Rob A. E. M. Tollenaar[2] | Anita T. M. Jansen[5]

[1]Nederlandse Obesitas Kliniek (Dutch Obesity Clinic), Utrecht, The Netherlands

[2]Department of Surgery, Leiden University Medical Center, Leiden, The Netherlands

[3]Torensma Research Consultancy, Toronto, Canada

[4]MetaAnalyses.com, Hees, Belgium

[5]Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands

Correspondence
Anne Jacobs, Nederlandse Obesitas Kliniek (Dutch Obesity Clinic), Amersfoortseweg 43, 3712 BA Huis ter Heide, Utrecht, The Netherlands.
Email: ajacobs@obesitaskliniek.nl

Summary

Introduction: Multiple factors are related to lower weight loss after bariatric surgery. This review and meta-analysis evaluates the influence of several mental and behavioral factors on weight loss.

Method: Six electronic databases were searched. Percentage excess weight loss (%EWL) was calculated for all moderator and non-moderator groups of the variables: symptoms of depression, anxiety and binge eating, compliance, physical activity, quality of life, and body image. All moderators, surgery types, and follow-up moments were analyzed separately.

Results: In total, 75 articles were included in the review; 12 meta-analyses were conducted. Higher postoperative compliance to follow-up was associated with 6.86%–13.68% higher EWL. Preoperative binge eating was related to more weight loss at 24- and 36-month follow-up (7.97% and 11.79%EWL, respectively). Patients with postoperative binge eating symptoms had an 11.92% lower EWL. Patients with preoperative depressive symptoms lost equal weight compared to patients without symptoms.

Conclusion: Despite the high heterogeneity between studies, a trend emerges suggesting that the presence of postoperative binge eating symptoms and lower postoperative compliance may be associated with less weight loss after bariatric-metabolic surgery. Additionally, preoperative depressive symptoms and binge eating do not seem to significantly impact weight loss.

KEYWORDS
bariatric surgery, behavioral factors, mental factors, psychological factors, weight loss

1 | INTRODUCTION

Bariatric-metabolic surgery generally results in long-term weight loss, improved associated medical problems such as diabetes mellitus, hypertension, and sleep apnea, and better quality of life (QoL).[1–4] However, there is notable variability in postoperative weight loss among patients.[5–7] It is estimated that approximately 10%–15% of patients experience suboptimal weight loss (percentage total weight loss [%TWL] < 20% 1 year after surgery), which may be considered an unsatisfactory outcome.[6,8,9] Early identification of factors influencing

these outcomes is essential for identifying patients at risk of suboptimal long-term weight loss and providing them with appropriate support. Factors associated with lower weight loss following bariatric-metabolic surgery encompass higher baseline weight, higher age, ethnicity, the presence of diabetes, and gastrointestinal hormone levels.[10–13] Furthermore, behavioral and mental aspects have been identified as influential factors affecting weight loss outcomes after bariatric-metabolic surgery.[13–15]

An important behavioral aspect is the compliance to follow-up appointments. It is well established that, in the context of bariatric-metabolic surgery, follow-up rates tend to be suboptimal, and there is considerable variation in attrition rates among different studies.[16] International guidelines recommend increasing follow-up rates after bariatric-metabolic surgery, as it is associated with improved outcomes.[17] This recommendation aligns with the findings of a 2014 meta-analysis, which reported higher excess weight loss (%EWL) 1 year after Roux-en-Y gastric bypass (RYGB) in patients who were more compliant with follow-up appointments.[18] This current study aims to provide an updated literature review and extend the investigation to longer-term follow-up periods.

Furthermore, patients undergoing bariatric-metabolic surgery are required to improve their lifestyle to attain and sustain weight loss.[17,19] Prior research has linked noncompliance with these lifestyle changes to lower weight loss following RYGB.[18,20] Consistent engagement in physical activity (PA) is essential to promote and maintain weight loss.[21] While evidence regarding the association between PA and weight loss is conflicting, meta-analyses have demonstrated a positive effect of PA following bariatric-metabolic surgery.[22,23]

Psychopathology, including eating disorders, appear to be particularly important in the bariatric population. Among individuals living with obesity, the most prevalent mental disorders include depressive disorders and eating disorders, particularly binge eating disorders.[24,25] Prior studies have explored the association between mental health and postoperative weight loss, but the results are inconsistent. Some studies suggest that various mental and behavioral factors, such as eating disorder psychopathology, loss of control over eating, depressive symptoms, impulsivity, and body avoidance, are associated with suboptimal weight loss following bariatric-metabolic surgery.[14,26,27] Conversely, other studies indicate no discernible impact of these factors on weight loss after surgery.[28–32] A prior meta-analysis reported no significant influence of preoperative binge eating on postoperative weight loss in bariatric-metabolic surgery patients.[33] In contrast, another meta-analysis showed a positive association between the two.[13] Furthermore, the association between other mental disorders, such as preoperative depression, remains unclear due to conflicting evidence in existing studies.[15,34,35] To the best of our knowledge, a meta-analysis assessing the association between mood disorders and postoperative weight loss has not been previously undertaken.

Individuals living with obesity tend to exhibit lower QoL, negative body image perceptions, and higher rates of mental health issues.[24,25,36–39] However, only seven prior studies have explored the potential impact of QoL or body image on post-bariatric weight loss.[30,40–45] No systematic review and meta-analysis addressing these predictors has been reported to date.

Understanding the impact of mental and behavioral factors on weight loss is essential for enhancing preoperative screening and treatment programs. Previous reviews generally include different types of bariatric-metabolic surgery, despite the well-established influence of surgical procedure type on weight loss outcomes.[46] In this study, compliance to follow-up, PA, depression, binge eating symptoms, anxiety, body image, and QoL are considered to be the most critical moderators of weight loss following bariatric-metabolic surgery. Therefore, the objective of this study is to comprehensively review and analyze the associations between these mental and behavioral factors and weight loss following primary RYGB and sleeve gastrectomy (SG).

2 | METHODS

2.1 | Protocol and search strategy

This review was registered at PROSPERO under protocol ID CRD42020200554, and the PRISMA statement checklist was used.[47] The search strategy was developed by an information specialist from the Leiden University Medical Center library with two authors Anne Jacobs (AJ) and Valerie Monpellier (VM). The databases PubMed, Embase, Cochrane, PsycINFO, Web of Science, and EmCare were searched up to the 6th of July 2021. The following terms and their synonyms were used, truncated where necessary: gastric bypass, sleeve gastrectomy, bariatric surgery, compliance, physical activity, psychopathology, depressive disorder, anxiety disorder, eating disorder, binge eating disorder, body image, quality of life, and outcome/weight loss. Detailed search queries are provided in Appendix S1. To ensure a comprehensive search, an exploration of grey literature was included, and a cross-reference check was performed to identify any articles that may not have been initially identified in the searches.

2.2 | Inclusion criteria

The inclusion criteria encompassed studies involving adult patients (aged >18 years) who had undergone primary RYGB or SG. When studies described multiple types of bariatric-metabolic surgery, studies were only included when the results of the RYGB and SG patients were presented separately. The studies considered for inclusion needed to describe at least one of the following factors: compliance to follow-up, PA, depressive symptoms, binge eating symptoms, anxiety symptoms, body image, or QoL with the outcome defined in terms of body weight, body mass index (BMI), weight loss, %EWL, or %TWL. Eligible study designs encompassed randomized controlled trials, prospective and retrospective cohort studies, cross-sectional studies, and case–control studies published in peer-reviewed journals, with the restriction that they were available in English or Dutch.

2.3 | Exclusion criteria

Studies that did not specify the type of bariatric-metabolic surgery or had unclear descriptions were excluded. Descriptive studies, case series, and case reports were also excluded because of their lower level of evidence.

2.4 | Study and data selection

Two reviewers, A.J. and V.M., independently conducted an initial screening of study titles and abstracts to determine their adherence to the inclusion and exclusion criteria. Subsequently, the same reviewers independently assessed the remaining full-text reports for eligibility. Data from full-text articles were extracted and subjected to double-checking. In cases of any discrepancies, consensus was reached through discussion between the two reviewers, with the availability of a third reviewer if required, though consultation was not necessary. Data pertaining to outcomes were collected and divided into separate groups for subsequent analysis. This included details regarding the type of surgery and duration of follow-up. Preoperative BMI was selected as baseline weight. When BMI was not provided, it was calculated from the mean baseline weight and mean height of the study population. Information regarding the methodologies used for assessing the moderating factors and the timing of these assessments (pre- or postoperatively) was extracted. Additional study characteristics such as the study design and the number of patients were also selected. Given the various methods for describing weight loss, data on all weight loss metrics were collected. The choice of outcome parameter for the subsequent meta-analyses, such as %EWL or %TWL, was determined by the availability of data and prioritized the parameter that was most frequently utilized in the included articles. Authors of the studies were contacted at least twice to request any additional data required for the meta-analysis, such group sizes and standard deviations. In cases where studies did not present data for two distinct groups based on the moderator (opting instead for regression analyses), authors were contacted to acquire the necessary data for inclusion in the meta-analysis.

2.5 | Assessment of risk of bias

Two reviewers, A.J. and V.M., independently conducted assessments of the methodological quality and risk of bias for each included study. The Newcastle–Ottawa Scale[48] was used to evaluate the quality of non-randomized studies, including cohort and case–control studies. This scale utilizes a scoring system with a maximum attainable score of nine points, distributed across three distinct domains: selection bias (four points), comparability (two points) and outcome bias (three points). The total scores were then categorized as high, medium, or low risk of bias, based on the number of points scored in each domain (Appendix 1).

2.6 | Data analysis

For each included study, patients were categorized into groups based on the presence or absence of specific moderators (e.g., patients with or without depression), in accordance with the definitions provided within the respective article (Tables 1–7). To minimize heterogeneity, separate meta-analyses were conducted for each type of bariatric-metabolic procedure and for distinct postoperative follow-up moments. Articles were only included if the standard deviation of follow-up durations fell within a range of less than 3 months. The mean difference in weight loss between groups was calculated using a random-effects model. Heterogeneity was evaluated by the I^2 statistic, for quantifying inconsistency. Interpretation of I^2 values was as follows: 0%–40% signified "might not be important," 30%–60% indicated "moderate heterogeneity," 50%–90% denoted "substantial heterogeneity," and 75%–100% represented "considerable heterogeneity."[49] In cases where heterogeneity exceeded 60% (surpassing the threshold for "moderate heterogeneity"), the meta-analysis was omitted, and the relevant articles were solely described in the review. All statistical analyses were conducted using Review Manager version 5.4.1,[50] and forest plots were generated. A p-value of <0.05 was considered statistically significant.

