Carving out success: identifying factors associated with metabolic and bariatric surgery outcomes

Jacobs, A.

CARVING OUT SUCCESS

Identifying factors associated with metabolic and bariatric surgery outcomes

Anne Jacobs

Carving out success – Identifying factors associated with metabolic and bariatric surgery outcomes
PhD thesis, Leiden University, Leiden, The Netherlands

Provided by thesis specialist Ridderprint, ridderprint.nl
Printing: Ridderprint
Layout and design: Erwin Timmerman, persoonlijkproefschrift.nl
ISBN: 978-94-6506-933-3

Financial support for this thesis by the Dutch Society for Metabolic and Bariatric Surgery, Celebrate Vitamins, WLS Products, Nederlandse Obesitas Kliniek, Dutch Obesity Academy, Elan Products|WLSvital, ABN AMRO and ChipSoft is gratefully acknowledged.

Carving out success

Identifying factors associated with metabolic and bariatric surgery outcomes

Proefschrift

ter verkrijging van
de graad van doctor aan de Universiteit Leiden,
op gezag van rector magnificus prof.dr.ir. H. Bijl,
volgens besluit van het college voor promoties
te verdedigen op woensdag 26 maart 2025
klokke 10:00 uur

door

Anne Jacobs
geboren te Den Helder
in 1996

Promotores:

prof. dr. R.A.E.M. Tollenaar
prof. dr. H. Pijl

Co-promotor:

dr. V.M. Monpellier	Nederlandse Obesitas Kliniek

Leden promotiecommissie:

prof. dr. I.P.J. Alwayn	
dr. I.M. Jazet	
prof. dr. J.W.M. Greve	Universiteit Maastricht
prof. dr. H.A. Cense	Rijksuniversiteit Groningen

Index

1

General introduction and outline of the thesis

Background

Obesity is a growing global health problem and affects individuals of all ages, genders and socioeconomic backgrounds. Obesity impacts physical and psychological well-being and poses a considerable burden on individuals and societies all over the world. Metabolic and bariatric surgery (MBS) has proven to be the most effective intervention for individuals living with severe obesity who have been unable to achieve sustainable weight loss through conservative methods [1]. This type of surgery entails multiple approaches that modify the gastrointestinal anatomy by reducing the capacity of the stomach and/or length of the small bowel. These anatomical changes also affect the body's gut hormone profile, including hormones such as Glucagon-Like Peptide-1 (GLP-1) and Peptide YY (PYY), as well as the gut microbiota and bile acids [2]. These alterations influence appetite, satiety and metabolism, thereby contributing to the weight loss process. However, the full extent of their impact is still being explored in ongoing research.

The introductory chapter of this thesis aims to provide an overview of the prevalence of overweight and obesity, their associated medical conditions, and the factors that are associated with obesity and weight loss after MBS.

Prevalence of overweight and obesity

Definitions and classifications

A healthy weight is defined by a Body Mass Index (BMI) ranging from 18.5 to 24.9 kg/m^2. A BMI above 25 is categorized as overweight. A BMI above 30 is classified as obesity, which is further divided into classes: Class I (BMI 30-34.9), Class II (BMI 35-39.9), and Class III (BMI ≥40). However, BMI alone does not fully capture the severity of obesity or its associated health risks; waist circumference and obesity-associated medical conditions must also be considered to assess overall weight-related health risks. Table 1 summarizes these health risks for adults according to the Dutch Guideline for Obesity [3].

Global Perspective

Overweight and obesity have reached epidemic proportions. On World Obesity Day in 2022, the World Health Organization reported that the global count of individuals affected by obesity exceeded 1 billion [4]. This number included an estimated 650 million adults, 340 million adolescents, and 39 million children. Over the past

decades, there has been a consistent upward trend in obesity rates, and this trajectory is still ongoing.

Table 1. Levels of weight-related health risk in adults.

BMI kg/m^2	**NO increase in waist circumference and no obesity-associated medical condition(s)**	**Increased waist circumference** Male ≥ 102cm Female ≥ 88cm	**Obesity-associated medical condition(s) present**
≥25 BMI <30 Overweight	Increased	High	
≥30 BMI <35 Obesity class I		Very high	
≥35 BMI <40 Obesity class II	Very high	Extremely high	
BMI ≥40 Obesity class III	Extremely high		

For individuals aged 70 and above, or those of ethnicities other than European or Middle-Eastern Mediterranean, different cut-off values apply.

Obesity in The Netherlands

Like this global trend, The Netherlands has also experienced a substantial increase in obesity prevalence. Data from the Netherlands Health Survey showed that 50.2% of the Dutch adult population is currently overweight, with 15.1% classified as having obesity [(5)]. These increasing numbers emphasize the need to address the obesity epidemic within the global as well as Dutch context.

Physical and psychological implications

Physical problems

Obesity, acknowledged by the WHO as a chronic disease, is a complex health problem. It is characterized by excessive adipose tissue accumulation, resulting in an elevated BMI with significant implications for physical and psychological well-being. Obesity is associated with various medical conditions, including cardiovascular diseases, type 2 diabetes, many types of cancer, obstructive sleep apnea, and osteoarthritis [(6)].

Psychological problems

In addition to the physical health problems, the psychological impact of obesity cannot be overlooked. Mental health disorders, such as depressive disorders,

anxiety disorders, substance use disorders and eating disorders, particularly binge eating disorders, are frequently observed in people living with obesity [7, 8]. The association between psychological disorders and obesity is often bidirectional. For example, research shows that individuals living with obesity have a 55% higher risk of developing depression, while those with depression have a 58% higher risk of developing obesity [9]. The lifetime prevalence of binge eating disorder in individuals living with obesity is estimated at 5.49% in women and 2.87% in men [10]. Among patients referred for MBS, 30% have previously received a DSM-5 diagnosis [11]. In addition, it is known that body dissatisfaction is more prevalent in individuals with obesity, when compared to people with a lower BMI [12].

Weight stigma is another challenge faced by individuals living with obesity. It refers to the negative stereotypes and discrimination faced by people with obesity, often based on incorrect beliefs about the causes of obesity [13]. This stigma can lead to harmful assumptions about their character, resulting in significant psychological, social, and physical consequences [13].

Understanding the associations between obesity and physical and psychological problems is crucial for developing strategies to effectively address the growing obesity epidemic. By recognizing obesity as a complex disease, healthcare professionals can implement comprehensive strategies that go beyond weight loss alone. These approaches should prioritize prevention and management of obesity-associated medical conditions to improve the overall well-being of individuals living with obesity.

The significance of addressing the obesity epidemic

Loss of healthy life years

The increasing prevalence of obesity has profound implications for public health. The total disease burden, expressed in Disability Adjusted Life Years and comprising both years lost due to premature mortality and years lived with health conditions weighted by their severity (disease year equivalents), in the Netherlands is attributed to 3.7% caused by severe obesity alone [14]. Additionally, prior research shows that severe obesity can lead up to 13.7 years of life lost [15].

Economic burden

Obesity places an enormous burden on healthcare systems and societies, resulting from increased healthcare costs and reduced work productivity [16, 17]. These costs include direct expenses associated with the treatment of obesity-related diseases, as well as indirect costs stemming from disability, absenteeism and unemployment [16-18]. Fortunately, many of the previously described obesity-related health problems can be reversed by achieving sufficient and sustained weight loss, thereby reducing risk of weight-related health problems [19].

Non-surgical treatment of overweight and obesity

Identifying underlying causes of obesity

According to the Dutch guideline released in 2023, it is crucial to first determine, optimize and treat the underlying causes and factors contributing to weight gain and maintenance of obesity [3]. Possible contributing factors may include lifestyle choices, socio-economic circumstances, psychological factors, medication usage, hormonal influences, hypothalamic function, and/or genetic predispositions.

Lifestyle advice and guidance

The cornerstone of every treatment plan is a healthy, varied diet with minimal processed food products, alongside adequate physical activity. In the Netherlands, individuals with overweight or class I obesity, particularly those with increased waist circumference and/or obesity-associated medical conditions, should be referred for combined lifestyle intervention (CLI). For patients with severe obesity (a BMI ≥40 kg/m^2) or those with a BMI ≥35 kg/m^2 combined with increased waist circumference and/or obesity-associated medical conditions, a specialized CLI where cognitive behavioral therapy is included can be considered [3].

Obesity management medication

Obesity management medication should be considered as an adjunct to a CLI for individuals with obesity (BMI ≥30 kg/m2) or overweight (BMI ≥27 kg/m2) with an increased waist circumference and/or obesity-associated medical conditions [3].

Surgical treatment of obesity

Indications for metabolic and bariatric surgery

Clinical practice guidelines are developed for, among other objectives, determining the indications for MBS [11, 20]. According to the Dutch Guideline, MBS is primarily recommended for individuals with severe obesity, typically defined as a BMI of 40 kg/m² or higher [11]. People with a BMI between 35 and 39.9 kg/m² may also be considered for surgery if they have significant obesity-associated medial conditions like type 2 diabetes, hypertension, dyslipidemia or obstructive sleep apnea. Recently, the criteria for considering MBS have expanded to include patients with a BMI of 30 to 34.9 kg/m² and type 2 diabetes with inadequate glycemic control despite optimal lifestyle changes and medical therapy [11].

Metabolic and bariatric procedures

In The Netherlands, the Roux-en-Y gastric bypass (RYGB) is the most performed procedure, followed by sleeve gastrectomy (SG) [21, 22]. However, the most frequently performed procedure varies by country, as shown in the IFSO Global Registry Report [22]. Indications for RYGB and SG are influenced by various factors, including the patient's BMI, obesity-associated medical conditions, surgical risks, and individual's or surgeon's preferences [20]. Both procedures are effective for achieving weight loss and improving obesity related medical problems [23]. Perioperative counselling programs that focus on behavioral change and monitor medical aspects are considered essential for optimal outcomes, regardless of the chosen procedure [20].

Outcomes after metabolic and bariatric surgery

The weight loss following MBS is dependent on the duration after the procedure and the surgical method that is performed [1, 24]. It is frequently quantified as a percentage of total weight loss (%TWL) using the following formula:

$$\%TWL = \frac{\text{preoperative weight} - \text{postoperative weight}}{\text{preoperative weight}} * 100$$

RYGB generally results in better weight loss outcomes compared to SG [23]. A prior randomized controlled trial observed that one year post-surgery, individuals who underwent RYGB had a %TWL of 29.9%, while those who had SG exhibited a %TWL of 28.4% [25]. At five-year follow-up, RYGB patients sustained a %TWL of 26.0%, whereas SG patients had a %TWL of 22.5% [25]. Weight loss seems to be higher in

the population studied in this thesis: data from the Nederlandse Obesitas Kliniek (Dutch Obesity Clinic, NOK), revealed that after one year, average %TWL was 32.1% for RYGB and 29.9% for SG [26]. After five years, these percentages were 27.2% and 24.7% TWL respectively for RYGB and SG.

Undoubtedly, MBS has been widely acknowledged for resulting in long-term sustained weight loss. However, the significance of MBS goes beyond weight reduction alone. MBS improves or resolves various obesity-related medical conditions, such as type 2 diabetes, hypertension, and obstructive sleep apnea [1, 19]. Moreover, individuals who have undergone MBS experience improvements in health-related quality of life and enhanced body image [27, 28]. Additionally, a recent meta-analysis comparing people living with obesity who underwent MBS to those who did not undergo MBS, revealed that MBS was correlated with a decreased overall occurrence of cancer, specifically obesity-related cancers, and cancer-related mortality [29]. So, it can be concluded that MBS leads to a reduction of health risk, which is important not only for individual well-being but also for the overall welfare of society.

Complications, adverse- and side effects of metabolic and bariatric surgery

While MBS is a highly effective treatment for severe obesity, offering numerous physiological and psychological benefits, it is equally important to acknowledge and address the complications, potential long-term adverse events and side effects in both the physical and psychological domains.

Apart from the immediate surgical complications like bleeding, leakage or infection, patients who undergo MBS may develop other significant physical consequences. There is a risk of nutritional deficiencies, especially in vitamins B12, D, calcium, and iron, which can cause conditions such as anemia, osteoporosis, or peripheral neuropathy [30]. To prevent this, the lifelong supplementation of tailored multivitamins is recommended [30]. Gastrointestinal side effects may also arise, such as dumping syndrome, gastro-esophageal reflux disease and alterations in stool patterns, all of which depend on the type of MBS performed [30, 31]. Furthermore, there is a potential risk for late complications, like bowel obstruction, ulcerations and perforations that may require additional surgical interventions [30].

There are also psychological complications associated with MBS, like the increased risk of suicide and substance misuse after surgery [32]. This underscores the need for continued psychological support after surgery.

Factors associated with weight loss

Individual variations in weight loss outcomes

Despite the reduction of health risk after MBS, it is crucial to acknowledge that the outcomes of surgical interventions can vary significantly among individuals. Approximately 10-15% of patients undergoing MBS experience suboptimal weight loss outcomes, often defined as achieving a %TWL of less than 20% within the first year after surgery [21, 33, 34]. Factors that have previously found to be related to lower postoperative weight loss include higher age, higher baseline weight, ethnicity, the presence of diabetes, and gastrointestinal hormone levels [35-38].