3 | RESULTS

3.1 | Search results

After removing duplicates, 6408 unique articles were identified (Figure 1). Titles and abstracts of all 6408 articles were reviewed, leading to the exclusion of 6185 articles. Subsequently, 222 full-text articles were assessed for eligibility. Ultimately, 75 articles met the inclusion criteria for this review. Among these, 30 studies reported the effect of multiple moderators, as detailed in Tables 1–7. Fourteen studies provided adequate data for the conduct of at least one meta-analysis.

3.2 | Definition of weight loss

In the majority of the included studies, data on weight loss were only reported as %EWL. Consequently, %EWL was chosen as the outcome parameter for analysis. In cases where the mean and/or standard deviations of %EWL were not explicitly provided within the articles, these values were computed according to Cochrane standards to facilitate the analysis.[49]

3.3 | Risk of bias

Out of the 75 articles included, 38 articles were classified as high risk of bias, 34 as low risk, and three fell within the medium risk category

TABLE 1 Overview of included studies that assessed compliance as moderator for weight loss after surgery.

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Preoperative compliance									
el Chaar[a]	2011	Prospective cohort	RYGB	12 months	177	*n.a.*	Missed <25% of preoperative appointments	No difference	Good
Hildebrandt[a]	1998	Cross-sectional	RYGB	*n.a.*	102	*n.a.*	Pre- and postoperative support group, yes/no question	No difference	Poor
Postoperative compliance									
el Chaar[a]	2011	Prospective cohort	RYGB	12 months	177	*n.a.*	Missed <25% of postoperative appointments	No difference	Good
Coleman	2010	Retrospective cohort	RYGB	32 ± 12 months	110	49.5 ± 7.7	Based on number of postoperative appointments	Depending on definition WL success/failure	Poor
Compher[b]	2012	Cross-sectional	RYGB	1.5, 6, 12, and 24 months	60	52.0 ± 10.1	Returned at FU 12 months postop	All positive	Good
Gould[b]	2007	Retrospective cohort	RYGB	12 and 36 months	85	*n.a.*	Attended every appointment up to 1–3 years after surgery	12 months: no difference 36 months: positive	Good
Harper[b]	2007	Retrospective cohort	RYGB	12 months	105	48.0 ± 6	Returned for annual appointment	Positive	Good
Hatoum	2008	Retrospective cohort	RYGB	12 months	246	52.3 ± 8.7	Attended ≥90% of appointments	Positive	Poor
Hildebrandt[a]	1998	Cross-sectional	RYGB	*n.a.*	102	*n.a.*	Pre- and postoperative support group, yes/no question	No difference	Poor
Jennings[b]	2013	Prospective cohort	RYGB	12 and 24 months	227	*n.a.*	Attended all follow-up postoperative appointments	12 months: positive 24 months: no difference	Good
Livhits	2010	Retrospective cohort	RYGB	40.1 ± 15.4 months	148	46.2	≥1 attendance of postoperative support groups	Positive	Poor
Lujan[b]	2020	Prospective cohort	RYGB	1, 6, 12, 24, 36, 48, and 60 months	294	43.24	Attended all follow-up postoperative appointments	Positive	Good
			SG	1, 6, 12, 24, 36, 48, and 60 months	95	46.45	Attended all follow-up postoperative appointments	Positive	
Orth	2008	Cross-sectional	RYGB	*n.a.*	33	*n.a.*	Attended postoperative support group meetings	Positive	Poor
Robinson	2014	Cross-sectional	RYGB	5.8 ± 3.1 years	274	47.4 ± 8.4	- Regular attendance support groups, yes/no question - Attendance at surgical follow-up appointments, yes/no question	- Positive - No difference	Poor
Shen[b]	2004	Prospective cohort	RYGB	12 months	115	47.7 [35–64.1]	>3 visits to clinic after surgery	No difference	Good
Song[b]	2008	Retrospective cohort	RYGB	2 and 6 weeks; 3, 6, 9, and 12 months	78	*n.a.*	>5 support group meeting after surgery	2 and 6 weeks, 3 and 6 months: no difference 9 and 12 months: positive	Good

Abbreviations: n.a., not available; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy.
[a]Compliance measured both pre- and postoperatively.
[b]Included in meta-analysis.

TABLE 2 Overview of included studies that assessed physical activity as moderator for weight loss after surgery.

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Physical activity measured preoperatively									
Bergh[a]	2016	Prospective cohort	RYGB	12 months	230	44.9 ± 5.7	International Physical Activity Questionnaire	Positive	Good
Boan	2004	Prospective cohort	RYGB	6 months	40	52.9 ± 8.9	Baseline Questionnaire of Activity	No difference	Good
Monpellier[a]	2019	Retrospective cohort	RYGB	1, 2, 3, and 4 years	4569	44.4	Baecke questionnaire	No difference	Good
Physical activity measured postoperatively									
Amundsen	2017	Case–control	RYGB	5 years	49	44.1	SenseWear Armband and International Physical Activity Questionnaire	Positive	Good
Bond	2004	Retrospective cohort	RYGB	24 months	1585	49.8 ± 7.4	Written self-report	Positive	Good
Evans	2007	Retrospective cohort	RYGB	3, 6, and 12 months	178; 128; 209	49.3 ± 7.6; 49.3 ± 7.0; 49.8 ± 7.5	International Physical Activity Questionnaire (≥150-min moderate/high-intensity PA)	3 months: no difference 6 and 12 months: positive	Good
Forbush	2011	Cross-sectional	RYGB	3–5 years	162	n.a.	Arizona Activity Frequency Questionnaire	Positive	Poor
Herman	2014	Cross-sectional	RYGB	7 ± 4 years	303	51.4 ± 9.3	≥1 session/week MVPA of ≥30 min	Positive	Poor
Josbeno	2011	Cross-sectional	RYGB	3.3 ± 1.1 years	40	48.8 ± 7.1	BodyMedia SenseWear® Pro armband	Positive	Fair
Kruseman	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Pedometer for 5 days	No difference	Good
Latner	2004	Retrospective cohort	RYGB	16.4 months	65	54.1 ± 10.2	PA frequency (>20 min)	Positive	Fair
Livhits	2010	Retrospective cohort	RYGB	40.1 ± 15.4 months	148	46.2	International Physical Activity Questionnaire-short	Positive	Poor
Monpellier[a]	2019	Retrospective cohort	RYGB	1, 2, 3, and 4 years	4569	44.4	Baecke questionnaire	Positive	Good
Robinson	2014	Cross-sectional	RYGB	5.8 ± 3.1 years	274	47.4 ± 8.4	Times/week and minutes	No difference	Poor
Rosenberger	2011	Retrospective Cohort	RYGB	12 months	131	51.6 ± 8.0	Godin Leisure Time Questionnaire	Frequency: no difference Intensity: positive	Good
Welch	2008	Cohort	RYGB	14.5 ± 13.9 months	200	53.5 ± 11.4	Bariatric Surgery Self-management Questionnaire	Positive	Fair
Welch	2011	Cross-sectional	RYGB	917.1 ± 9 6.8 days	75	49.8 ± 6.9	Bariatric Surgery Self-management Questionnaire	Positive	Good
Wolfe	2006	Cross-sectional	RYGB	78.5 ± 35.7 weeks	93	52.5 ± 10.1	Frequency, length, and type of exercise during the 3 months prior to surgery and in the past 3 months	No difference	Poor
Yanos	2015	Cross-sectional	RYGB	8.86 ± 3.59 years	97	53.3	Global Physical Activity Questionnaire version 2 and Bariatric Surgery Self-management Questionnaire	No difference	Poor

(Continues)

TABLE 2 (Continued)

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Change in physical activity									
Bergh[a]	2016	Prospective cohort	RYGB	12 months	230	44.9 ± 5.7	International Physical Activity Questionnaire	No difference	Good
Bond	2009	Prospective cohort	RYGB	12 months	199	49.8 ± 7.8	International Physical Activity Questionnaire short form	Positive	Good
Monpellier[a]	2019	Retrospective cohort	RYGB	1, 2, 3, and 4 years	4569	44.4	Baecke questionnaire	Positive	Good
Wefers	2017	Prospective cohort	RYGB	9 months	50	38.1 ± 7.0	SenseWear Pro armband	Positive	Poor
Unclear when physical activity was measured									
Junior	2011	Retrospective cohort	RYGB	6, 12, 18, 24, 36, and 48 months	149	52.1 ± 7.7	≥2 days/week more than 1 h of activity, unclear when measured	No difference	Poor

Abbreviations: PA, physical activity; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy.
[a]PA measured both pre- and postoperatively.

(Appendix 1). The primary factor contributing to a high risk of bias in most articles was the utilization of cohorts that were incomparable, resulting in only 22 out of the 75 articles earning both points in this domain. Additionally, inadequate follow-up was identified in 36 of the 75 studies included. The domain with the most common issue was the "selection of the non-exposed group," with most studies earning just one point out of a possible two (73 out of 75 studies).

3.4 | Compliance to follow-up

Fourteen studies evaluated the effect of compliance to the follow-up program on weight loss[51–64] (Table 1). Compliance was calculated using attendance in postoperative appointments,[52,53,55,56,58–60,64] postoperative support group meetings,[54,57,62–64] or both pre- and postoperative support group meetings.[51,61] The study populations ranged from 33 to 389 patients, mean preoperative BMI ranged from 46.2 to 52.3 kg/m^2, and the maximum follow-up duration was 5.8 years.

Seven studies did not have sufficient data for a meta-analysis and were reviewed. Preoperative compliance had no significant correlation with weight loss in two studies.[51,61] In three studies, postoperative adherence was associated with more weight loss and successful weight loss,[56,57,63] two studies found no difference,[51,61] and in one study, it was dependent on how weight loss success/failure was defined.[62] One study demonstrated that attending support group meetings was associated with increased weight loss, whereas attendance to surgical follow-up appointments did not yield the same effect.[64] Among these seven studies, one exhibited a low risk of bias.

Meta-analyses including seven studies revealed a statistically significantly increased in mean %EWL for the compliant group following RYGB[52–55,58–60] (Figure 2A–D). Difference in %EWL ranged from 6.86% at 6 months to 13.68% at 36 months' follow-up. Heterogeneity (I^2) ranged from 0% at 36 months to 58% at 6 months. All seven studies included in these analyses exhibited a low risk of bias.

3.5 | PA

Twenty-one studies evaluated the association between PA and weight loss following RYGB[40,41,43,63–80] (Table 2). Four studies employed activity bands to measure PA,[40,41,75,79] PA was assessed with questionnaires in 12 studies,[41,43,63,65,66,69,71–74,76,78] and in six studies, patients were queried about their PA without the use of a validated questionnaire.[64,67,68,70,77,80]

The assessment of PA before surgery was conducted in three studies,[43,65,66] four studied the impact of change in PA on weight loss,[43,66,72,79] one study did not specify the timing of PA assessment,[80] and all remaining studies evaluated PA after surgery. The preoperative mean BMI ranged from 38.1 to 54.1 kg/m^2, the number of patients from 40 to 4569, and the maximum follow-up reached 9 years.

TABLE 3 Overview of included studies that assessed depressive symptoms as moderator for weight loss after surgery.

Reference	Pub. Date	Study design	RYGB/ SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Depression measured preoperatively									
Alabi	2018	Retrospective cohort	RYGB	6 and 12 months	73	38.8 ± 3.8	Beck Depression Inventory II	No difference	Poor
Alfonsson	2014	Prospective cohort	RYGB	12 months	129	42.95 ± 3.98	Hospital Anxiety and Depression Scale	No difference	Good
Alger-mayer	2009	Prospective cohort	RYGB	3, 6, 12, 24, 36, 48, 60, and 72 months	157	50.7 ± 8.0	Beck Depression Inventory	No difference	Good
Ames	2017	Prospective cohort	RYGB	1 and 2 years	305	45.3 [32.7–83.1]	Patient Health Questionnaire-9	No difference	Good
			SG	1 and 2 years	117	45.3 [35.5–77.1]	Patient Health Questionnaire-9	No difference	
Averbukh	2003	Retrospective cohort	RYGB	12 months	47	52.9 ± 12.1	Beck Depression Inventory	Negative	Poor
Bergh	2016	Prospective cohort	RYGB	12 months	230	44.9 ± 5.7	Hospital Anxiety and Depression Scale	No difference	Good
Brunault	2012	Prospective cohort	SG	12 months	34	55.3 ± 10.2	Beck Depression Inventory and the depression subscale of the Symptom Checklist-90-Revised	Negative for BDI No difference for SCL-90-R	Good
Coleman	2010	Retrospective cohort	RYGB	32 ± 12 months	110	49.5 ± 7.7	Beck Depression Inventory	Depending on definition WL success/failure	Poor
Dymek	2001	Prospective cohort	RYGB	1–3 weeks, 6 months	32	56.7 ± 11.5	Beck Depression Inventory	No difference	Poor
Fox	2015	Retrospective cohort	RYGB	12 months	97	45.2 ± 7.1	Beck Depression Inventory	No difference	Poor
Hatoum	2009	Retrospective cohort	RYGB	12 months	246	52.3 ± 8.7	Present or absent during preop evaluation	No difference	Good
Kops	2020	Prospective cohort	RYGB	3–60 months	108	48.2 ± 7.2	Structured Clinical Interview for DSM-IV Disorder	No difference	Poor
Kruseman[a]	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Hospital Anxiety and Depression Scale	No difference	Good
Lai	2019	Prospective cohort	RYGB	3 and 6 months	76	44 ± 5.6	Hamilton Depression Scale	3 months: no difference 6 months: negative	Good
Lai	2021	Prospective cohort	RYGB	3, 6, and 24–30 months	76	44 ± 5.8	Hamilton Depression Scale	3 and 6 months: no difference 24–30 months: negative	Good
Lanyon	2007	Prospective cohort	RYGB	12.8 months	125	*n.a.*	Beck Depression Inventory	No difference	Poor
Lanza	2012	Retrospective cohort	RYGB	3 years	98	46.9 ± 8.2	Hospital Anxiety and Depression Scale	Negative	Good
Livhits	2010	Retrospective cohort	RYGB	40.1 ± 15.4 months	148	46.2	Not specified	No difference	Poor
Love	2008	Retrospective cohort	RYGB	6 and 12 months	116	*n.a.*	Usage of antidepressive medication	Negative	Good
Ma	2006	Retrospective cohort	RYGB	12 months	494	51.5 ± 8.5	Beck Depression Inventory	No difference	Poor

(Continues)

TABLE 3 (Continued)

Reference	Pub. Date	Study design	RYGB/ SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Marek	2017	Prospective cohort	RYGB	5 years	446	49.14 ± 9.50	According to DSM-5 criteria by semi-structured clinical interview	No difference	Poor
Sallet	2007	Prospective cohort	RYGB	6–36 months	216	45.9 ± 6.0	Beck Depression Inventory	No difference	Good
Semanscin-Doerr	2010	Prospective cohort	SG	1, 3, 6, 9, and 12 months	104	60.4 [31.4–129.1]	Semistructured psychiatric interview and Millon Behavioral Medicine Diagnostic or Symptom Checklist-90	No difference	Poor
White[a]	2015	Prospective cohort	RYGB	6, 12, and 24 months	357	51.2 ± .8.3	Beck Depression Inventory	No difference	Poor
Wise	2016	Retrospective cohort	RYGB	6 and 12 months	647	47.0 ± 8.5	Assessed with no specification	No difference	Poor
Wolfe	2006	Cross-sectional	RYGB	78.5 ± 35.7 weeks	93	52.5 ± 10.1	Frequency and severity of depression before and since surgery	No difference	Poor
Depression measured postoperatively									
Amundsen	2017	Case–control	RYGB	5 years	49	44.1	Beck Depression Inventory II	No difference	Good
Beck	2012	Cross-sectional	RYGB	23.2 months [14–30 months]	45	46.1 ± 5.8	Hospital Anxiety and Depression Scale	No difference	Good
Delin	1995	Cross-sectional	RYGB	24 months	20	*n.a.*	Beck Depression Inventory	Negative	Poor
Kruseman[a]	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Hospital Anxiety and Depression Scale	Negative	Good
Schag	2016	Cross-sectional	SG	48 ± 14 months	65	*n.a.*	Patient Health Questionnaire module Depression	No difference	Poor
Vanoh	2015	Cross-sectional	SG	9.8 months	43	45.5 ± 7.5	Beck Depression Inventory	No difference	Poor
Welch	2011	Cross-sectional	RYGB	917.1 ± 9 6.8 days	75	49.8 ± 6.9	Patient Health Questionnaire	No difference	Fair
White[a]	2015	Prospective cohort	RYGB	6, 12, and 24 months	357	51.2 ± .8.3	Beck Depression Inventory	6-month FU: 6 and 12 mnd negative, 24 mnd no difference 12-month FU: 12 mnd positive, 24 mnd no difference 24-month FU: no difference	Poor
Yanos	2015	Cross-sectional	RYGB	8.86 ± 3.59 years	97	53.3	Patient Health Questionnaire	No difference	Poor
Unclear when depression was measured									
Junior	2011	Retrospective cohort	RYGB	6, 12, 18, 24, 36, and 48 months	149	52.1 ± 7.7	Presence of depression, unclear when measured	Depended on WL definition	Poor
Susmallian	2019	Prospective cohort	SG	3 years	300	42.02 ± 5.03	Assessed with no specification, unclear when measured	Negative	Poor

Abbreviations: n.a., not available; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy.
[a]Depression measured both pre- and postoperatively.

TABLE 4 Overview of included studies that assessed binge eating as moderator for weight loss after surgery.

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Binge eating measured pre-operatively									
Alger-mayer	2009	Prospective cohort	RYGB	3, 6, 12, 24, 36, 48, 60, and 72 months	157	50.7 ± 8.0	Binge Eating Scale	No difference	Good
Ames	2017	Prospective cohort	RYGB	1 and 2 years	305	45.3 [32.7–83.1]	Questionnaire of Eating and Weight Patterns—Revised	No difference	Good
			SG	1 and 2 years	117	45.3 [35.5–77.1]	Questionnaire of Eating and Weight Patterns—Revised	No difference	
Ben-Porat[a]	2021	Prospective cohort	SG	3, 6, and 12 months	54	44.9 ± 4.9	Binge Eating Scale	No difference at all FU moments	Good
Bergh	2016	Prospective cohort	RYGB	12 months	230	44.9 ± 5.7	Survey for eating disorders (SED)	No difference	Good
Bianciardi	2021	Prospective cohort	SG	12 and 48 months	78	43.2 ± 6.0	Binge Eating Scale	No difference	Poor
Boan	2004	Prospective cohort	RYGB	6 months	40	52.9 ± 8.9	Binge Eating Scale	Positive	Poor
Bocchieri	2006	Prospective cohort	RYGB	79.9 ± 27.8 weeks	72	54.0 ± 9.3	Questionnaire of Eating and Weight Patterns or Questionnaire of Eating and Weight Patterns—Revised	No difference	Good
Brunault	2012	Cohort	SG	12 months	34	55.3 ± 10.2	Bulimic Investigatory Test	Negative for overall and symptom scores No difference with the severity score	Good
Coleman	2010	Retrospective cohort	RYGB	32 ± 12 months	110	49.5 ± 7.7	Structured interview (DSM-IV criteria)	Depending on definition WL success/failure	Poor
Crowley	2011	Retrospective cohort	RYGB	6 months	102	*n.a.*	Inventory of Binge Eating Situations	Negative	Poor
Dymek	2001	Prospective cohort	RYGB	1–3 weeks, 6 months	32	56.7 ± 11.5	Questionnaire on Eating and Weight Patterns—Revised	Negative	Poor
Fox	2015	Retrospective cohort	RYGB	12 months	97	45.2 ± 7.1	Assessed with no specification	No difference	Good
Fujioka	2008	Retrospective cohort	RYGB	12 and 24 months	121	48.9	Form with DSM-IV criteria	No difference	Poor
Green	2004	Prospective cohort	RYGB	6 months	65	54.8 ± 10.1	Questionnaire of Eating and Weight Patterns—Revised	Negative	Good
Kops	2020	Prospective cohort	RYGB	3–60 months	108	48.2 ± 7.2	Binge Eating Scale	3, 24, and 36 months: positive 6, 12, 48, and 60 months: no difference	Good
Latner	2004	Retrospective cohort	RYGB	16.4 months	65	54.1 ± 10.2	Eating disorder examination with supplemental BED questions (during semi-structured interview)	Positive	Good
Livhits	2010	Retrospective cohort	RYGB	40.1 ± 15.4 months	148	46.2	Binge Eating Scale	Negative	Poor
Luiz[a]	2016	Cross-sectional	RYGB	12 months	132	48.3 ± 7.9	Binge Eating Scale	No difference	Poor