Preoperative prerequisites

International guidelines recommend that all individuals considering MBS undergo a thorough screening process [20]. This evaluation aims to detect potential risk factors that could affect treatment outcomes and long-term adherence and to facilitate proper postoperative monitoring. This step is crucial as achieving and maintaining weight loss post-surgery necessitates lifestyle improvements [20, 39]. Previous studies have established a correlation between non-adherence to these lifestyle changes and reduced weight loss following MBS [40, 41].

Several approaches have been utilized to identify patients who are willing to commit to the necessary lifestyle changes. Historically, clinics, insurance companies and policymakers have used the "last resort criterion" as a guideline, suggesting MBS only after traditional weight loss attempts or mandatory weight loss programs (MWPs) were unsuccessful [42]. The rationale behind MWPs is based on the belief that these programs would facilitate preoperative weight loss, help patients adapt to lifestyle modifications, and consequently result in greater postoperative weight loss [43]. However, over the past decade, the practice of requiring patients to follow a MWP before MBS has not shown to increase postoperative weight loss [42, 44]. Consequently, MWPs are no longer advised in the most recent guidelines [20, 45].

Another approach to identify patients' motivation involves requiring a certain amount of weight loss before surgery. Nonetheless, studies have reported inconsistent results on the effects of preoperative weight loss on weight loss after MBS [46-49]. The conflicting evidence highlights the complexity of this issue. While some patients may benefit from preoperative weight loss programs by adopting healthier

habits and preparing for lifestyle changes, others might not experience a significant impact on their postoperative outcomes. Therefore, the effectiveness of mandating preoperative weight loss as a criterion to predict postoperative success remains uncertain and needs further investigation.

Psychological factors

As discussed earlier in this introduction, psychopathological conditions are common among individuals who undergo MBS. The most prevalent mental health disorders in this population are depression and eating disorders, particularly binge eating disorders [7, 8]. A psychological evaluation by a licensed professional should always be part of the preoperative screening process before MBS [11, 20]. The Dutch guideline for bariatric psychology recommends to use the Cleveland Clinic Behavioral Rating System during the preoperative screening [50]. This tool provides a structured psychodiagnostic assessment to identify risk factors that may impede optimal weight loss outcomes or increase the likelihood of postoperative psychological complications. Psychological contraindications for MBS include confirmed eating disorders, an insufficiently extensive social network, and other psychiatric disorders that are unstable, severe, or untreated, such as severe depression, anxiety disorders, post-traumatic stress disorder, and substance abuse [11].

Prior studies have examined the relationship between mental health and weight loss following MBS; however, findings have been inconclusive. Some studies suggest that various mental and behavioral factors, such as eating disorder pathology, loss of control over eating, depressive symptoms, impulsiveness, and body avoidance, are associated with suboptimal postoperative weight loss [51-53]. Conversely, other studies suggest that these factors do not notably affect post-surgical weight loss [54-57].

Food and health literacy

Food literacy is defined as the combination of knowledge, skills, and behaviors required for planning, managing, selecting, preparing, and consuming food to meet dietary needs and regulate food intake [58]. Health literacy is the ability to locate, comprehend, and utilize information and services to make informed decisions and take actions regarding one's own health and that of others [59]. Despite guidelines suggesting that insufficient knowledge about healthy eating may require dietary counseling and potentially delay surgery, conducting a formal evaluation of food and health literacy is not standard clinical practice [11].

Assessing food and health literacy used to be challenging; however, measurement is now possible with validated questionnaires. Still, in the context of patients undergoing MBS, there is often a lack of information about their existing nutritional knowledge, dietary skills, and health literacy, resulting in a substantial knowledge gap [60]. Further research is needed to bridge this gap and to develop effective treatment programs or interventions for individuals undergoing MBS.

Aims and outline of the thesis

The studies in this thesis primarily aim to identify and analyze factors potentially influencing weight loss outcomes following MBS. It aims to establish the associations among these factors and to determine their clinical implications. Identifying these factors is crucial to recognize patients who are vulnerable to suboptimal (long-term) weight loss, thereby enabling to provide them with appropriate support.

The thesis comprises of three parts. **Part I** focuses on understanding psychological factors associated with weight loss after MBS. In **Chapter 2,** a systematic review and meta-analysis is reported, which examines preoperative and postoperative behavioral and mental factors related to weight loss following MBS. In **Chapter 3,** it is assessed whether a psychologic screening tool (the Cleveland Clinic Behavioral Rating System) can predict weight loss or postoperative compliance.

Part II of this thesis aims to evaluate if preoperative prerequisites for MBS are correlated with postoperative weight loss. **Chapter 4** reports the usefulness of mandatory weight loss programs considered a "last resort criterion" before MBS. In **Chapter 5** it is examined whether preoperative weight changes impact postoperative and total weight loss outcomes.

Part III aims to explore the preoperative levels of food and health literacy among people who undergo MBS and compares these levels with those of the general population, as detailed in **Chapter 6**.

Part IV integrates the findings of this thesis within a comprehensive framework discussed in **Chapter 7**, including a summery, clinical implications and future research perspectives. **Chapter 8** provides a Dutch summary of the thesis.

References

1. Sjöström L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. J Intern Med. 2013;273(3):219-34.
2. Tu J, Wang Y, Jin L, Huang W. Bile acids, gut microbiota and metabolic surgery. Front Endocrinol (Lausanne). 2022;13:929530.
3. Richtlijn overgewicht en obesitas bij volwassenen en kinderen: Federatie Medisch Specialisten; 2023 [Available from: https://richtlijnendatabase.nl/richtlijn/overgewicht_en_obesitas_bij_volwassenen_en_kinderen/startpagina_richtlijn_overgewicht_en_obesitas_bij_volwassenen_en_kinderen.html.
4. (WHO) WHO. World Obesity Day 2022 – Accelerating action to stop obesity 2022 [updated 4-3-22. Available from: https://www.who.int/news/item/04-03-2022-world-obesity-day-2022-accelerating-action-to-stop-obesity#:~:text=More%20than%201%20billion%20people,they%20are%20overweight%20or%20obese.
5. VZinfo.nl. Overgewicht | Leeftijd en geslacht | Volwassenen Bilthoven: RIVM; 2023 [updated 6-7-23. Available from: https://www.vzinfo.nl/overgewicht/leeftijd-geslacht/volwassenen.
6. (CDC) CfDCaP. Overweight & Obesity | Obesity Basics | Consequences of Obesity 2022 [updated 15-07-2022. Available from: https://www.cdc.gov/obesity/basics/consequences.html.
7. Simon GE, Von Korff M, Saunders K, et al. Association between obesity and psychiatric disorders in the US adult population. Arch Gen Psychiatry. 2006;63(7):824-30.
8. de Zwaan M. Binge eating disorder and obesity. International Journal of Obesity. 2001;25(1):S51-S5.
9. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, Obesity, and Depression: A Systematic Review and Meta-analysis of Longitudinal Studies. Archives of General Psychiatry. 2010;67(3):220-9.
10. Duncan AE, Ziobrowski HN, Nicol G. The Prevalence of Past 12-Month and Lifetime DSM-IV Eating Disorders by BMI Category in US Men and Women. Eur Eat Disord Rev. 2017;25(3):165-71.
11. Chirurgische behandeling van Obesitas - Richtlijn - Richtlijnendatabase [Internet] 2020 [Accessed 16th February 2024]. Available from: https://richtlijnendatabase.nl/richtlijn/chirurgische_behandeling_van_obesitas/startpagina_-_chirurgische_behandeling_van_obesitas.html.
12. Weinberger NA, Kersting A, Riedel-Heller SG, Luck-Sikorski C. Body Dissatisfaction in Individuals with Obesity Compared to Normal-Weight Individuals: A Systematic Review and Meta-Analysis. Obes Facts. 2016;9(6):424-41.
13. Westbury S, Oyebode O, van Rens T, Barber TM. Obesity Stigma: Causes, Consequences, and Potential Solutions. Current Obesity Reports. 2023;12(1):10-23.
14. VZinfo.nl. Overgewicht | Ziektelast 2023 [22-11-23]. Available from: https://www.vzinfo.nl/overgewicht/ziektelast.
15. Kitahara CM, Flint AJ, Berrington de Gonzalez A, et al. Association between class III obesity (BMI of 40-59 kg/m2) and mortality: a pooled analysis of 20 prospective studies. PLoS Med. 2014;11(7):e1001673.
16. Massie DC, Amaro A, Kaplan M. Patient well-being and the clinical and economic burdens associated with obesity in the United States. Am J Manag Care. 2022;28(15 Suppl):S279-s87.
17. Goettler A, Grosse A, Sonntag D. Productivity loss due to overweight and obesity: a systematic review of indirect costs. BMJ Open. 2017;7(10):e014632.
18. Robroek SJ, Reeuwijk KG, Hillier FC, Bambra CL, van Rijn RM, Burdorf A. The contribution of overweight, obesity, and lack of physical activity to exit from paid employment: a meta-analysis. Scand J Work Environ Health. 2013;39(3):233-40.

19. Haase CL, Lopes S, Olsen AH, Satylganova A, Schnecke V, McEwan P. Weight loss and risk reduction of obesity-related outcomes in 0.5 million people: evidence from a UK primary care database. Int J Obes (Lond). 2021;45(6):1249-58.

20. Eisenberg D, Shikora SA, Aarts E, et al. 2022 American Society for Metabolic and Bariatric Surgery (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO): Indications for Metabolic and Bariatric Surgery. Surgery for Obesity and Related Diseases. 2022;18(12):1345-56.

21. Poelemeijer YQM, Liem RSL, Nienhuijs SW. A Dutch Nationwide Bariatric Quality Registry: DATO. Obes Surg. 2018;28(6):1602-10.

22. Brown WA, Liem R, Al-Sabah S, et al. Metabolic Bariatric Surgery Across the IFSO Chapters: Key Insights on the Baseline Patient Demographics, Procedure Types, and Mortality from the Eighth IFSO Global Registry Report. Obesity Surgery. 2024;34(5):1764-77.

23. Salminen P, Grönroos S, Helmiö M, et al. Effect of Laparoscopic Sleeve Gastrectomy vs Roux-en-Y Gastric Bypass on Weight Loss, Comorbidities, and Reflux at 10 Years in Adult Patients With Obesity: The SLEEVEPASS Randomized Clinical Trial. JAMA Surgery. 2022;157(8):656-66.

24. Arterburn DE, Johnson E, Coleman KJ, et al. Weight Outcomes of Sleeve Gastrectomy and Gastric Bypass Compared to Nonsurgical Treatment. Ann Surg. 2021;274(6):e1269-e76.

25. Biter LU, t Hart JW, Noordman BJ, et al. Long-term effect of sleeve gastrectomy vs Roux-en-Y gastric bypass in people living with severe obesity: a phase III multicentre randomised controlled trial (SleeveBypass). Lancet Reg Health Eur. 2024;38:100836.

26. Tettero OM, Monpellier VM, Janssen IMC, Steenhuis IHM, van Stralen MM. Early Postoperative Weight Loss Predicts Weight Loss up to 5 Years After Roux-En-Y Gastric Bypass, Banded Roux-En-Y Gastric Bypass, and Sleeve Gastrectomy. Obes Surg. 2022;32(9):2891-902.

27. Kolotkin RL, Andersen JR. A systematic review of reviews: exploring the relationship between obesity, weight loss and health-related quality of life. Clin Obes. 2017;7(5):273-89.

28. Makarawung DJS, Dijkhorst PJ, de Vries CEE, et al. Body Image and Weight Loss Outcome After Bariatric Metabolic Surgery: a Mixed Model Analysis. Obes Surg. 2023;33(8):2396-404.

29. Wilson RB, Lathigara D, Kaushal D. Systematic Review and Meta-Analysis of the Impact of Bariatric Surgery on Future Cancer Risk. Int J Mol Sci. 2023;24(7).

30. 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 & BARIATRIC SURGERY, OBESITY MEDICINE ASSOCIATION, AND AMERICAN SOCIETY OF ANESTHESIOLOGISTS - EXECUTIVE SUMMARY. Endocr Pract. 2019;25(12):1346-59.

31. Potoczna N, Harfmann S, Steffen R, Briggs R, Bieri N, Horber FF. Bowel habits after bariatric surgery. Obes Surg. 2008;18(10):1287-96.

32. Backman O, Stockeld D, Rasmussen F, Näslund E, Marsk R. Alcohol and substance abuse, depression and suicide attempts after Roux-en-Y gastric bypass surgery. Br J Surg. 2016;103(10):1336-42.

33. Grover BT, Morell MC, Kothari SN, Borgert AJ, Kallies KJ, Baker MT. Defining Weight Loss After Bariatric Surgery: a Call for Standardization. Obes Surg. 2019;29(11):3493-9.

34. Corcelles R, Boules M, Froylich D, et al. Total Weight Loss as the Outcome Measure of Choice After Roux-en-Y Gastric Bypass. Obes Surg. 2016;26(8):1794-8.