(Continues)

TABLE 4 (Continued)

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Malone	2004	Prospective cohort	RYGB	3–36 months	109	*n.a.*	Binge Eating Scale	No difference	Good
Marek	2017	Prospective cohort	RYGB	5 years	446	49.14 ± 9.50	According to DSM-5 criteria by semi-structured clinical interview	Negative	Poor
Sallet	2007	Prospective cohort	RYGB	6–36 months	216	45.9 ± 6.0	Semi-structured interview according to DSM-IV	Negative	Good
Toussi	2009	Retrospective cohort	RYGB	24 months	67	49.91 ± 8.46	According to DSM-IV	Negative	Poor
White	2006	Prospective cohort	RYGB	12 months	139	*n.a.*	Eating Disorder Examination-Questionnaire	No difference	Poor
White	2010	Prospective cohort	RYGB	12 and 24 months	361	51.1 ± 8.3	Eating Disorder Examination-Questionnaire and DSM-IV criteria	No difference	Poor
Wolfe	2006	Cross-sectional	RYGB	78.5 ± 35.7 weeks	93	52.5 ± 10.1	Frequency of binge eating; y/n question	No difference	Poor
Binge eating measured postoperatively									
Beck	2012	Cross-sectional	RYGB	23.2 months [14–30 months]	45	46.1 ± 5.8	Self-made binge eating survey	Negative	Good
Ben-Porat[a]	2021	Prospective cohort	SG	3, 6, and 12 months	54	44.9 ± 4.9	Binge Eating Scale	12 months: no difference	Good
Garcia Diaz	2013	Prospective cohort	RYGB	6–24 months	45	44.4 ± 4.6	Questionnaire on Eating and Weight Patterns—Revised	No difference at all FU moments	Poor
Kalarchian	2002	Cross-sectional	RYGB	4 ± 1.5 years	99	49.3 ± 8.3	Eating Disorder Examination-Questionnaire	No difference	Poor
Kofman	2010	Cross-sectional	RYGB	4.2 years [3–10 years]	497	*n.a.*	Questionnaire of Eating and Weight Patterns—Revised	Negative	Poor
Luiz[a]	2016	Cross-sectional	RYGB	12 months	132	48.3 ± 7.9	Binge Eating Scale	Negative	Poor
Vanoh	2015	Cross-sectional	SG	9.8 months	43	*45.5* ± 7.5	Binge Eating Scale	No difference	Good
Welch	2011	Cross-sectional	RYGB	917.1 ± 9 6.8 days	75	49.8 ± 6.9	Two-item scale based on DSM-IV criteria	No difference	Fair

Abbreviations: BED, binge eating disorder; n.a., not available; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy.
[a]BED measured both pre- and postoperatively.

TABLE 5 Overview of included studies that assessed anxiety symptoms as moderator for weight loss after surgery.

Reference	Pub. date	Study design	RYGB/ SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Anxiety measured preoperatively									
Alfonsson	2014	Prospective cohort	RYGB	12 months	129	43.0 ± 4.0	Hospital Anxiety and Depression Scale	No difference	Good
Ames	2017	Prospective cohort	RYGB	1 and 2 years	305	45.3 [32.7–83.1]	Generalized Anxiety Disorder-7	No difference	Good
			SG	1 and 2 years	117	45.3 [35.5–77.1]	Generalized Anxiety Disorder-7	No difference	
Bergh	2016	Prospective cohort	RYGB	12 months	230	44.9 ± 5.7	Hospital Anxiety and Depression Scale	No difference	Good
Brunault	2012	Cohort	SG	12 months	34	55.3 ± 10.2	Hamilton Anxiety Rating Scale and four SCL-90-R subscales: anxiety, obsessive–compulsive, phobic anxiety and interpersonal sensitivity	Negative for phobic anxiety No difference for other forms of anxiety	Good
Fox	2015	Retrospective cohort	RYGB	12 months	97	45.2 ± 7.1	State–Trait Anxiety Inventory	No difference	Poor
Kalarchian	2008	Prospective cohort	RYBG	6 months	213	51.4 ± 9.6	Structured Clinical Interview for the DSM-IV	Negative	Poor
Kruseman[a]	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Hospital Anxiety and Depression Scale	No difference	Good
Lai	2019	Prospective cohort	RYGB	3 and 6 months	76	44 ± 5.6	Hamilton Anxiety Scale	No difference	Good
Lai	2021	Prospective cohort	RYGB	3, 6 and 24–30 months	76	44 ± 5.8	Hamilton Anxiety Scale	No difference	Good
Lanyon	2007	Prospective cohort	RYGB	12.8 months	125	*n.a.*	Assessed with no specification	No difference	Poor
Marek	2017	Prospective cohort	RYGB	5 years	446	49.14 ± 9.50	According to DSM-5 criteria by semi-structured clinical interview	No difference	Poor
Sallet	2007	Prospective cohort	RYGB	6–36 months	216	45.9 ± 6.0	Hamilton Anxiety Scale	No difference	Good
Wise	2016	Retrospective cohort	RYGB	6 and 12 months	647	47.0 ± 8.5	Assessed with no specification	No difference	Poor
Wolfe	2006	Cross-sectional	RYGB	78.5 ± 35.7 weeks	93	52.5 ± 10.1	Frequency and severity of anxiety before and since surgery	No difference	Poor
Anxiety measured postoperatively									
Beck	2012	Cross-sectional	RYGB	23.2 months [14–30 months]	45	46.1 ± 5.8	Hospital Anxiety and Depression Scale	No difference	Good
Delin	1995	Cross-sectional	RYGB	24 months	20	*n.a.*	IPAT Anxiety Scale Questionnaire	No difference	Poor
Kruseman[a]	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Hospital Anxiety and Depression Scale	No difference	Good

Abbreviations: n.a., not available; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy.
[a]Anxiety measured both pre- and postoperatively.

TABLE 6 Overview of included studies that assessed body image as moderator for weight loss after surgery.

Reference	Pub. Date	Study design	RYGB/ SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Body image measured preoperatively									
Bergh	2016	Prospective cohort	RYGB	12 months	230	44.9 ± 5.7	Body Areas Satisfaction Scale (BASS)	No difference	Poor
Hrabosky	2006	Prospective cohort	RYGB	6 and 12 month	109	51.5 ± 7.6	Body Shape Questionnaire and Shape and Weight concern subscales of the Eating Disorder Examination-Questionnaire (EDE-Q)	No difference	Poor
Change in body image									
Teufel	2012	Prospective cohort	SG	1 year	51	51.3 ± 8.7	Body Image Questionnaire, BIQ-20	No difference	Poor

Abbreviations: RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy.

TABLE 7 Overview of included studies that assessed quality of life as moderator for weight loss after surgery.

Reference	Pub. date	Study design	RYGB/ SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
QoL measured preoperatively									
Alger-mayer	2009	Prospective cohort	RYGB	3, 6, 12, 24, 36, 48, 60, and 72 months	157	50.7 ± 8.0	SF-36	1 year: no difference 4 years: no difference 5- and 6-year negative: general health 5-year positive: physical health 6-year positive: pain	Poor
Kruseman[a]	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Nottingham Health Profile	No difference	Good
QoL measured postoperatively									
Amundsen	2017	Case–control	RYGB	5 years	49	44.1	Impact of Weight on Quality of Life-Lite	Positive	Good
Kofman	2010	Cross-sectional	RYGB	4.2 years [3–10 years]	497	*n.a.*	Moorehead–Ardelt Quality of Life Questionnaire II	Positive	Poor
Kruseman[a]	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Nottingham Health Profile	Positive	Good

Abbreviations: n.a., not available; QoL, quality of life; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy.
[a]QoL measured both pre- and postoperatively.

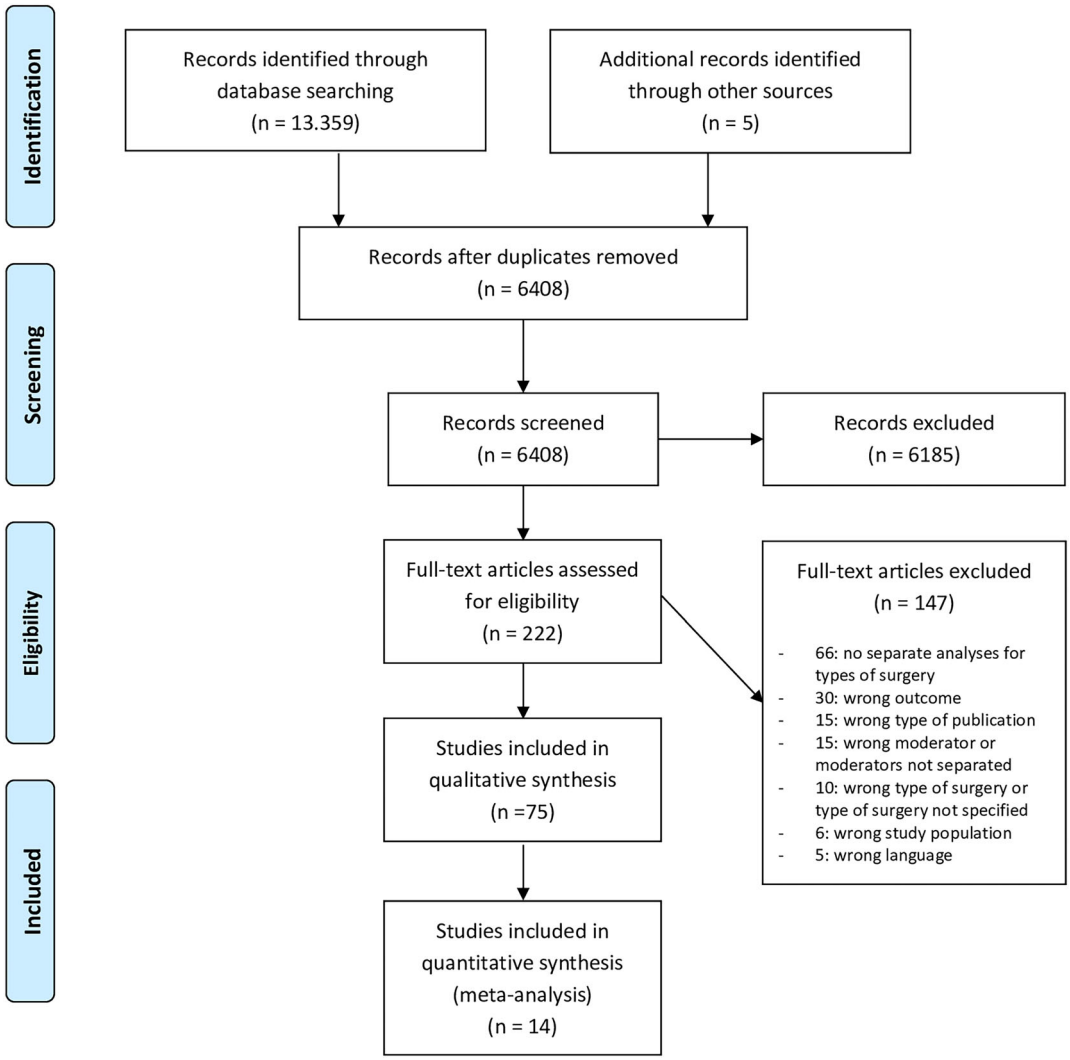

FIGURE 1 PRISMA flow diagram.