35. Benoit SC, Hunter TD, Francis DM, De La Cruz-Munoz N. Use of bariatric outcomes longitudinal database (BOLD) to study variability in patient success after bariatric surgery. Obes Surg. 2014;24(6):936-43.

36. de Hollanda A, Jiménez A, Corcelles R, Lacy AM, Patrascioiu I, Vidal J. Gastrointestinal hormones and weight loss response after Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2014;10(5):814-9.

37. Coleman KJ, Brookey J. Gender and racial/ethnic background predict weight loss after Roux-en-Y gastric bypass independent of health and lifestyle behaviors. Obes Surg. 2014;24(10):1729-36.

38. Livhits M, Mercado C, Yermilov I, et al. Preoperative predictors of weight loss following bariatric surgery: systematic review. Obes Surg. 2012;22(1):70-89.

39. Faria SL, Faria OP, Buffington C, de Almeida Cardeal M, Ito MK. Dietary protein intake and bariatric surgery patients: a review. Obes Surg. 2011;21(11):1798-805.

40. Kim HJ, Madan A, Fenton-Lee D. Does patient compliance with follow-up influence weight loss after gastric bypass surgery? A systematic review and meta-analysis. Obes Surg. 2014;24(4):647-51.

41. Sheets CS, Peat CM, Berg KC, et al. Post-operative psychosocial predictors of outcome in bariatric surgery. Obes Surg. 2015;25(2):330-45.

42. Jacobs A, Liem RSL, Janssen IMC, Tollenaar R, Monpellier VM. Weight loss after bariatric surgery: a comparison between delayed and immediate qualification according to the last resort criterion. Surg Obes Relat Dis. 2021;17(4):718-25.

43. Tewksbury C, Williams NN, Dumon KR, Sarwer DB. Preoperative Medical Weight Management in Bariatric Surgery: a Review and Reconsideration. Obes Surg. 2017;27(1):208-14.

44. Schneider A, Hutcheon DA, Hale A, Ewing JA, Miller M, Scott JD. Postoperative outcomes in bariatric surgical patients participating in an insurance-mandated preoperative weight management program. Surg Obes Relat Dis. 2018;14(5):623-30.

45. Kim JJ, Rogers AM, Ballem N, Schirmer B. ASMBS updated position statement on insurance mandated preoperative weight loss requirements. Surg Obes Relat Dis. 2016;12(5):955-9.

46. Livhits M, Mercado C, Yermilov I, et al. Does weight loss immediately before bariatric surgery improve outcomes: a systematic review. Surg Obes Relat Dis. 2009;5(6):713-21.

47. Gerber P, Anderin C, Thorell A. Weight loss prior to bariatric surgery: an updated review of the literature. Scand J Surg. 2015;104(1):33-9.

48. Cassie S, Menezes C, Birch DW, Shi X, Karmali S. Effect of preoperative weight loss in bariatric surgical patients: a systematic review. Surg Obes Relat Dis. 2011;7(6):760-7; discussion 7.

49. Kim JJ. Evidence Base for Optimal Preoperative Preparation for Bariatric Surgery: Does Mandatory Weight Loss Make a Difference? Curr Obes Rep. 2017;6(3):238-45.

50. S.C.H. Hinnen; P.J. Daansen SS. Richtlijn Bariatrische Psychologie. Nederlands Instituut van Psychologen; 2014.

51. 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):963-72.

52. Lai C, Aceto P, Santucci FR, et al. Preoperative psychological characteristics affecting mid-term outcome after bariatric surgery: a follow-up study. Eat Weight Disord. 2021;26(2):585-90.

53. Susmallian S, Nikiforova I, Azoulai S, Barnea R. Outcomes of bariatric surgery in patients with depression disorders. PLoS One. 2019;14(8):e0221576.

54. Kops NL, Vivan MA, de Castro MLD, Horvath JDC, Costa FS, Friedman R. Binge eating scores pre-bariatric surgery and subsequent weight loss: A prospective, 5 years follow-up study. Clin Nutr ESPEN. 2020;38:146-52.

55. Marek RJ, Ben-Porath YS, Dulmen M, Ashton K, Heinberg LJ. Using the presurgical psychological evaluation to predict 5-year weight loss outcomes in bariatric surgery patients. Surg Obes Relat Dis. 2017;13(3):514-21.

56. Alger-Mayer S, Rosati C, Polimeni JM, Malone M. Preoperative binge eating status and gastric bypass surgery: a long-term outcome study. Obes Surg. 2009;19(2):139-45.

57. Hrabosky JI, Masheb RM, White MA, Rothschild BS, Burke-Martindale CH, Grilo CM. A prospective study of body dissatisfaction and concerns in extremely obese gastric bypass patients: 6- and 12-month postoperative outcomes. Obes Surg. 2006;16(12):1615-21.

58. Vidgen HA, Gallegos D. Defining food literacy and its components. Appetite. 2014;76:50-9.

59. Health.gov. Health Literacy in Healthy People 2030 2021 [updated August 24th 2021. Available from: https://health.gov/our-work/national-health-initiatives/healthy-people/healthy-people-2030/health-literacy-healthy-people-2030.

60. Sherf Dagan S, Keidar A, Raziel A, et al. Do Bariatric Patients Follow Dietary and Lifestyle Recommendations during the First Postoperative Year? Obes Surg. 2017;27(9):2258-71.

I

Psychological factors

2

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

Anne Jacobs
Valerie M. Monpellier
Bart Torensma
Evangelia E. Antoniou
Ignace M.C. Janssen
Rob A.E.M. Tollenaar
Anita T.M. Jansen

Obes Rev. 2024 Jun;25(6):e13729

Abstract

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.

Methods

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; twelve 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 months follow-up (respectively 7.97% and 11.79 %EWL). Patients with postoperative binge eating symptoms had a 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.

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% one 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) one 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, physical activity, 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).

Methods

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 1. 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.

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, physical activity, 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.

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.

Study and data selection

Two reviewers, AJ and VM, 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.

Assessment of Risk of Bias

Two reviewers, AJ and VM, 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 2).

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 three 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 "moder-

ate 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.

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 to 7. Fourteen studies provided adequate data for the conduct of at least one meta-analysis.

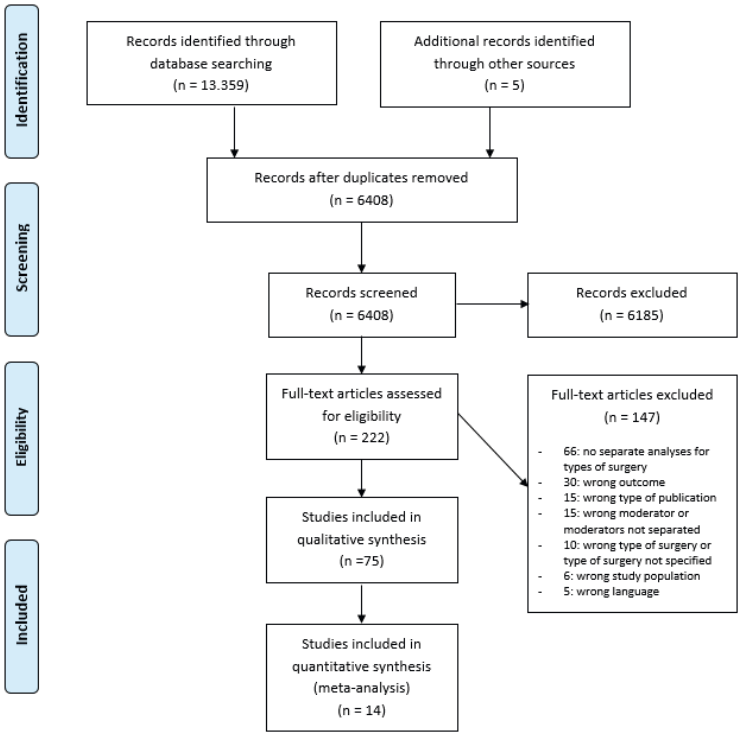


Figure 1. PRISMA Flow Diagram

Definition of weight loss

In the majority of the included studies, data on weight loss was 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].

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 (Appendix 2). 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).

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 kg/m^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. Pre-operative compliance had no significant correlation with weight loss in two studies [51, 61]. In three studies, post-operative 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.

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
Pre-operative complicance									
el Chaar*	2011	Prospective cohort	RYGB	12 months	177	*n.a.*	Missed <25% of preoperative appointments	No difference	Good
Hildebrandt*	1998	Cross-sectional	RYGB	*n.a.*	102	*n.a.*	Pre- and postoperative support group, yes/no question	No difference	Poor
Post-operative compliance									
el Chaar*	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 succes/failure	Poor
Compher[m]	2012	Cross-sectional	RYGB	1.5, 6, 12, 24 months	60	52.0 ± 10.1	Returned at FU 12 months postop	All positive	Good
Gould[m]	2007	Retrospective cohort	RYGB	12 and 36 months	85	*n.a.*	Attended every appointment up to 1-3 years after surgery	12 mo: no difference 36 mo: positive	Good
Harper[m]	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*	1998	Cross-sectional	RYGB	*n.a.*	102	*n.a.*	Pre- and postoperative support group, yes/no question	No difference	Poor

Table 1. Overview of included studies that assessed compliance as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/ SG	Follow-up	Sample size	BMI-pre	Definition moderator	Effect moderator	Quality article
Jennings[m]	2013	Prospective cohort	RYGB	12 and 24 months	227	*n.a.*	Attended all follow-up postoperative appointments	12 mo: positive 24 mo: 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[m]	2020	Prospective cohort	RYGB	1, 6, 12, 24, 36, 48, 60 months	294	43.24	Attended all follow-up postoperative appointments	Positive	Good
			SG	1, 6, 12, 24, 36, 48, 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 - Attandence at surgical follow-up appointments, yes/no quesiton	- Positive - No difference	Poor
Shen[m]	2004	Prospective cohort	RYGB	12 months	115	47.7 [35-64.1]	>3 visits to clinic after surgery	No difference	Good
Song[m]	2008	Retrospective cohort	RYGB	2 wk, 6 wk, 3 mo 6 mo, 9 mo 12 mo	78	*n.a.*	>5 support group meeting after surgery	2 wk, 6 wk, 3 mo, 6 mo: no difference 9 and 12 mo: positive	Good

*Compliance measured both pre-and postoperatively, [m] Included in meta-analysisRYGB=Roux-en-Y Gastric Bypass, SG=Sleeve Gastrectomy, n.a.=not available, wk=weeks, mo=months

Meta-analyses including seven studies revealed a statistically significantly increased in mean %EWL for the compliant group following RYGB [52-55, 58-60] (Figures 2.a-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.

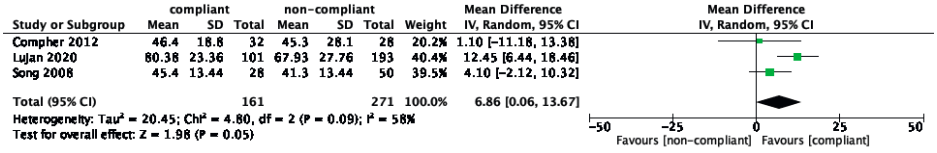


Figure 2.a. 6 months after RYGB.

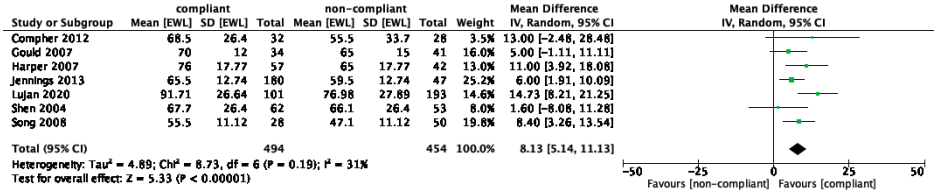


Figure 2.b. 12 months after RYGB.

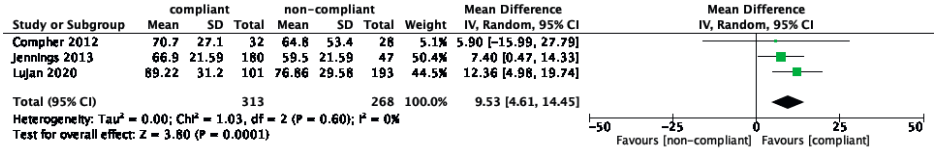


Figure 2.c. 24 months after RYGB.

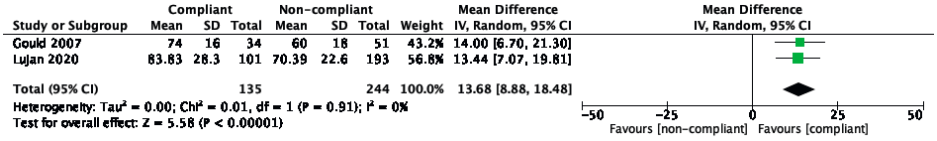


Figure 2.d. 36 months after RYGB.

Figures 2. Meta-analysis of the association of postoperative compliance and % Excess Weight Loss after RYGB

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 pre-operatively									
Bergh*	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*	2019	Retrospective cohort	RYGB	1, 2, 3 and 4 years	4569	44.4	Beacke questionnaire	No difference	Good
Physical activity measured post-operatively									
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	Retropective 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 minutes moderate/hig 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*	2019	Retrospective cohort	RYGB	1, 2, 3 and 4 years	4569	44.4	Beacke questionnaire	Positive	Good

Table 2. Overview of included studies that assessed physical activity as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
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 & Bariatric Surgery Self-management Questionnaire	No difference	Poor
Change in physical activity									
Bergh*	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*	2019	Retrospective cohort	RYGB	1, 2, 3 and 4 years	4569	44.4	Beacke questionnaire	Positive	Good
Wefers	2017	Prospective cohort	RYGB	9 months	50	38.1 ± 7.0	Sensewear pro armband	Positive	Poor

Table 2. Overview of included studies that assessed physical activity as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
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

* PA measured both pre-and postoperatively

PA=Physical Activity, RYGB=Roux-en-Y Gastric Bypass, SG=Sleeve Gastrectomy

Physical activity

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 twelve 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 nine years.

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 twelve studies, post-operative PA as well as PA intensity were predictive of higher weight loss [41, 63, 66-69, 71, 73-77], whereas in five studies, post-operative 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.

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).

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 pre-operatively									
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[m]	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 succes/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

Table 3. Overview of included studies that assessed depressive symptoms as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
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*	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 mo: no difference 6 mo: negative	Good
Lai[m]	2021	Prospective cohort	RYGB	3, 6 and 24-30 months	76	44 ± 5.8	Hamilton Depression Scale	3 and 6 mo: no difference 24-30 mo: 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

Table 3. Overview of included studies that assessed depressive symptoms as moderator for weight loss after surgery. *(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[m]	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, 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*	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 post-operatively									
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

Table 3. Overview of included studies that assessed depressive symptoms as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
Kruseman*	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*	2015	Prospective cohort	RYGB	6, 12 and 24 months	357	51.2 ±.8.3	Beck Depression Inventory	6 mo FU: 6 en 12 mnd negative, 24 mnd no difference 12 mo FU: 12 mnd positive, 24 mnd no difference 24 mo 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

* Depression measured both pre-and postoperatively
RYGB=Roux-en-Y Gastric Bypass, SG=Sleeve Gastrectomy, n.a.=not available, wk=weeks, mo=months

Roux-en-Y gastric bypass

A total of 30 studies evaluated the association between depressive symptoms and weight loss following RYGB. Among these, twenty-two 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 twenty-seven studies had to be excluded due to the use of %TWL as outcome, parameter and despite multiple requests for additional information, the authors did not respond [90]. In the context of preoperative depressive symptoms, four studies showed an inverse association with weight loss [83, 84, 86, 92], while in sixteen 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 twenty-eight 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] (Figures 3.a-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-months follow-up (I^2 = 72% and 87%, respectively), these meta-analyses were excluded.

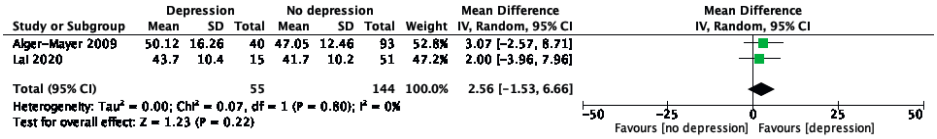


Figure 3.a. 3 months after RYGB.

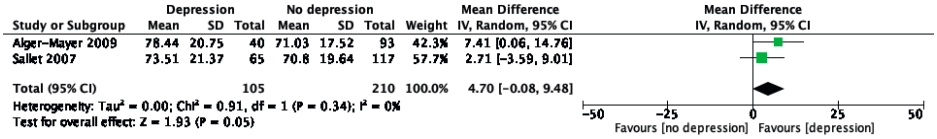


Figure 3.b. 12 months after RYGB.

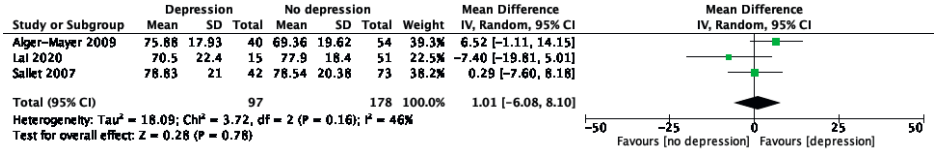


Figure 3.c. 24 months after RYGB.

Figures 3. Meta-analysis of the association of preoperative depressive symptoms and % Excess Weight Loss after RYGB

Sleeve Gastrectomy

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 four 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 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.

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).

Roux-en-Y gastric bypass

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 seventeen 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 six 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 one-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 twenty-two studies exhibited a low risk of bias.

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*	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 disoders (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

Table 4. Overview of included studies that assessed binge eating as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
Brunault	2012	Cohort	SG	12 months	34	55.3 ± 10.2	Bulimic Investigatory Test	Negative for overall and symtpom 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 succes/ 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 chort	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

Table 4. Overview of included studies that assessed binge eating as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
Kops	2020	Prospective cohort	RYGB	3 - 60 months	108	48.2 ± 7.2	Binge Eating Scale	3, 24 and 36 mo: positive 6, 12, 48 and 60 mo: 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*	2016	Cross-sectional	RYGB	12 months	132	48.3 ± 7.9	Binge Eating Scale	No difference	Poor
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

Table 4. Overview of included studies that assessed binge eating as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
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 post-operatively									
Beck	2012	Cross-sectional	RYGB	23.2 months [14-30 months]	45	46.1 ± 5.8	Self-made binge eating survery	Negative	Good
Ben-Porat*	2021	Prospective cohort	SG	3, 6 and 12 months	54	44.9 ± 4.9	Binge Eating Scale	12 mo: 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*	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

Table 4. Overview of included studies that assessed binge eating as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
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

* BED measured both pre-and postoperatively
BED=Binge Eating Disorder, RYGB=Roux-en-Y Gastric Bypass, SG=Sleeve Gastrectomy, n.a.=not available, mo=months

Meta-analysis including five studies showed that preoperative symptoms of binge eating were associated with greater weight loss at 24- and 36- months 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 (Figures 4.a-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.

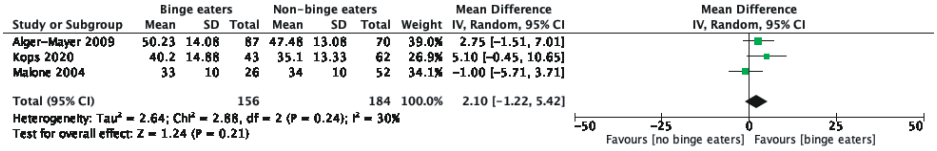


Figure 4.a. 3 months after RYGB.

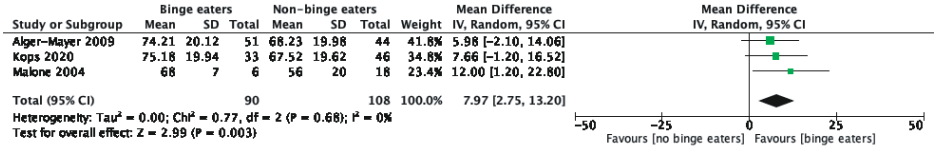


Figure 4.b. 24 months after RYGB.

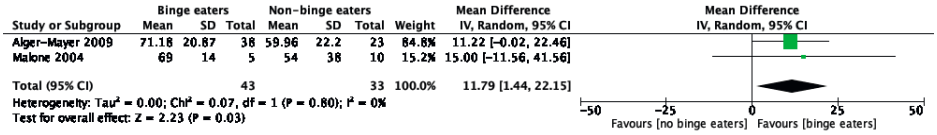


Figure 4.c. 36 months after RYGB.

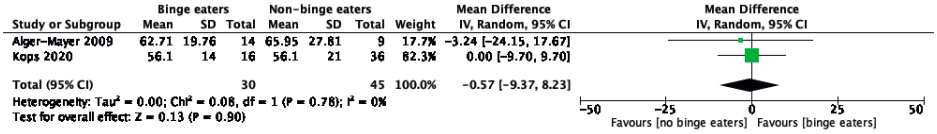


Figure 4.d. 60 months after RYGB.

Figures 4. Meta-analysis of the association of preoperative binge eating symptomatology and % Excess Weight Loss after RYGB

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 – -3.80, I^2 = 0%; Figure 5). Both studies had a high risk of bias.

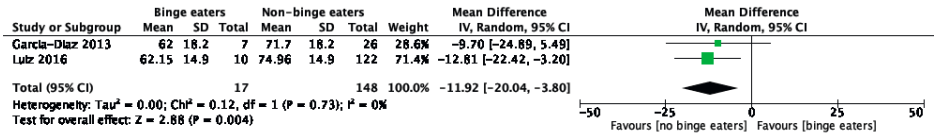


Figure 5: Meta-analysis of the association of postoperative binge eating symptomatology and %Excess Weight Loss 12 months after RYGB

2

Sleeve gastrectomy

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 four years.

The available data was 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, post-operative 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.

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, eleven 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 eight years.

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 pre-operatively									
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*	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

Table 5. Overview of included studies that assessed anxiety symptoms as moderator for weight loss after surgery. *(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	Hamilton anxiety scale for Anxiety	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 post-operatively									
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*	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Hospital Anxiety and Depression Scale	No difference	Good

* Anxiety measured both pre-and postoperatively
RYGB=Roux-en-Y Gastric Bypass, SG=Sleeve Gastrectomy, n.a.=not available

The available data was 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 twelve 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 sixteen studies, nine exhibited a low risk of bias.

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 was 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.

Quality of life

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 eight years.

There was 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 one- and four-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.

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 pre-operatively									
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 and12 month	109	51.5 ± 7.6	Body shape questionnaire & 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

RYGB=Roux-en-Y Gastric Bypass, SG=Sleeve Gastrectomy

Table 7. Overview of included studies that assessed QoL 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 pre-operatively									
Alger-mayer	2009	Prospective cohort	RYGB	3, 6, 12, 24, 36, 48, 60 and 72 months	157	50.7 ± 8.0	SF-36	1 yr: no difference 4 yr: no difference 5 and 6 yr negative: general health 5 yr positive: physical health 6 yr positive: pain	Poor
Kruseman*	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Nottingham Health Profile	No difference	Good

Table 7. Overview of included studies that assessed QoL as moderator for weight loss after surgery. *(Continued)*

Reference	Pub. date	Study design	RYGB/ SG	Follow-up	Sample size	BMI-Pre	Definition moderator	Effect moderator	Quality article
QoL measured post-operatively									
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*	2010	Prospective cohort	RYGB	8 ± 1.2 years	80	46.0 ± 7.0	Nottingham Health Profile	Positive	Good

* QoL measured both pre-and postoperatively

QoL=Quality of Life, RYGB=Roux-en-Y Gastric Bypass, SG=Sleeve Gastrectomy, yr=year, n.a.=not available

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, physical activity, postoperative depressive symptoms, anxiety, body image and QoL due to the lack of sufficient data.

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 non-compliant 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.

Physical activity

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 post-

operative 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 favourable 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].

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.

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-months 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.

Anxiety symptoms

Fourteen out of the sixteen 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.

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.

Quality of life

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].

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 analysed pre- and postoperative psychological factors, and therefore provides a more nuanced perspective on the role of psychological factors in bariatric-metabolic surgery.

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's 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.

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.

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 analysed 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, sixty-six articles were excluded from this study because they did not present results independently for different types of surgery, e.g., 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 quality of life, 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.

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.