Three studies provided sufficient data for a meta-analysis, but due to differences in follow-up moments, a meta-analysis could not be conducted, and a review was carried out. In one study, higher preoperative PA was associated with increased weight loss,[43] while two other studies found no significant relationship between preoperative PA and weight loss.[65,66] Change in PA was linked to higher weight loss in three studies,[66,72,79] while one study found no such association.[43] In 12 studies, postoperative PA as well as PA intensity were predictive of higher weight loss,[41,63,66–69,71,73–77] whereas in five studies, postoperative PA and frequency of PA were not related to weight loss.[40,64,70,74,78] Ten out of 21 studies had a low risk of bias.

3.6 | Depressive symptoms

A total of 35 studies analyzed the effect of self-reported depressive symptoms on weight loss[26–32,40,41,43,56,62,63,70,76,78,80–98] (Table 3).

3.6.1 | RYGB

A total of 30 studies evaluated the association between depressive symptoms and weight loss following RYGB. Among these, 22 studies used in total six different validated questionnaires to assess depressive symptoms.[26,30–32,40,41,43,62,76,78,82,84–92,94,95] Other studies performed structured interviews based on the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders) criteria,[28] or DSM-V criteria,[29] measured frequency and severity of symptoms,[70] or considered the use of antidepressants.[83] It was unclear how depression was measured in five studies.[27,56,63,80,81] The number of patients included in these studies ranged from 20 to 647, the mean BMI from 38.8 to 56.7 kg/m^2, and the maximum duration of follow-up was 8.9 years.

Twenty-seven studies did not provide sufficient data for a meta-analysis and were consequently included in the review. One of these 27 studies had to be excluded due to the use of %TWL as outcome, or parameter, and despite multiple requests for additional information, the authors did not respond.[90] In the context of preoperative

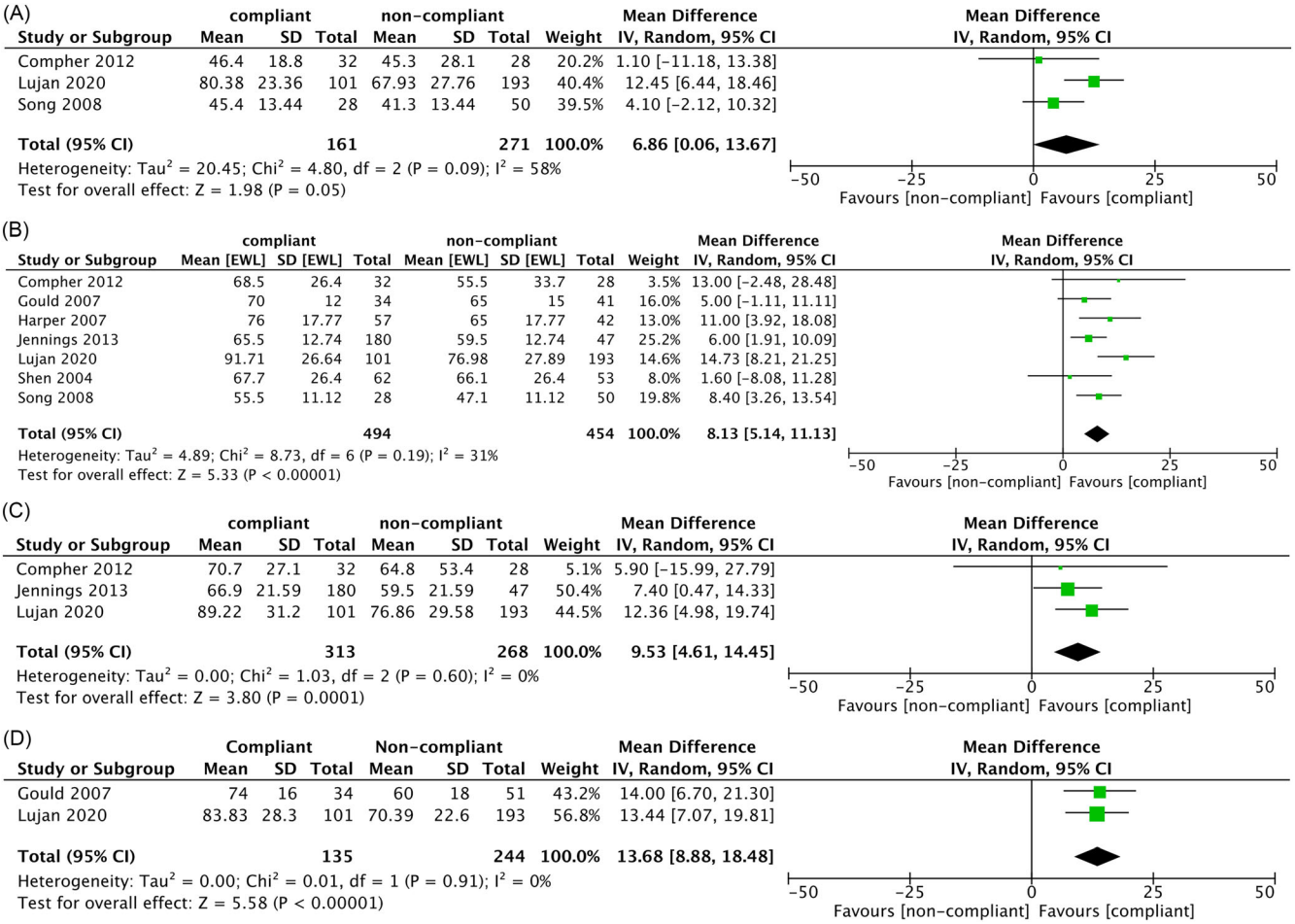

FIGURE 2 Meta-analysis of the association of postoperative compliance and % excess weight loss after RYGB. (A) 6 months after RYGB. (B) 12 months after RYGB. (C) 24 months after RYGB. (D) 36 months after RYGB.

depressive symptoms, four studies showed an inverse association with weight loss,[83,84,86,92] while in 16 other studies, no significant correlation was observed.[23,26,31–34,55,62,69,80,81,84,86,88–90] When assessing postoperative depressive symptoms, two studies reported lower weight loss among patients with depressive symptoms,[40,94] whereas five studies revealed no difference in weight loss outcomes.[41,76,82,95,96] In one study, the impact of depressive symptoms on weight loss was found to be contingent on how successful weight loss was defined.[62] Ten out of 28 studies were deemed to have a low risk of bias.

Meta-analyses involving three studies illustrated no significant difference in %EWL between patients with and without depressive symptoms before RYGB[26,30,88] (Figure 3A–C). Difference in %EWL ranged from 0.90% at 6 months to 2.56% at 3 months' follow-up. Heterogeneity (I^2) ranged from 0% at 3 months to 46% at 24 months. All three studies exhibited a low risk of bias. Due to high heterogeneity at 6- and 36-month follow-up ($I^2 = 72\%$ and 87%, respectively), these meta-analyses were excluded.

3.6.2 | SG

Six studies evaluated the relationship between depressive symptoms and weight loss following SG[27,91,93,96–98] using four different questionnaires. Depressive symptoms were assessed prior to surgery in three studies[91,97,98] and post-surgery in two studies.[93,96] In one study, there was a lack of clarity regarding the methodology and timing employed for the assessment of depression.[27] The patient populations ranged from 34 to 300 individuals, the mean BMI from 42 to 60.4 kg/m^2, and the maximum duration of follow-up was 4 years.

A single study provided sufficient data for a meta-analysis.[97] Consequently, a meta-analysis was unfeasible due to the limited data availability. In two studies, preoperative depressive symptoms were found to have no impact on weight loss after SG.[91,97] However, one study found that depressive symptoms were associated with lower weight loss when assessed with the Beck Depression Inventory, although there was no relationship with weight loss when assessed with the Symptom Checklist-90-Revised.[98] Postoperative depressive

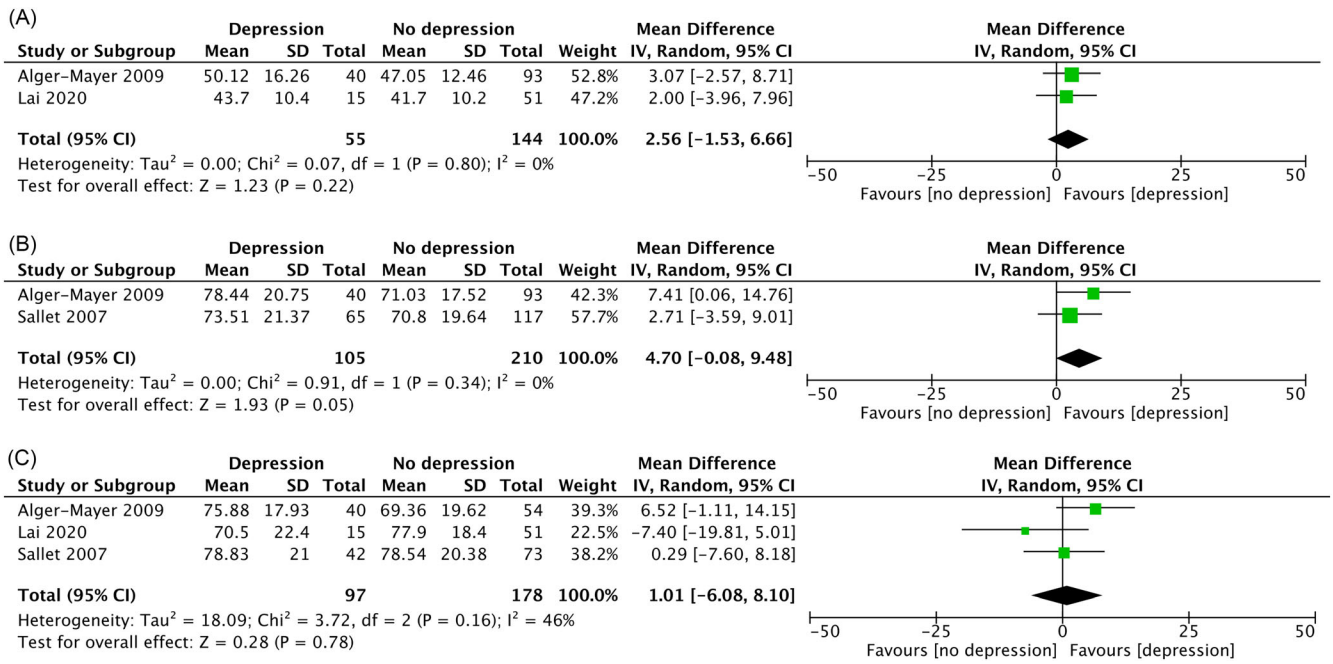

FIGURE 3 Meta-analysis of the association of preoperative depressive symptoms and % excess weight loss after RYGB. (A) 3 months after RYGB. (B) 12 months after RYGB. (C) 24 months after RYGB.

symptoms were not associated with weight loss in two studies.[93,96] The study with unclear measurement timing suggested that depressive symptoms were related to less weight loss.[27] Two out of six studies had a low risk of bias.