References

1. Julia C, Ciangura C, Capuron L, et al. Quality of life after Roux-en-Y gastric bypass and changes in body mass index and obesity-related comorbidities. Diabetes Metab. 2013;39(2):148-54.
2. Kubik JF, Gill RS, Laffin M, Karmali S. The impact of bariatric surgery on psychological health. J Obes. 2013;2013:837989.
3. Sjöström L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. J Intern Med. 2013;273(3):219-34.
4. 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. International Journal of Obesity. 2007;31(8):1248-61.
5. Karmali S, Brar B, Shi X, Sharma AM, de Gara C, Birch DW. Weight recidivism post-bariatric surgery: a systematic review. Obesity surgery. 2013;23(11):1922-33.
6. Grover BT, Morell MC, Kothari SN, Borgert AJ, Kallies KJ, Baker MT. Defining Weight Loss After Bariatric Surgery: a Call for Standardization. Obesity surgery. 2019;29(11):3493-9.
7. Azagury D, Papasavas P, Hamdallah I, Gagner M, Kim J. ASMBS Position Statement on medium- and long-term durability of weight loss and diabetic outcomes after conventional stapled bariatric procedures. Surgery for Obesity and Related Diseases. 2018;14(10):1425-41.
8. Corcelles R, Boules M, Froylich D, et al. Total Weight Loss as the Outcome Measure of Choice After Roux-en-Y Gastric Bypass. Obesity surgery. 2016;26(8):1794-8.
9. Poelemeijer YQM, Liem RSL, Nienhuijs SW. A Dutch Nationwide Bariatric Quality Registry: DATO. Obesity surgery. 2018;28(6):1602-10.
10. Benoit SC, Hunter TD, Francis DM, De La Cruz-Munoz N. Use of Bariatric Outcomes Longitudinal Database (BOLD) to Study Variability in Patient Success After Bariatric Surgery. Obesity surgery. 2014.
11. de Hollanda A, Jimenez A, Corcelles R, Lacy AM, Patrascioiu I, Vidal J. Gastrointestinal hormones and weight loss response after Roux-en-Y gastric bypass. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2014.
12. Coleman KJ, Brookey J. Gender and Racial/Ethnic Background Predict Weight Loss after Roux-en-Y Gastric Bypass Independent of Health and Lifestyle Behaviors. Obesity surgery. 2014.
13. Livhits M, Mercado C, Yermilov I, et al. Preoperative predictors of weight loss following bariatric surgery: systematic review. Obes Surg. 2012;22(1):70-89.
14. 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):963-72.
15. Wimmelmann CL, Dela F, Mortensen EL. Psychological predictors of weight loss after bariatric surgery: A review of the recent research. Obesity Research & Clinical Practice. 2014;8(4):e299-e313.
16. Moroshko I, Brennan L, O'Brien P. Predictors of attrition in bariatric aftercare: a systematic review of the literature. Obes Surg. 2012;22(10):1640-7.
17. 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. Obesity (Silver Spring). 2020;28(4):O1-o58.
18. Kim HJ, Madan A, Fenton-Lee D. Does patient compliance with follow-up influence weight loss after gastric bypass surgery? A systematic review and meta-analysis. Obes Surg. 2014;24(4):647-51.

19. Faria SL, Faria OP, Buffington C, de Almeida Cardeal M, Ito MK. Dietary protein intake and bariatric surgery patients: a review. Obes Surg. 2011;21(11):1798-805.

20. Sheets CS, Peat CM, Berg KC, et al. Post-operative Psychosocial Predictors of Outcome in Bariatric Surgery. Obesity surgery. 2015;25(2):330-45.

21. Oppert JM, Bellicha A, van Baak MA, et al. Exercise training in the management of overweight and obesity in adults: Synthesis of the evidence and recommendations from the European Association for the Study of Obesity Physical Activity Working Group. Obes Rev. 2021;22 Suppl 4(Suppl 4):e13273.

22. Egberts K, Brown WA, Brennan L, O'Brien PE. Does Exercise Improve Weight Loss after Bariatric Surgery? A Systematic Review. Obesity surgery. 2012;22(2):335-41.

23. Livhits M, Mercado C, Yermilov I, et al. Exercise following bariatric surgery: systematic review. Obesity surgery. 2010;20(5):657-65.

24. Cargill BR, Clark MM, Pera V, Niaura RS, Abrams DB. Binge eating, body image, depression, and self-efficacy in an obese clinical population. Obes Res. 1999;7(4):379-86.

25. Stunkard AJ, Wadden TA. Psychological aspects of severe obesity. Am J Clin Nutr. 1992;55(2 Suppl):524s-32s.

26. Lai C, Aceto P, Santucci FR, et al. Preoperative psychological characteristics affecting mid-term outcome after bariatric surgery: a follow-up study. Eat Weight Disord. 2021;26(2):585-90.

27. Susmallian S, Nikiforova I, Azoulai S, Barnea R. Outcomes of bariatric surgery in patients with depression disorders. PLoS One. 2019;14(8):e0221576.

28. Kops NL, Vivan MA, de Castro MLD, Horvath JDC, Costa FS, Friedman R. Binge eating scores pre-bariatric surgery and subsequent weight loss: A prospective, 5 years follow-up study. Clin Nutr ESPEN. 2020;38:146-52.

29. Marek RJ, Ben-Porath YS, Dulmen M, Ashton K, Heinberg LJ. Using the presurgical psychological evaluation to predict 5-year weight loss outcomes in bariatric surgery patients. Surg Obes Relat Dis. 2017;13(3):514-21.

30. Alger-Mayer S, Rosati C, Polimeni JM, Malone M. Preoperative binge eating status and gastric bypass surgery: a long-term outcome study. Obes Surg. 2009;19(2):139-45.

31. Fox B, Chen E, Suzo A, et al. Dietary and psych predictors of weight loss after gastric bypass. J Surg Res. 2015;197(2):283-90.

32. Lanyon RI, Maxwell BM. Predictors of outcome after gastric bypass surgery. Obesity surgery. 2007;17(3):321-8.

33. Kops NL, Vivan MA, Fülber ER, Fleuri M, Fagundes J, Friedman R. Preoperative Binge Eating and Weight Loss After Bariatric Surgery: A Systematic Review and Meta-analysis. Obes Surg. 2021;31(3):1239-48.

34. Hindle A, de la Piedad Garcia X, Brennan L. Early post-operative psychosocial and weight predictors of later outcome in bariatric surgery: a systematic literature review. Obes Rev. 2017;18(3):317-34.

35. van Hout GCM, Verschure SKM, Van Heck GL. Psychosocial Predictors of Success following Bariatric Surgery. Obesity surgery. 2005;15(4):552-60.

36. Friedman KE. Body Image obesity and psycological distress. 2001.

37. Adami GF. Body image and body weight in obese patients. 1998.

38. Malik S, Mitchell JE, Engel S, Crosby R, Wonderlich S. Psychopathology in bariatric surgery candidates: A review of studies using structured diagnostic interviews. Comprehensive Psychiatry. 2014;55(2):248-59.

39. Bocchieri LE, Meana M, Fisher BL. Perceived psychosocial outcomes of gastric bypass surgery: a qualitative study. Obesity surgery. 2002;12(6):781-8.

40. Kruseman M, Leimgruber A, Zumbach F, Golay A. Dietary, weight, and psychological changes among patients with obesity, 8 years after gastric bypass. J Am Diet Assoc. 2010;110(4):527-34.

41. Amundsen T, Strømmen M, Martins C. Suboptimal Weight Loss and Weight Regain after Gastric Bypass Surgery-Postoperative Status of Energy Intake, Eating Behavior, Physical Activity, and Psychometrics. Obesity surgery. 2017;27(5):1316-23.

42. Kofman MD, Lent MR, Swencionis C. Maladaptive eating patterns, quality of life, and weight outcomes following gastric bypass: results of an Internet survey. Obesity. 2010;18(10):1938-43.

43. Bergh I, Lundin Kvalem I, Risstad H, Sniehotta FF. Preoperative predictors of adherence to dietary and physical activity recommendations and weight loss one year after surgery. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2016;12(4):910-8.

44. Hrabosky JI, Masheb RM, White MA, Rothschild BS, Burke-Martindale CH, Grilo CM. A prospective study of body dissatisfaction and concerns in extremely obese gastric bypass patients: 6- and 12-month postoperative outcomes. Obes Surg. 2006;16(12):1615-21.

45. Teufel M, Rieber N, Meile T, et al. Body image after sleeve gastrectomy: reduced dissatisfaction and increased dynamics. Obesity surgery. 2012;22(8):1232-7.

46. Yang P, Chen B, Xiang S, Lin XF, Luo F, Li W. Long-term outcomes of laparoscopic sleeve gastrectomy versus Roux-en-Y gastric bypass for morbid obesity: Results from a meta-analysis of randomized controlled trials. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2019;15(4):546-55.

47. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.

48. Wells GA SB, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses [Available from: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp.

49. Julian Higgins SG. Chochrane Handbook for Systematic Reviews of Interventions: Wiley-Blackwell; 2008.

50. Review Manager (RevMan) [Computer program]. Version 5.4.1. The Cochrane Collaboration; 2020.

51. El Chaar M, McDeavitt K, Richardson S, Gersin KS, Kuwada TS, Stefanidis D. Does patient compliance with preoperative bariatric office visits affect postoperative excess weight loss? Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2011;7(6):743-8.

52. Shen R, Dugay G, Rajaram K, Cabrera I, Siegel N, Ren CJ. Impact of patient follow-up on weight loss after bariatric surgery. Obesity surgery. 2004;14(4):514-9.

53. Gould JC, Beverstein G, Reinhardt S, Garren MJ. Impact of routine and long-term follow-up on weight loss after laparoscopic gastric bypass. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2007;3(6):627-30; discussion 30.

54. Song Z, Reinhardt K, Buzdon M, Liao P. Association between support group attendance and weight loss after Roux-en-Y gastric bypass. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2008;4(2):100-3.

55. Harper J, Madan AK, Ternovits CA, Tichansky DS. What happens to patients who do not follow-up after bariatric surgery? Am Surg. 2007;73(2):181-4.

56. Hatoum IJ, Stein HK, Merrifield BF, Kaplan LM. Capacity for physical activity predicts weight loss after Roux-en-Y gastric bypass. Obesity. 2009;17(1):92-9.

57. Orth WS, Madan AK, Taddeucci RJ, Coday M, Tichansky DS. Support group meeting attendance is associated with better weight loss. Obesity surgery. 2008;18(4):391-4.

58. Compher CW, Hanlon A, Kang Y, Elkin L, Williams NN. Attendance at clinical visits predicts weight loss after gastric bypass surgery. Obesity surgery. 2012;22(6):927-34.

59. Jennings N, Boyle M, Mahawar K, Balupuri S, Small P. The relationship of distance from the surgical centre on attendance and weight loss after laparoscopic gastric bypass surgery in the United Kingdom. Clin Obes. 2013;3(6):180-4.

60. Lujan J, Tuero C, Landecho MF, et al. Impact of Routine and Long-Term Follow-Up on Weight Loss after Bariatric Surgery. Obesity surgery. 2020;30(11):4293-9.

61. Hildebrandt SE. Effects of participation in bariatric support group after Roux-en-Y gastric bypass. Obesity surgery. 1998;8(5):535-42.

62. Coleman KJ, Toussi R, Fujioka K. Do gastric bypass patient characteristics, behavior, and health differ depending upon how successful weight loss is defined? Obesity surgery. 2010;20(10):1385-92.

63. Livhits M, Mercado C, Yermilov I, et al. Behavioral factors associated with successful weight loss after gastric bypass. Am Surg. 2010;76(10):1139-42.

64. Robinson AH, Adler S, Stevens HB, Darcy AM, Morton JM, Safer DL. What variables are associated with successful weight loss outcomes for bariatric surgery after 1 year? Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2014;10(4):697-704.

65. Boan J, Kolotkin RL, Westman EC, McMahon RL, Grant JP. Binge eating, quality of life and physical activity improve after Roux-en-Y gastric bypass for morbid obesity. Obesity surgery. 2004;14(3):341-8.

66. Monpellier VM, Janssen IMC, Antoniou EE, Jansen ATM. Weight Change After Roux-en Y Gastric Bypass, Physical Activity and Eating Style: Is There a Relationship? Obesity surgery. 2019;29(2):526-33.

67. Latner JD, Wetzler S, Goodman ER, Glinski J. Gastric bypass in a low-income, inner-city population: eating disturbances and weight loss. Obesity research. 2004;12(6):956-61.

68. Bond DS, Evans RK, Wolfe LG, et al. Impact of self-reported physical activity participation on proportion of excess weight loss and BMI among gastric bypass surgery patients. Am Surg. 2004;70(9):811-4.

69. Evans RK, Bond DS, Wolfe LG, et al. Participation in 150 min/wk of moderate or higher intensity physical activity yields greater weight loss after gastric bypass surgery. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2007;3(5):526-30.

70. Wolfe BL, Terry ML. Expectations and outcomes with gastric bypass surgery. Obesity surgery. 2006;16(12):1622-9.

71. Welch G, Wesolowski C, Piepul B, Kuhn J, Romanelli J, Garb J. Physical activity predicts weight loss following gastric bypass surgery: findings from a support group survey. Obesity surgery. 2008;18(5):517-24.

72. Bond DS, Phelan S, Wolfe LG, et al. Becoming physically active after bariatric surgery is associated with improved weight loss and health-related quality of life. Obesity. 2009;17(1):78-83.

73. Forbush S, Nof L, Echternach J, Hill C, Rainey J. Influence of activity levels and energy intake on percent excess weight loss after Roux-en-Y gastric bypass. Obesity surgery. 2011;21(11):1731-8.

74. 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. Obesity surgery. 2011;21(10):1564-9.

75. Josbeno DA, Kalarchian M, Sparto PJ, Otto AD, Jakicic JM. Physical activity and physical function in individuals post-bariatric surgery. Obesity surgery. 2011;21(8):1243-9.

76. Welch G, Wesolowski C, Zagarins S, et al. Evaluation of clinical outcomes for gastric bypass surgery: results from a comprehensive follow-up study. Obesity surgery. 2011;21(1):18-28.

77. Herman KM, Carver TE, Christou NV, Andersen RE. Keeping the weight off: physical activity, sitting time, and weight loss maintenance in bariatric surgery patients 2 to 16 years postsurgery. Obesity surgery. 2014;24(7):1064-72.

78. Yanos BR, Saules KK, Schuh LM, Sogg S. Predictors of Lowest Weight and Long-Term Weight Regain Among Roux-en-Y Gastric Bypass Patients. Obesity surgery. 2015;25(8):1364-70.

79. Wefers JF, Woodlief TL, Carnero EA, et al. Relationship among physical activity, sedentary behaviors, and cardiometabolic risk factors during gastric bypass surgery-induced weight loss. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2017;13(2):210-9.

80. Júnior WS, do Amaral JL, Nonino-Borges CB. Factors related to weight loss up to 4 years after bariatric surgery. Obesity surgery. 2011;21(11):1724-30.

81. Wise ES, Hocking KM, Kavic SM. Prediction of excess weight loss after laparoscopic Roux-en-Y gastric bypass: data from an artificial neural network. Surg Endosc. 2016;30(2):480-8.

82. 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. Obesity surgery. 2015;25(10):1909-16.

83. Love RJ, Love AS, Bower S, Carlos Poston WS. Impact of antidepressant use on gastric bypass surgery patients' weight loss and health-related quality-of-life outcomes. Psychosomatics. 2008;49(6):478-86.

84. Lanza L, Carrard I, Pataky Z, Reiner M, Golay A. Effect of psycho-pedagogical preparation before gastric bypass. Education Thérapeutique du Patient - Therapeutic Patient Education. 2012;5:101-6.

85. Ma Y, Pagoto SL, Olendzki BC, et al. Predictors of weight status following laparoscopic gastric bypass. Obesity surgery. 2006;16(9):1227-31.

86. Averbukh Y, Heshka S, El-Shoreya H, et al. Depression score predicts weight loss following Roux-en-Y gastric bypass. Obesity surgery. 2003;13(6):833-6.

87. Dymek MP, le Grange D, Neven K, Alverdy J. Quality of life and psychosocial adjustment in patients after Roux-en-Y gastric bypass: a brief report. Obesity surgery. 2001;11(1):32-9.

88. Sallet PC, Sallet JA, Dixon JB, et al. Eating behavior as a prognostic factor for weight loss after gastric bypass. Obesity surgery. 2007;17(4):445-51.

89. 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):644-7.

90. Alabi F, Guilbert L, Villalobos G, et al. Depression Before and After Bariatric Surgery in Low-Income Patients: the Utility of the Beck Depression Inventory. Obesity surgery. 2018;28(11):3492-8.

91. Ames GE, Heckman MG, Diehl NN, et al. Guiding Patients Toward the Appropriate Surgical Treatment for Obesity: Should Presurgery Psychological Correlates Influence Choice Between Roux-en-Y Gastric Bypass and Vertical Sleeve Gastrectomy? Obesity surgery. 2017;27(10):2759-67.

92. Lai C, Aceto P, Petrucci I, et al. The influence of preoperative psychological factors on weight loss after bariatric surgery: A preliminary report. J Health Psychol. 2019;24(4):518-25.

93. Vanoh D, Shahar S, Mahmood NR. Association between nutrient adequacy and psychosocial factors with overall rate of weight loss after bariatric surgery. Asia Pac J Clin Nutr. 2015;24(4):610-9.

94. Delin CR, Watts JM, Bassett DL. An Exploration of the Outcomes of Gastric Bypass Surgery for Morbid Obesity: Patient Characteristics and Indeces of Success. Obesity surgery. 1995;5(2):159-70.

95. Beck NN, Mehlsen M, Støving RK. Psychological characteristics and associations with weight outcomes two years after gastric bypass surgery: Postoperative eating disorder symptoms are associated with weight loss outcomes. Eat Behav. 2012;13(4):394-7.

96. Schag K, Mack I, Giel KE, et al. The Impact of Impulsivity on Weight Loss Four Years after Bariatric Surgery. Nutrients. 2016;8(11).

97. Semanscin-Doerr DA, Windover A, Ashton K, Heinberg LJ. Mood disorders in laparoscopic sleeve gastrectomy patients: does it affect early weight loss? Surgery for Obesity and Related Diseases. 2010;6(2):191-6.

98. Brunault P, Jacobi D, Miknius V, et al. High preoperative depression, phobic anxiety, and binge eating scores and low medium-term weight loss in sleeve gastrectomy obese patients: a preliminary cohort study. Psychosomatics. 2012;53(4):363-70.

99. Bianciardi E, Raimondi G, Samela T, et al. Neurocognitive and Psychopathological Predictors of Weight Loss After Bariatric Surgery: A 4-Year Follow-Up Study. Front Endocrinol (Lausanne). 2021;12:662252.

100. Bocchieri-Ricciardi LE, Chen EY, Munoz D, et al. Pre-surgery binge eating status: effect on eating behavior and weight outcome after gastric bypass. Obesity surgery. 2006;16(9):1198-204.

101. 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):175-84.

102. Luiz LB, Brito CL, Debon LM, et al. Variation of Binge Eating One Year after Roux-en-Y Gastric Bypass and Its Relationship with Excess Weight Loss. PLoS One. 2016;11(12):e0167577.

103. Fujioka K, Yan E, Wang HJ, Li Z. Evaluating preoperative weight loss, binge eating disorder, and sexual abuse history on Roux-en-Y gastric bypass outcome. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2008;4(2):137-43.

104. Crowley N, Budak A, Byrne TK, Thomas S. Patients who endorse more binge eating triggers before gastric bypass lose less weight at 6 months. Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery. 2011;7(1):55-9.

105. Malone M, Alger-Mayer S. Binge status and quality of life after gastric bypass surgery: a one-year study. Obesity research. 2004;12(3):473-81.

106. 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):1928-35.

107. Toussi R, Fujioka K, Coleman KJ. Pre- and post-surgery behavioral compliance, patient health, and postbariatric surgical weight loss. Obesity. 2009;17(5):996-1002.

108. 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. Obesity surgery. 2004;14(7):975-85.

109. Kalarchian MA, Marcus MD, Wilson GT, Labouvie EW, Brolin RE, LaMarca LB. Binge eating among gastric bypass patients at long-term follow-up. Obesity surgery. 2002;12(2):270-5.

110. García Díaz E, Jerez Arzola ME, Martín Folgueras T, Morcillo Herrera L, Jiménez Sosa A. Effect of binge eating disorder on the outcomes of laparoscopic gastric bypass in the treatment of morbid obesity. Nutr Hosp. 2013;28(3):618-22.

111. Ben-Porat T, Weiss R, Sherf-Dagan S, et al. Food Addiction and Binge Eating During One Year Following Sleeve Gastrectomy: Prevalence and Implications for Postoperative Outcomes. Obesity surgery. 2021;31(2):603-11.

112. Kalarchian MA, Marcus MD, Levine MD, Soulakova JN, Courcoulas AP, Wisinski MSC. Relationship of psychiatric disorders to 6-month outcomes after gastric bypass. Surgery for Obesity and Related Diseases. 2008;4(4):544-9.

113. Greeno CG, Marcus MD, Wing RR. Diagnosis of binge eating disorder: discrepancies between a questionnaire and clinical interview. Int J Eat Disord. 1995;17(2):153-60.

114. Gill H, Kang S, Lee Y, et al. The long-term effect of bariatric surgery on depression and anxiety. Journal of Affective Disorders. 2019;246:886-94.

115. Sarwer DB, Wadden TA, Moore RH, Eisenberg MH, Raper SE, Williams NN. Changes in quality of life and body image after gastric bypass surgery. Surgery for Obesity and Related Diseases. 2010;6(6):608-14.

116. Akkayaoğlu H, Çelik S. Eating attitudes, perceptions of body image and patient quality of life before and after bariatric surgery. Applied Nursing Research. 2020;53:151270.

117. Nijland LMG, Reiber BMM, Monpellier VM, et al. The association between patient attendance to a perioperative group-based lifestyle program and weight loss after bariatric surgery. Surgery for Obesity and Related Diseases. 2022.

118. Belo G, Siqueira LT, Melo Filho DAA, Kreimer F, Ramos VP, Ferraz Á AB. Predictors of poor follow-up after bariatric surgery. Rev Col Bras Cir. 2018;45(2):e1779.

119. Brethauer SA, Kim J, el Chaar M, et al. Standardized outcomes reporting in metabolic and bariatric surgery. Surgery for Obesity and Related Diseases. 2015;11(3):489-506.

Appendix 1: Details of searches performed.

Search details Pubmed

((“gastric bypass”[Mesh] OR “bariatric surger*”[ti] OR “obesity surger*”[ti] OR “gastric bypas*”[tiab] OR “Gastric Sleeve”[ti] OR “Gastric Sleeves”[ti] OR “Bariatric Surgery”[majr:noexp] OR “Bariatric Surgery”[ti] OR “Bariatric Surgical Procedures”[ti] OR “Bariatric Surgical Procedure”[ti]) AND (“Patient Compliance”[Mesh] OR complian*[tiab] OR noncomplian*[tiab] OR “Exercise”[Mesh] OR “physical activit*”[tiab] OR “exercis*”[tiab] OR “fitness”[tiab] OR “Physical Fitness”[Mesh] OR “Body image”[Mesh] OR “body image*”[tiab] OR “Quality of life”[Mesh] OR “quality of life”[tiab] OR “life quality”[tiab] OR “QoL”[tiab] OR “Feeding Behavior”[Mesh] OR “eating behav*”[tiab] OR “food habit*”[tiab] OR “eating habit*”[tiab] OR “diet habit*”[tiab] OR “dietary habit*”[tiab] OR “Feeding and Eating Disorders”[Mesh] OR “eating disorder*”[tiab] OR “binge*”[tiab] OR “Psychopathology”[Mesh] OR “psychopathol*”[tiab] OR “Depression”[Mesh] OR “Depressive Disorder”[Mesh] OR “Mood Disorders”[Mesh] OR “depression*”[tiab] OR “depressive”[tiab] OR “determinant*”[tiab] OR “predict*”[tiab] OR “prognostic*”[tiab] OR “influenc*”[tiab] OR “Bipolar Disorder”[Mesh] OR “Bipolar”[tiab] OR “lost to follow-up”[tiab] OR “Anxiety Disorders”[Mesh] OR “anxiety”[mesh] OR anxiet*[tiab] OR “phobia”[tiab] OR “phobias”[tiab] OR “mood”[tiab] OR “moods”[tiab]) AND (“treatment outcome”[majr] OR “outcome*”[tiab] OR “effectiveness”[tiab] OR “effective treatment*”[tiab] OR “efficacy”[tiab] OR “weight loss”[majr] OR “weight loss*”[tiab] OR “weight reduc*”[tiab])) NOT ((“Case Reports”[ptyp] OR “case report”[ti]) NOT (“Review”[ptyp] OR “review”[ti] OR “Clinical Study”[ptyp] OR “trial”[ti] OR “RCT”[ti]))

Search details Embase

((exp *”gastric bypass surgery”/ OR “bariatric surger*”.ti OR “obesity surger*”.ti OR “gastric bypas*”.ti,ab OR *”Gastric Sleeve”/ OR “Gastric Sleeve”.ti OR “Gastric Sleeves”.ti OR *”Bariatric Surgery”/ OR “Bariatric Surgery”.ti OR “Bariatric Surgical Procedures”.ti OR “Bariatric Surgical Procedure”.ti) AND (exp *”Patient Compliance”/ OR complian*.ti,ab OR noncomplian*.ti,ab OR exp *”Exercise”/ OR “physical activit*”.ti,ab OR “exercis*”.ti,ab OR “fitness”.ti,ab OR *”Fitness”/ OR exp *”Body image”/ OR “body image*”.ti,ab OR exp *”Quality of life”/ OR “quality of life”.ti,ab OR “life quality”.ti,ab OR “QoL”.ti,ab OR exp *”Feeding Behavior”/ OR “eating behav*”.ti,ab OR “food habit*”.ti,ab OR “eating habit*”.ti,ab OR “diet habit*”.ti,ab OR “dietary habit*”.ti,ab OR exp *”Eating Disorder”/ OR “eating disorder*”.ti,ab OR “binge*”.ti,ab OR *”Mental Disease”/ OR “psychopathol*”.ti,ab OR exp *”Depression”/ OR exp *”Mood Disorders”/ OR “depression*”.ti,ab OR “depressive”.ti,ab OR “determinant*”.ti,ab OR “predict*”.ti,ab OR “prognostic*”.ti,ab OR “influenc*”.ti,ab OR exp *”Bipolar Disorder”/ OR “Bipolar”.ti,ab OR “lost to follow-up”.ti,ab OR exp *”Anxiety Disorder”/ OR exp *”anxiety”/ OR anxiet*.ti,ab. OR “phobia”.ti,ab. OR “phobias”.ti,ab. OR “mood”.ti,ab. OR “moods”.ti,ab) AND (exp *”treatment outcome”/ OR “outcome*”.ti,ab OR “effectiveness”.ti,ab OR “effective treatment*”.ti,ab. OR “efficacy”.ti,ab OR exp *”body weight loss”/ OR “weight loss*”.ti,ab OR “weight reduc*”.ti,ab)) NOT ((“Case Report”/ OR “case report”.ti) NOT (exp “Review”/ OR “review”.ti OR “Clinical Study”/ OR exp “clinical trial”/ OR “trial”.ti OR “RCT”.ti)) NOT (conference review or conference abstract).pt NOT (exp “Animals”/ NOT exp “Humans”/)