3.7 | Binge eating

Thirty-one studies assessed the association of binge eating symptomatology with weight loss after bariatric-metabolic surgery[28–31,42,43,62,63,65,67,70,76,87,88,91,93,95,98–111] (Table 4).

3.7.1 | 3.6.1. RYGB

A total of 27 studies evaluated the presence of binge eating on weight loss following RYGB.[28–31,42,43,62,63,65,67,70,76,87,88,91,95,100–110] Binge eating symptomatology was assessed using validated questionnaires in 17 studies.[28,30,42,43,63,65,87,91,100–102,104–106,108–110] Other studies performed a structured interview based on the DSM-IV criteria,[62,76,88,101,103,107] the DSM-V criteria,[29] did not specify a particular questionnaire,[31,67] assessed the frequency of binge eating,[70] or used a self-designed eating survey.[95] These studies encompassed patient populations ranging from 32 to 497 individuals, mean BMI ranged from 44.4 to 56.7 kg/m^2, and the maximum follow-up duration was 6 years.

Twenty-one studies lacked adequate data for inclusion in the meta-analysis, whereas one study possessed the requisite data for incorporation[108]; however, this meta-analysis had to be excluded due to significant heterogeneity, necessitating the inclusion of the study in the review. Preoperative binge eating was related to reduced weight loss in seven studies,[29,63,87,88,104,107,108] and associated with increased weight loss in two studies,[65,67] while not showing a significant relationship with weight loss in eight studies.[31,43,70,91,100,101,103,106] Postoperative binge eating was associated with less weight loss in two studies[42,95] and was not significantly associated with weight loss in two other studies.[76,109] In one study, patients classified as successful (<30 kg/m^2 at 1-year post-RYGB) were less likely to report binge eating, although this trend disappeared when alternative definitions of successful weight loss were applied.[62] Eight out of 22 studies exhibited a low risk of bias.

Meta-analysis including five studies showed that preoperative symptoms of binge eating were associated with greater weight loss at 24- and 36-month follow-up. The mean difference in %EWL was 7.97% (95% CI 2.75–13.20, $I^2 = 0\%$) for the 24-month follow-up and 11.79% (95% CI 1.44–22.15, $I^2 = 0\%$) for the 36-month follow-up (Figure 4A–D). No significant differences in %EWL were observed at 3 and 60 months. Due to high heterogeneity at 6- and 12-month follow-up ($I^2 = 61\%$ and 80%, respectively), these meta-analyses were excluded. Four out of five studies had a low risk of bias.

A meta-analysis including two studies illustrated that patients with postoperative binge eating symptoms experienced less weight loss compared to those without such symptoms. The mean difference in %EWL was −11.92% (95% CI −20.04 to −3.80, $I^2 = 0\%$; Figure 5). Both studies had a high risk of bias.

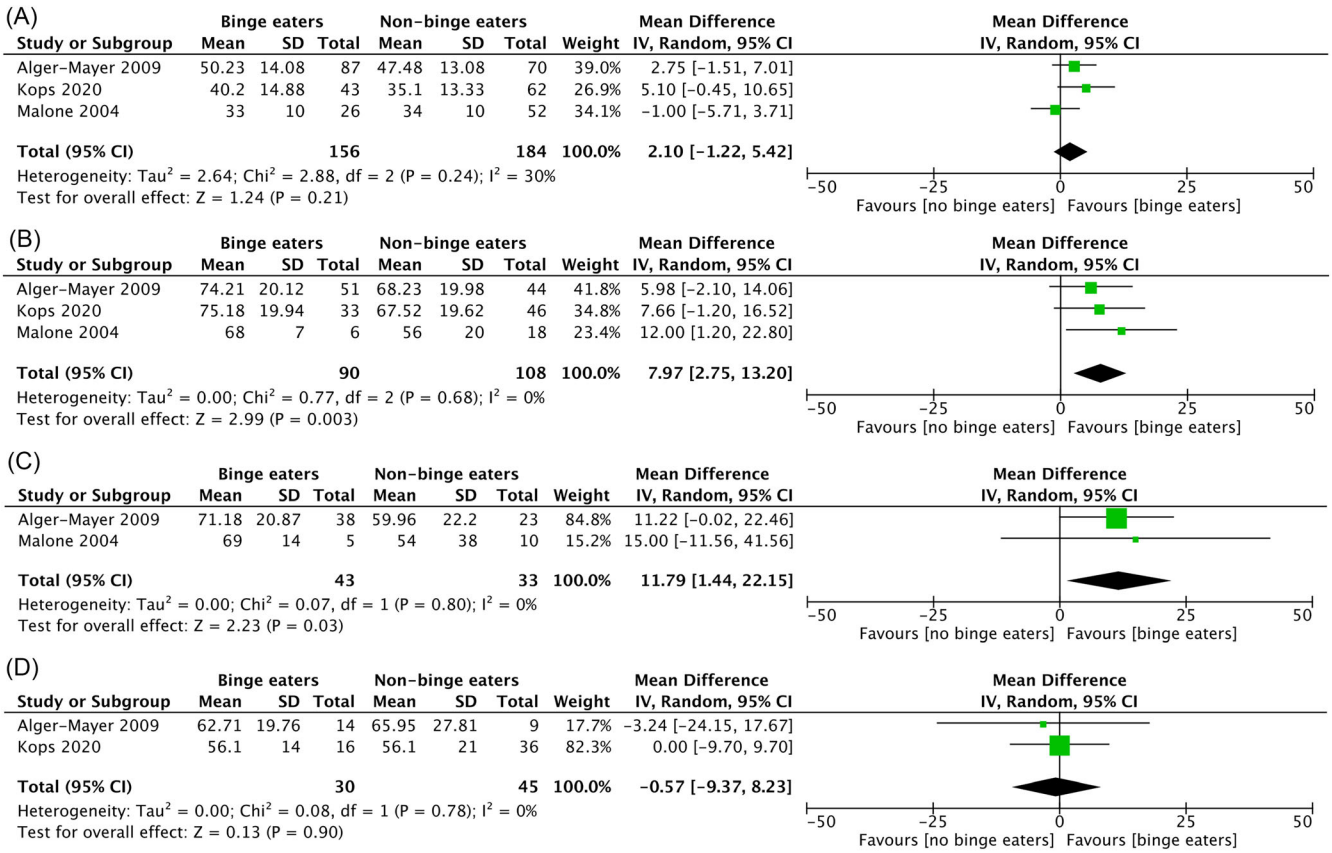

FIGURE 4 Meta-analysis of the association of preoperative binge eating symptomatology and % excess weight loss after RYGB. (A) 3 months after RYGB. (B) 24 months after RYGB. (C) 36 months after RYGB. (D) 60 months after RYGB.

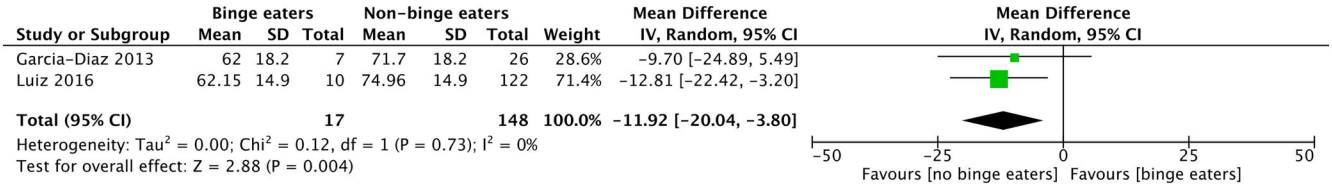

FIGURE 5 Meta-analysis of the association of postoperative binge eating symptomatology and %excess weight loss 12 months after RYGB.

3.7.2 | SG

A total of five studies evaluated the association between binge eating symptomatology and weight loss after SG using validated questionnaires.[91,93,98,99,111] These studies included between 34 and 117 patients, with mean BMIs ranging from 43.2 to 55.3 kg/m^2, and had a maximum follow-up period of 4 years.

The available data were inadequate to conduct a meta-analysis. Among these studies, one indicated that preoperative binge eating negatively impacted weight loss.[98] In contrast, the other three studies reported no significant relationship between preoperative binge eating and weight loss.[91,99,111] Furthermore, postoperative binge eating was not associated with weight loss in two studies.[93,111] Four out of the five studies exhibited a low risk of bias.

3.8 | Anxiety

Sixteen studies examined the impact of anxiety on weight loss following surgery[26,29,31,32,40,43,70,81,88,89,91,92,94,95,98,112] (Table 5). Among these, 11 studies employed a validated questionnaire to assess anxiety,[26,31,40,43,88,89,91,92,94,95,98] two utilized a (semi-)structured interview,[29,112] one inquired about the frequency and severity of anxiety,[70] and two studies did not specify the methodology for measuring anxiety.[32,81] The study populations ranged from 20 to 647 patients, with mean BMIs from 43.0 to 55.3 kg/m^2, and the maximum follow-up duration was 8 years.