Search details Cochrane

((“gastric bypass surgery” OR “bariatric surger*” OR “obesity surger*” OR “gastric bypas*” OR “Gastric Sleeve” OR “Gastric Sleeve” OR “Gastric Sleeves” OR “Bariatric Surgery” OR “Bariatric Surgery” OR “Bariatric Surgical Procedures” OR “Bariatric Surgical Procedure”) AND (“Patient Compliance” OR complian* OR noncomplian* OR “Exercise” OR “physical activit*” OR “exercis*” OR “fitness” OR “Fitness” OR “Body image” OR “body image*” OR “Quality of life” OR “quality of life” OR “life quality” OR “QoL” OR “Feeding Behavior” OR “eating behav*” OR “food habit*” OR “eating habit*” OR “diet habit*” OR “dietary habit*” OR “Eating Disorder” OR “eating disorder*” OR “binge*” OR “Mental Disease” OR “psychopathol*” OR “Depression” OR “depression*” OR “depressive” OR “determinant*” OR “predict*” OR “prognostic*” OR “influenc*” OR “Bipolar Disorder” OR “Bipolar” OR “lost to follow-up” OR “anxiet*” OR “phobia” OR “phobias” OR “mood” OR “moods”) AND (“treatment outcome” OR “outcome*” OR “effectiveness” OR “effective treatment*” OR “efficacy” OR “body weight loss” OR “weight loss*” OR “weight reduc*”)):ti,ab,kw
NOT (conference abstract OR meeting abstract):pt

Search details Psycinfo

(TX("gastric bypass surgery" OR "bariatric surger*" OR "obesity surger*" OR "gastric bypas*" OR "Gastric Sleeve" OR "Gastric Sleeve" OR "Gastric Sleeves" OR "Bariatric Surgery" OR "Bariatric Surgery" OR "Bariatric Surgical Procedures" OR "Bariatric Surgical Procedure") AND TX("Patient Compliance" OR complian* OR noncomplian* OR "Exercise" OR "physical activit*" OR "exercis*" OR "fitness" OR "Fitness" OR "Body image" OR "body image*" OR "Quality of life" OR "quality of life" OR "life quality" OR "QoL" OR "Feeding Behavior" OR "eating behav*" OR "food habit*" OR "eating habit*" OR "diet habit*" OR "dietary habit*" OR "Eating Disorder" OR "eating disorder*" OR "binge*" OR "Mental Disease" OR "psychopathol*" OR "Depression" OR "depression*" OR "depressive" OR "determinant*" OR "predict*" OR "prognostic*" OR "influenc*" OR "Bipolar Disorder" OR "Bipolar" OR "lost to follow-up" OR anxiet* OR "phobia" OR "phobias" OR "mood" OR "moods") AND TX("treatment outcome" OR "outcome*" OR "effectiveness" OR "effective treatment*" OR "efficacy" OR "body weight loss" OR "weight loss*" OR "weight reduc*") NOT TI("Case Report"))

Search details Web of Science

((ti=("gastric bypass surgery" OR "bariatric surger*" OR "obesity surger*" OR "gastric bypas*" OR "Gastric Sleeve" OR "Gastric Sleeve" OR "Gastric Sleeves" OR "Bariatric Surgery" OR "Bariatric Surgery" OR "Bariatric Surgical Procedures" OR "Bariatric Surgical Procedure") AND ti=("Patient Compliance" OR complian* OR noncomplian* OR "Exercise" OR "physical activit*" OR "exercis*" OR "fitness" OR "Fitness" OR "Body image" OR "body image*" OR "Quality of life" OR "quality of life" OR "life quality" OR "QoL" OR "Feeding Behavior" OR "eating behav*" OR "food habit*" OR "eating habit*" OR "diet habit*" OR "dietary habit*" OR "Eating Disorder" OR "eating disorder*" OR "binge*" OR "Mental Disease" OR "psychopathol*" OR "Depression" OR "depression*" OR "depressive" OR "determinant*" OR "predict*" OR "prognostic*" OR "influenc*" OR "Bipolar Disorder" OR "Bipolar" OR "lost to follow-up" OR "anxiet*" OR "phobia" OR "phobias" OR "Mood" OR "moods") AND ts=("treatment outcome" OR "outcome*" OR "effectiveness" OR "effective treatment*" OR "efficacy" OR "body weight loss" OR "weight loss*" OR "weight reduc*") NOT ti=(("Case Report" OR "case report") NOT ("review" OR "Clinical Study" OR "clinical trial" OR "trial" OR "RCT")) NOT dt=(meeting abstract)) OR (ti=("gastric bypass surgery" OR "bariatric surger*" OR "obesity surger*" OR "gastric bypas*" OR "Gastric Sleeve" OR "Gastric Sleeve" OR "Gastric Sleeves" OR "Bariatric Surgery" OR "Bariatric Surgery" OR "Bariatric Surgical Procedures" OR "Bariatric Surgical Procedure") AND ts=("Patient Compliance" OR complian* OR noncomplian* OR "Exercise" OR "physical activit*" OR "exercis*" OR "fitness" OR "Fitness" OR "Body image" OR "body image*" OR "Quality of life" OR "quality of life" OR "life quality" OR "QoL" OR "Feeding Behavior" OR "eating behav*" OR "food habit*" OR "eating habit*" OR "diet habit*" OR "dietary habit*" OR "Eating Disorder" OR "eating disorder*" OR "binge*" OR "Mental Disease" OR "psychopathol*" OR "Depression" OR "depression*" OR "depressive" OR "determinant*" OR "predict*" OR "prognostic*" OR "influenc*" OR "Bipolar Disorder" OR "Bipolar" OR "lost to follow-up" OR "anxiet*" OR "phobia" OR "phobias" OR "Mood" OR "moods") AND ti=("treatment outcome" OR "outcome*" OR "effectiveness" OR "effective treatment*" OR "efficacy" OR "body weight loss" OR "weight loss*" OR "weight reduc*") NOT ti=(("Case Report" OR "case report") NOT ("review" OR "Clinical Study" OR "clinical trial" OR "trial" OR "RCT")) NOT dt=(meeting abstract))) NOT ti=("veterinary" OR "rabbit" OR "rabbits" OR "animal" OR "animals" OR "mouse" OR "mice" OR "rodent" OR "rodents" OR "rat" OR "rats" OR "pig" OR "pigs" OR "porcine" OR "horse" OR "horses" OR "equine" OR "cow" OR "cows" OR "bovine" OR "goat" OR "goats" OR "sheep" OR "ovine" OR "canine" OR "dog" OR "dogs" OR "feline" OR "cat" OR "cats")
NOT dt=(conference abstract)

Search details Emcare

((exp *"gastric bypass surgery"/ OR "bariatric surger*".ti OR "obesity surger*".ti OR "gastric bypas*".ti,ab OR *"Gastric Sleeve"/ OR "Gastric Sleeve".ti OR "Gastric Sleeves".ti OR *"Bariatric Surgery"/ OR "Bariatric Surgery". ti OR "Bariatric Surgical Procedures".ti OR "Bariatric Surgical Procedure".ti) AND (exp *"Patient Compliance"/ OR complian*.ti,ab OR noncomplian*.ti,ab OR exp *"Exercise"/ OR "physical activit*".ti,ab OR "exercis*".ti,ab OR "fitness".ti,ab OR *"Fitness"/ OR exp *"Body image"/ OR "body image*".ti,ab OR exp *"Quality of life"/ OR "quality of life".ti,ab OR "life quality".ti,ab OR "QoL".ti,ab OR exp *"Feeding Behavior"/ OR "eating behav*".ti,ab OR "food habit*".ti,ab OR "eating habit*".ti,ab OR "diet habit*".ti,ab OR "dietary habit*".ti,ab OR exp *"Eating Disorder"/ OR "eating disorder*".ti,ab OR "binge*".ti,ab OR *"Mental Disease"/ OR "psychopathol*".ti,ab OR exp *"Depression"/ OR exp *"Mood Disorders"/ OR "depression*".ti,ab OR "depressive".ti,ab OR "determinant*". ti,ab OR "predict*".ti,ab OR "prognostic*".ti,ab OR "influenc*".ti,ab OR exp *"Bipolar Disorder"/ OR "Bipolar".

ti,ab OR "lost to follow-up".ti,ab OR exp *"Anxiety Disorder"/ OR exp *"anxiety"/ OR anxiet*.ti,ab. OR "phobia".ti,ab. OR "phobias".ti,ab. OR "mood".ti,ab. OR "moods".ti,ab) AND (exp *"treatment outcome"/ OR "outcome*".ti,ab OR "effectiveness".ti,ab OR "effective treatment*".ti,ab. OR "efficacy".ti,ab OR exp *"body weight loss"/ OR "weight loss*".ti,ab OR "weight reduc*".ti,ab)) NOT (("Case Report"/ OR "case report".ti) NOT (exp "Review"/ OR "review".ti OR "Clinical Study"/ OR exp "clinical trial"/ OR "trial".ti OR "RCT".ti))

Appendix 2: Risk of bias (RoB) table.

			Selection				Comparability	Outcome			
	Author	Year	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*	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
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

			Selection				Comparability	Outcome			
	Author	Year	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*	RoB
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
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

Low RoB (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 RoB (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 Rob (poor quality): 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 or 1 stars in outcome/exposure domain

3

Long-Term Weight Loss and Attendance Outcomes Following Metabolic and Bariatric Surgery: An Evaluation of The Cleveland Clinic Behavioral Rating System

Anne Jacobs
Karlijn Vermeer
Anna N. Slok
Ignace M.C. Janssen
Rob A.E.M. Tollenaar
Valerie M. Monpellier

Obes Surg. 2024 Nov;34(11):4166-4178

Abstract

Introduction

Interdisciplinary guidelines recommend preoperative psychological evaluation before metabolic and bariatric surgery (MBS). The Cleveland Clinic Behavioral Rating System (CCBRS) has been developed to evaluate the psychological state of individuals undergoing MBS. However, its predictive value concerning long-term weight loss and follow-up attendance has not been extensively studied. This study aims to assess the predictive value of the CCBRS regarding weight loss and follow-up attendance up to five years after MBS.

Methods

In this cohort study (n=1,236), psychologists administered the CCBRS to each patient prior to MBS in addition to the standard psychosocial-behavioral screening. The CCBRS consists of nine psychological domains and is scored on a five-point Likert scale, from 'poor' to 'excellent'. Linear mixed models and ordinal regression analysis were used to analyze the percentage total weight loss over time and follow-up attendance up to five years after surgery.

Results

A total of 1,086 patients underwent subsequent MBS. Significant differences in weight loss and follow-up attendance were observed between some CCBRS groups compared to the reference group 'excellent'. However, these differences were not consistent across all groups within any given domain.

Conclusion

In this cohort, the predictive value of the CCBRS for weight loss and follow-up attendance up to five years after MBS was limited. It is important to consider certain limitations, such as considerable loss to follow-up. Nevertheless, the CCBRS remains valuable for structured psychological assessments by helping to identify patients' strengths and areas needing improvement.

Introduction

International guidelines on metabolic and bariatric surgery (MBS) recommend that all patients who are referred for MBS undergo a psychological evaluation prior to the procedure to identify any potential vulnerabilities and areas of concern that may impact treatment outcomes and long-term adherence, as well as to enable appropriate postoperative monitoring [1, 2]. The guidelines also outline what elements should be included in this psychological assessment. However, the specific implementation of these guidelines varies between institutions, and a variety of tools are available for assessing multiple domains of concern [3].

The Cleveland Clinic has developed a comprehensive instrument for evaluating the psychological state of individuals seeking MBS, known as the Cleveland Clinic Behavioral Rating System (CCBRS) [4]. The goal of the CCBRS is to provide a succinct summary of the patient's strengths and areas for improvement, with a particular emphasis on assessing their 'readiness' for the procedure, instead of delivering a final decision on whether they meet the necessary requirements. This system consists of nine discrete domains, including eight psychosocial domains (consent, expectations, social support, adherence, coping/stressors, mental health, substance use/abuse/dependence, eating behaviors) and an overall impression domain.

Although the CCBRS was not originally designed for the prediction of post-operative weight loss or attendance to follow-up, it has been investigated in prior studies, showing varying outcomes [4-6]. The CCBRS was found to be a useful instrument for the psychosocial assessment among 389 patients undergoing MBS (Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy and laparoscopic adjustable gastric banding) in the United States [4]. In this study, the CCBRS predicted the duration of hospital stay, but did not predict postoperative weight loss up to one year after MBS. Another study in the United States included 179 patients and illustrated that the domains 'social support', 'coping' and 'overall impression' were associated with better attendance to follow-up, while only the domain 'social support' had a significant association with weight loss two years after MBS [5]. In contrast, a recent study by the same author solely focused on the CCBRS domain 'social support' and found no association with postoperative weight loss or attendance at two-year follow-up [6]. Researchers advised further research should assess the predictive utility of the tool for longer term postoperative weight loss [4]. The CCBRS was implemented in the Dutch guideline for Bariatric psychology to facilitate structured psychodiagnostic screening aimed at identifying risk factors that may impede optimal weight

loss outcomes or may elevate the likelihood of postoperative psychological complications [7].