The available data were insufficient for conducting a meta-analysis. In the case of RYGB, preoperative anxiety was found to be associated with reduced weight loss in only one study,[112] and in the

context of SG, a single study reported that only the subscale of phobic anxiety had a negative impact on weight loss.[98] However, the remaining studies, comprising 12 related to preoperative anxiety and three related to postoperative anxiety, did not demonstrate any significant predictive power for weight loss after RYGB or SG.[26,29,31,32,40,43,70,81,88,89,91,92,94,95] Among these 16 studies, nine exhibited a low risk of bias.

3.9 | Body image

Three studies evaluated the association between body image and weight loss, employing distinct questionnaires for their assessments (Table 6).[43–45] The number of patients ranged from 51 to 230, the mean BMI from 44.9 to 51.5 kg/m^2, and the maximum follow-up duration reached 12 months.

The available data were insufficient to conduct a meta-analysis. Two studies reported no significant association between preoperative body image and weight loss following RYGB.[43,44] Similarly, no correlations were identified between the change in body image and weight loss after SG in the third study.[45] All three studies had a high risk of bias.

3.10 | QoL

Four studies evaluated the impact of QoL on weight loss after RYGB, each study utilizing a different questionnaire[30,40–42] (Table 7). The number of included patients ranged from 49 to 497, the mean BMI from 44.1 to 50.7 kg/m^2, and the maximum follow-up period was 8 years.

There were insufficient data to conduct a meta-analysis. Among the two studies that evaluated preoperative QoL, one observed a positive correlation, where higher preoperative QoL was linked to increased weight loss at 5- and 6-year post-surgery, specifically for the physical health and pain scales.[30] However, this relationship did not persist at 1- and 4-year follow-up.[30] Conversely, the second study found no association between preoperative QoL and weight loss.[40]

In the case of postoperative QoL, all three studies found that higher postoperative QoL corresponded to greater weight loss.[40–42] Two out of the four studies were classified as having a low risk of bias.

4 | DISCUSSION

This systematic review and meta-analysis aimed to provide a comprehensive overview of the mental and behavioral factors related to weight loss following primary RYGB and SG. The findings reveal that lower postoperative compliance and the presence of postoperative binge eating are associated with lower weight loss after RYGB. Additionally, preoperative binge eating symptoms are associated with higher %EWL 24 and 36 months after RYGB, while no discernible difference in weight loss was evident at 3 and 60 months. Conversely, no significant difference in weight loss after RYGB is observed when comparing patients with and without preoperative depressive symptoms. It is noteworthy that no meta-analyses could be conducted for preoperative compliance, PA, postoperative depressive symptoms, anxiety, body image, and QoL due to the lack of sufficient data.

4.1 | Compliance to follow-up

Recently updated international guidelines recommend increasing follow-up rates after bariatric-metabolic surgery, as it is associated with improved outcomes.[17] This review and meta-analysis substantiate this recommendation: meta-analyses for all follow-up moments (up to 36 months after surgery) demonstrated that postoperative compliant patients achieved a higher %EWL compared to noncompliant patients. There was either moderate or no heterogeneity between studies, and all studies that were included in the meta-analysis had a low risk of bias, enhancing the comparability of studies and the validity of the conclusions. However, the data do not allow to draw definitive conclusions regarding the direction of this effect. It remains unclear whether adherence to follow-up appointments leads to more weight loss, or if patients with more weight loss are more likely to attend these appointments. A prior review suggests that follow-up rates tend to be lower in patients with less weight loss.[18] Another plausible explanation is that motivated patients exhibit better compliance with consultations and lifestyle recommendations, which, in turn, results in more weight loss. This could result in a selection bias that may impact the study results.

4.2 | PA

The positive impact of compliance, especially in terms of higher weight loss among patients who engage in postoperative PA, aligns with the concept of compliance as a broader concept that encompasses various aspects of patient adherence. While this study did not provide sufficient data for a meta-analysis, most studies included in the systematic review highlighted a positive association between postoperative PA and weight loss after RYGB and SG. For instance, one study with a follow-up period of 2–5 years demonstrated a 15% greater weight loss in physically active patients.[75] Regular PA is strongly recommended for individuals undergoing bariatric-metabolic surgery. Engaging in PA not only contributes to physical improvements such as weight loss, weight maintenance, enhanced cardiorespiratory fitness, and improved insulin sensitivity but also has favorable effects on QoL and other psychological outcomes.[21] Therefore, consistent with previous guidelines, promoting PA should be a fundamental component of the care plan for all patients undergoing bariatric-metabolic surgery.[17]

4.3 | Binge eating

The current meta-analysis has revealed an association between postoperative binge eating and reduced weight loss following bariatric-metabolic surgery. However, it is important to note that the relationship between preoperative binge eating and postoperative weight loss appears to be inconsistent across various follow-up moments. This variability can be attributed, in part, to the heterogeneity observed among the included studies. One source of this heterogeneity is the diverse array of self-reported questionnaires employed to assess binge eating symptoms. Self-reported questionnaires may not be sufficiently reliable for accurately diagnosing and assessing binge eating. Instead, a (semi-)structured interview is considered the gold standard for evaluating disordered eating patterns.[113] Moreover, it is essential to recognize that the studies with long-term assessments (3–5 years) had relatively small sample sizes, ranging from 15 to 61 patients,[28,30,105] which may introduce potential bias. To enhance the quality of research in this area, we recommend using standardized questionnaires to ensure more consistent and comparable outcomes. Additionally, it is crucial to implement early detection strategies for postoperative disordered eating patterns and provide appropriate interventions to optimize patient outcomes.

4.4 | Depressive symptoms

No meta-analysis has been conducted to comprehensively assess the impact of depressive symptoms on weight loss following RYGB or any other bariatric-metabolic procedure. The findings from this study reveal that there is no discernible association between preoperative depression and weight loss at 3-, 12- and 24-month post-surgery. However, considerable heterogeneity was observed at the 6- and 36-month follow-up moments, which ultimately led to exclusion of these meta-analyses. Only four out of 27 studies (which were not included in the meta-analysis) reported an association between preoperative depressive symptoms and weight loss following RYGB. These findings suggest that preoperative depressive symptoms are not associated with weight loss outcomes following bariatric-metabolic surgery.

4.5 | Anxiety symptoms

Fourteen out of the 16 studies that were included in the systematic review reported that symptoms of anxiety, either before or after surgery, were not significantly associated with weight loss following bariatric-metabolic surgery. These findings align with the results of another recent systematic review, which similarly concluded that there is no clear correlation between changes in BMI after bariatric-metabolic surgery and the presence of anxiety.[114] Although the available data did not permit a meta-analysis in the current study, the collective evidence suggests that anxiety is unlikely to lead to reduced postoperative weight loss. Therefore, it is important to emphasize that patients with mood disorders, including depression and anxiety, should not be automatically denied from consideration for bariatric-metabolic surgery.

4.6 | Body image

All three included studies consistently revealed no significant association between preoperative body image or change in body image and postoperative weight loss. Notably, these studies had relatively brief follow-up periods, with a maximum of 12 months, and were found to have a high risk of bias. Given these limitations, it is not feasible to definitively determine the existence of a significant relationship between body image and weight loss outcomes following bariatric-metabolic surgery.

4.7 | QoL

Current review suggests that higher levels of postoperative, rather than preoperative, QoL are associated with higher weight loss after bariatric-metabolic surgery. However, it remains challenging to distinguish whether higher QoL leads to increased weight loss, or conversely, whether the weight loss achieved through bariatric-metabolic surgery results in enhanced QoL. This dynamic is complex, and it is worth noting that previous research has already well established that weight loss following bariatric-metabolic surgery is associated with improvements in QoL.[115,116]

4.8 | Treatment prior to surgery

The impact of psychological factors on the outcomes of bariatric-metabolic surgery is complex and requires careful consideration. In accordance with international guidelines, it is common practice for patients with known or suspected psychiatric illness, such as severe depressive symptoms or binge eating, to undergo formal mental health evaluation before being accepted for surgery.[17] It is crucial to acknowledge that the effects of psychological diagnoses on bariatric-metabolic surgery outcomes may vary between pre- and postoperative diagnoses. While preoperative treatments may positively impact patient outcomes, focusing solely on this phase fails to provide a comprehensive understanding. Therefore, the present review and meta-analysis separately analyzed pre- and postoperative psychological factors and therefore provides a more nuanced perspective on the role of psychological factors in bariatric-metabolic surgery.

4.9 | Risk of bias

Most studies exhibited a high risk of bias, primarily due to incomplete follow-up data and substantial baseline differences between compared cohorts. This disparity can be attributed to the fact that

psychological factors cannot be randomized, which increases the likelihood of having different cohorts at baseline. To address this issue, case–control studies could be conducted, where patients with psychological disorders are matched with those without that disorder. It is also known that loss to follow-up rates are high among patients who have undergone bariatric-metabolic surgery,[117,118] as was affirmed in the current risk of bias assessment and could lead to inadequate data and results. To address this, prospective trials should be designed with a strong emphasis on achieving and maintaining higher follow-up rates. Despite these challenges, it is important to note that many of the included studies demonstrated a strong methodological quality with a low risk of bias, lending reliability to their results.

4.10 | Heterogeneity

The high heterogeneity observed in several meta-analyses can be attributed to the diverse methodologies used in the included studies, making direct comparisons difficult. To address this challenge in future research, the adoption of more gold-standard assessments and increased collaboration among researchers could enhance study comparability and reduce heterogeneity.

4.11 | Strengths and limitations

A significant strength of this study is the approach of conducting separate meta-analyses for each follow-up moment. Since weight loss after bariatric-metabolic surgery is strongly dependent on the time since surgery, this method allows for a precise examination of the factors that influence weight loss at different postoperative intervals. Furthermore, RYGB and SG were analyzed separately, recognizing that these two surgical procedures lead to varying weight loss outcomes.[46] However, due to the limited published literature concerning SG, the conduct of meta-analyses was only feasible for RYGB. In addition, 66 articles were excluded from this study because they did not present results independently for different types of surgery, for example, combined data for RYGB and laparoscopic adjustable gastric banding (Figure 1).

One of the limitations of this review and meta-analysis is that it solely focuses on weight loss as outcome parameter. While many studies primarily emphasize weight loss as the key outcome, it is crucial to question whether this is the most important indicator. Other outcomes, such as the resolution or improvement of associated medical conditions, medication usage, and QoL, as well as societal outcomes like absenteeism and premature death, may hold equal or even greater significance. Consequently, it is imperative to allocate more attention to these multifaceted aspects of bariatric-metabolic surgery in future research. Moreover, it is important to acknowledge that the predominant inclusion of qualitative studies (75 in total) in this study, compared to a smaller number of quantitative studies (14), may limit the robustness of the conclusions. Most of these studies were conducted in the past decade, a period when the use of %EWL as a standardized metric for weight loss evaluation was not as established as per current guidelines. This has inevitably led to a greater representation of qualitative research in our analysis. While qualitative studies offer valuable insights into patient experiences and perspectives, quantitative studies are typically lauded for their ability to yield more quantifiable and generalizable results. In light of this, future meta-analyses could enhance their methodological rigor by strictly adhering to contemporary guidelines for outcome reporting in bariatric-metabolic surgery, thereby ensuring a more balanced inclusion of quantitative data.[119] Additionally, it is important to note that mental disorders were often diagnosed using self-report questionnaires. This approach is suboptimal for making precise diagnoses and may have introduced notable bias into the data and, consequently, the study's findings. Lastly, the presence of range restriction, wherein the significant impact of bariatric-metabolic procedures on postoperative weight loss outcomes, coupled with the use of a dichotomous diagnostic variable, may have constrained the variability of our data. Consequently, this limitation could potentially obscure the detection of associations between psychological factors and postoperative weight loss, thereby influencing the comprehensive interpretation and generalizability of our findings within the larger context of the literature and clinical implications. To address range restriction, future research could adopt strategies to enhance the study's generalizability. These strategies include employing longitudinal designs with multiple assessment points in both pre- and postoperative periods, utilizing continuous (gold-standard) measures for psychiatric symptoms, and incorporating outcome measures beyond weight loss.

5 | CONCLUSION

This study aimed to comprehensively review and analyze the associations between several mental and behavioral factors and weight loss following bariatric-metabolic surgery. The literature reveals high heterogeneity between studies, particularly in the methods used to assess psychological factors, with a common reliance on self-reported questionnaires rather than the gold-standard assessments. Nonetheless, based on the findings of this study, a trend emerges suggesting that the presence of postoperative binge eating symptoms and lower postoperative compliance may be associated with less weight loss after bariatric-metabolic surgery. Additionally, preoperative depressive symptoms and binge eating do not seem to significantly impact weight loss.

Predicting post-surgery outcomes solely based on preoperative mental and behavioral factors is challenging. Therefore, decisions regarding a patient's eligibility for bariatric-metabolic surgery should not be based on a single psychological diagnosis or questionnaire alone. Rather, a comprehensive evaluation conducted by a multidisciplinary team, which includes a mental health professional, should be the standard. Early detection of postoperative binge eating symptoms is advised for, as this seems to be associated with lower weight loss.

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CONFLICT OF INTEREST STATEMENT

Jacobs and Monpellier receive salary from the Nederlandse Obesitas Kliniek. The other authors declare that they have no conflict of interest.

ORCID

Anne Jacobs https://orcid.org/0000-0002-6375-0111

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SUPPORTING INFORMATION

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

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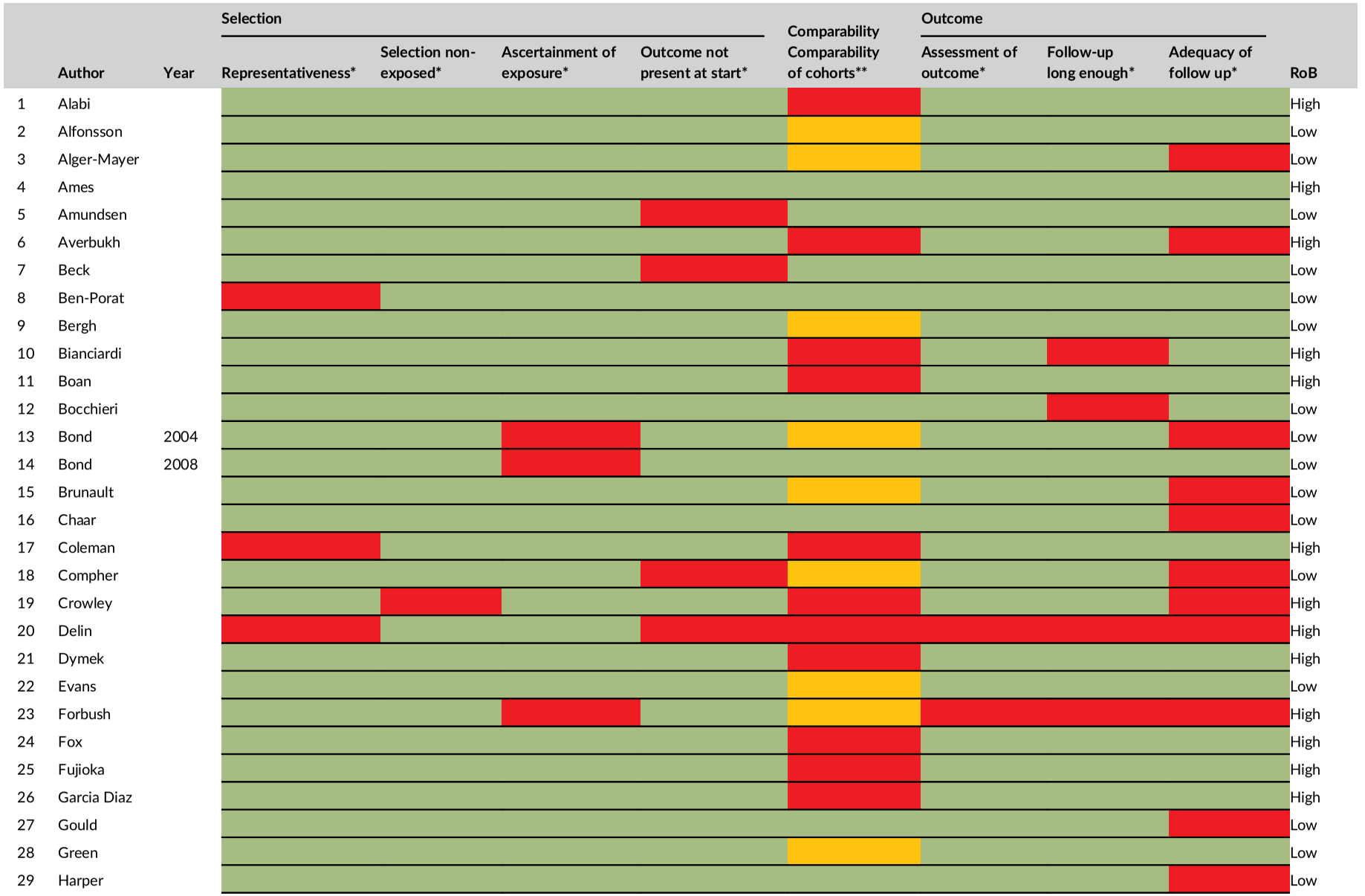
APPENDIX A



	Author	Year	Selection: Representativeness*	Selection: Selection non-exposed*	Selection: Ascertainment of exposure*	Selection: Outcome not present at start*	Comparability: Comparability of cohorts**	Outcome: Assessment of outcome*	Outcome: Follow-up long enough*	Outcome: Adequacy of follow up*	RoB
1	Alabi										High
2	Alfonsson										Low
3	Alger-Mayer										Low
4	Ames										High
5	Amundsen										Low
6	Averbukh										High
7	Beck										Low
8	Ben-Porat										Low
9	Bergh										Low
10	Bianciardi										High
11	Boan										High
12	Bocchieri										Low
13	Bond	2004									Low
14	Bond	2008									Low
15	Brunault										Low
16	Chaar										Low
17	Coleman										High
18	Compher										Low
19	Crowley										High
20	Delin										High
21	Dymek										High
22	Evans										Low
23	Forbush										High
24	Fox										High
25	Fujioka										High
26	Garcia Diaz										High
27	Gould										Low
28	Green										Low
29	Harper										Low

	Author	Year	Selection				Comparability	Outcome			RoB
			Representativeness*	Selection non-exposed*	Ascertainment of exposure*	Outcome not present at start*	Comparability of cohorts**	Assessment of outcome*	Follow-up long enough*	Adequacy of follow up*	
30	Hatoum										Low
31	Herman										High
32	Hildebrandt										High
33	Hrabosky										High
34	Jennings										Low
35	Josbeno										Medium
36	Junior										High
37	Kalarchian	2002									High
38	Kalarchian	2008									High
39	Kofman										High
40	Kops										Low
41	Kruseman										Low
42	Lai	2019									Low
43	Lai	2020									Low
44	Lanyon										High
45	Lanza										Low
46	Latner										Medium
47	Livhits										High
48	Love										Low
49	Luiz										High
50	Lujan										Low
51	Ma										High
52	Malone										Low
53	Marek										Low
54	Monpellier										Low
55	Orth										High
56	Robinson										High
57	Rosenberger										Low
58	Sallet										Low
59	Schag										High
60	Sesmanscin Doerr										High
61	Shen										Low

(Continues)

	Author	Year	Selection: Representativeness*	Selection: Selection non-exposed*	Selection: Ascertainment of exposure*	Selection: Outcome not present at start*	Comparability: Comparability of cohorts**	Outcome: Assessment of outcome*	Outcome: Follow-up long enough*	Outcome: Adequacy of follow up*	RoB
62	Song		★	★	★	★	★★	★	★	☆	Low
63	Susmallian		★	★	☆	★	☆☆	★	★	★	High
64	Teufel		★	★	★	★	☆☆	★	★	★	High
65	Toussi		☆	★	★	★	☆☆	★	★	★	High
66	Vanoh		★	★	★	☆	★★	★	★	☆	Low
67	Wefers		★	★	★	★	☆☆	★	★	★	High
68	Welch	2008	★	★	☆	☆	★★	★	★	☆	Medium
69	Welch	2011	☆	★	★	★	★★	★	★	☆	Low
70	White	2006	☆	★	★	★	☆☆	★	★	★	High
71	White	2010	★	☆	★	★	★★	☆	★	☆	High
72	White	2015	★	★	★	★	★★	☆	★	☆	High
73	Wise		★	☆	★	★	☆☆	☆	☆	☆	High
74	Wolfe		★	☆	☆	☆	★★	☆	☆	★	High
75	Yanos		★	★	★	☆	★★	☆	☆	☆	High

	All points
	1 out of 2 points
	No points
*	Amount of points to be given per subcategory

RoB:	Risk of Bias	
Low	(good quality):	3 or 4 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain
Medium	(fair quality):	2 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain
High	(poor quality):	0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 or 1 stars in outcome/exposure domain