Thus, the CCBRS is believed to be a useful tool for the preoperative psychological evaluation of individuals undergoing MBS. However, no previous research evaluated the predictive value of the CCBRS on longer term weight loss and attendance to follow-up after MBS in a large study population. Therefore, the aim of this study is to evaluate the predictive value of the CCBRS on weight loss and attendance up to five years after MBS in a Dutch sample.

Methods

Patient and data selection

In this prospective cohort study, all participants were screened between February 2016 and July 2017 at one location of a multicenter outpatient clinic for MBS in The Netherlands. The treatment at the clinic comprises a comprehensive pre- and postoperative counseling program [8]. The preoperative program consists of six group sessions conducted over a six-week period prior to surgery, and the postoperative program comprises eleven sessions in the first year following surgery, with subsequent yearly follow-up appointments up to five years after the procedure.

This study was approved by the Medical Ethical committee (METC Zuidwest Holland 19-005). Data was collected up to the 27th of December 2022.

Standard psychosocial-behavioral evaluation

Before being accepted for treatment, patients were screened according to the International Federation for the Surgery of Obesity criteria by a multidisciplinary team comprising of a medical doctor, dietitian, and a psychologist [1]. In this study, patients were evaluated by one of the seven psychologists working at the clinic in The Hague.

The psychosocial-behavioral assessment protocol implemented at the clinic starts with the completion of two questionnaires by the patient, prior to undergoing the preoperative screening process. The first questionnaire is the Brief Symptom Inventory, which encompasses nine symptom dimensions of depression, namely somatization, obsession-compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism [9]. The second ques-

tionnaire is an intake questionnaire specifically developed by the clinic, designed to gather information on various subjects including the patient's eating pattern, symptoms of binge eating disorder or bulimia, previous psychological illnesses and/or treatment, and the use of alcohol, drugs, or tobacco. The psychologist then conducts a semi-structured interview, which covers topics such as the reasons for seeking MBS, the patient's expectations for the treatment, and any potential pitfalls, such as emotional-eating or irregular work patterns. The interview also evaluates the patient's social support system, mood and mood disorders, the presence of social phobia, post-traumatic stress disorder, psychosis, (binge) eating disorders or other chronic psychiatric disorders, substance use, motivation for behavioral change, and the patient's suitability for group therapy. Additionally, the psychosocial-behavioral evaluation aims to identify any potential postoperative risk factors. Finally, the patient's case is discussed by the multidisciplinary team, who make a recommendation for treatment ('positive,' 'postponed decision,' or 'negative'). Alongside this recommendation, tailored propositions for subsequent treatment are provided, considering the specific pitfalls and areas for improvement identified in each patient. For example, proposing a preliminary consultation to address emotional eating tendencies—a potential pitfall that necessitates attention but does not warrant a negative screening recommendation. Reasons for a 'postponed decision' include the patient's requirement for guidance from a registered dietitian, as well as the need for psychological evaluation and treatment, for conditions such as depressive disorder or (symptoms of) binge eating disorder, prior to the patient being suitable for surgery.

Cleveland Clinic Behavioral Rating System

The CCBRS evaluates nine domains that are believed to be important for the patient's psychosocial consultation, including consent, expectations, social support, adherence, coping/stressors, mental health, substance use/abuse/dependence, eating behaviors, and overall impression [4]. Each domain is assessed by a licensed psychologist using a five-point Likert scale. The ratings were classified as follows: 5 for 'excellent', indicating no concerns and no further psychological follow-up is needed unless problems arise in the future; 4 for 'good', indicating a manageable problem with concerns that can be addressed without significant intervention; 3 for 'fair', indicating the presence of concerns or risk factors that are reasonably controlled or managed, with a balance between the patient's strengths and areas for improvement; 2 for 'guarded', indicating the strong recommendation for intervention before proceeding and requiring discussion in multidisciplinary rounds; and 1 for 'poor', indicating an inappropriate risk that very likely outweighs benefits.

In this study, all psychologists were instructed to administer the CCBRS to each patient in addition to the standard psychosocial-behavioral evaluation that was conducted during the screening process. Prior to the initiation of the study, the psychologists underwent a training process, which involved written instructions detailing how to accurately complete the CCBRS assessment. Furthermore, a collaborative session involving all psychologists was conducted to review and discuss examples, thereby reinforcing the standardized approach. Additionally, a subsequent session was organized to verify consistent implementation of the assessment methodology across the team. These efforts were aimed at maintaining uniformity in the application of the CCBRS and enhancing its reliability. Lastly, it should be noted that the results obtained from the CCBRS had no impact on the ultimate decision regarding a patient's suitability for surgery in this study.

Body weight and other parameters

The study data were collected from the prospectively maintained database of the clinic. It encompassed patient demographic information (age and gender), along with the presence of obesity-associated medical problems such as hypertension, diabetes mellitus, hyperlipidemia, and obstructive sleep apnea. Details regarding the type of surgery were also recorded, and whether it was the primary or secondary bariatric-metabolic procedure (surgical revision). Additionally, measurements of height and weight were taken during the initial screening at the clinic and weight was also measured at the start of the preoperative care program, and during subsequent follow-up appointments up to five years after surgery (at intervals of 3, 6, 12, 18, 24, 36, 48, and 60 months). From March 2020 to August 2021, patients provided self-reported bodyweight due to telephone appointments prompted by the COVID-19 pandemic. Baseline and all follow-up measurements were used to calculate (change in) body mass index (BMI) and percentage Total Weight Loss (%TWL): %TWL = ((preoperative weight – weight at follow-up) / preoperative weight) x 100%.

Statistical analysis

Descriptive statistics were used to summarize the baseline characteristics of the population and CCBRS scores. Different groups were compared: patients scored with the CCBRS versus those who were not, patients who underwent MBS versus those who did not, and patients who attended versus those who did not attend the five-year follow-up appointment. Continuous variables were analyzed using student's *t* test and binary variables with the χ^2 test.

Visual representations of the %TWL over time were generated for the entire study population, as well as for CCBRS scores for the 'overall impression' domain, where a higher %TWL corresponds to more weight loss. Linear mixed models were used to analyze %TWL over time up to five years after MBS. Subsequently, a linear mixed model was conducted to assess the association between %TWL and each separate domain of the CCBRS. Five study groups were established based on the CCBRS score categories assigned by the psychologist (5: 'excellent', 4: 'good', 3: 'fair', 2: 'guarded' and 1: 'poor'). First, to evaluate differences in %TWL between the five study groups, a crude linear mixed model was conducted with CCBRS score categories as predictor and %TWL as outcome. Second, an adjusted model was conducted with age at day of surgery, gender, type of surgery, surgical revision and preoperative BMI as confounders.

For each patient, the number of attended follow-up appointments from years one to five was calculated. Individuals who attended all follow-up visits were assigned a score of five, while those who missed all sessions received a score of zero. This resulted in the creation of six distinct groups based on attendance score. Ordinal regression analyses were used to examine the association between CCBRS scores and the attendance scores up to the five-year follow-up visit. Again, a crude model was initially created, which was then adjusted for age at day of surgery, gender, type of surgery, surgical revision and preoperative BMI. The outcome category 'excellent' was used as the reference category for both the linear mixed models and ordinal regression analyses. The log odds and corresponding confidence intervals of each model were converted to odds ratios (OR) and presented in the tables.

Above analyses were conducted using IBM SPSS Statistics for Mac, version 27.0. A p-value of less than 0.05 was considered statistically significant.

Results

Study population

A total of 2,190 patients were screened during a period extending from February 2016 to July 2017. Of these, 954 patients (44%) were excluded from the study as their CCBRS scores were not recorded (Figure 1). The baseline characteristics of patients scored with the CCBRS and those not scored were comparable for both groups (Table 1). In 1,236 patients a CCBRS score was available, and these patients were included in the study. The mean age of the study population was 43.2 (±11.7) years,

with 75.6% of the participants being female (Table 2). The mean BMI at screening was 43.5 (±5.7) kg/m^2.

A total of 1,086 patients (88%) were assessed with the CCBRS and underwent subsequent MBS, while 150 patients (12%) did not undergo surgery. RYGB was the most frequently performed surgical procedure (n=769, 70.8%). The group of patients who underwent surgery had a higher percentage of female patients compared to the group who did not undergo surgery (77.3% versus 63.3%, Table 2).

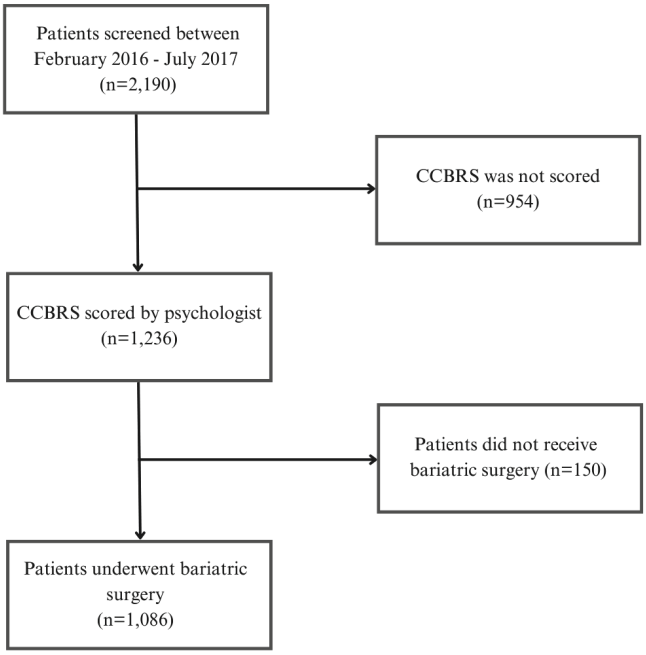


Figure 1. Flowchart of the study population

CCBRS: Cleveland Clinic Behavioral Rating System+

Table 1. Baseline characteristics, comparing patients who were and were not scored with the CCBRS. Presented as mean ± standard deviation or n (%).

	All (n=2,190)	Scored with CCBRS (n=1,236)	Not scored with CCBRS (n=954)	P-value
Age at screening, years	43.6±11.8	43.3±11.7	44.0±12.0	.155
Sex				
Female	1657 (75.7)	935 (75.6)	722 (75.7)	.985
Weight, kg				
Preoperative screening	123.6±21.4	124.1±21.2	122.9±21.6	.207
Body Mass Index, kg/m²				
Preoperative screening	43.3±5.7	43.5±5.7	43.1±5.7	.181
Associated medical problems				
Hypertension	761 (34.7)	445 (36.0)	316 (33.1)	<.001
Type II diabetes	429 (19.6)	253 (20.5)	176 (18.4)	<.001
Dyslipidemia	429 (19.6)	239 (19.3)	190 (19.9)	<.001
Sleepapnea	365 (16.7)	200 (16.2)	165 (17.3)	<.001
Osteoarthritis	301 (13.7)	183 (14.8)	118 (12.4)	<.001

CCBRS: Cleveland Clinic Behavioral Rating System

Table 2. Baseline characteristics of the included population, comparing patients who had surgery with patients who did not have surgery. Presented as mean ± standard deviation or n (%).

	All (n=1,236)	Surgery (n=1,086)	No surgery (n=150)	P-value
Age at screening, years	43.2±11.7	43.2±11.6	43.7±12.5	.708
Sex				
Female	935 (75.6)	840 (77.3)	95 (63.3)	<.001
Weight, kg				
Preoperative screening	124.1±21.2	124.1±20.7	124.0±25.7	.926
Body Mass Index, kg/m²				
Preoperative screening	43.5±5.7	43.5±5.6	43.0±6.8	.360
Start preoperative counselling program		43.7±5.6		
Associated medical problems				
Hypertension	445 (36.0)	398 (36.6)	47 (31.3)	<.001
Type II diabetes	253 (20.5)	234 (21.5)	19 (12.7)	<.001
Dyslipidemia	239 (19.3)	216 (19.9)	23 (15.3)	<.001
Sleepapnea	200 (16.2)	178 (16.4)	22 (14.7)	<.001
Osteoarthritis	183 (14.8)	171 (15.7)	12 (8.0)	<.001
Surgical method				

Table 2. Baseline characteristics of the included population, comparing patients who had surgery with patients who did not have surgery. Presented as mean ± standard deviation or n (%). *(Continued)*

	All (n=1,236)	Surgery (n=1,086)	No surgery (n=150)	P-value
Roux-en-Y gastric bypass		769 (70.8)		
Sleeve gastrectomy		294 (27.1)		
Single Anastomosis Duodenal Ileal bypass		14 (1.3)		
One-Anastomosis Gastric Bypass		6 (0.6)		
Elongated Roux-en-Y gastric bypass		3 (0.3)		
Primary procedure		1038 (95.6)		
Secondary procedure		48 (4.4)		

Distribution of CCBRS scores

Upon examination of the assigned scores for each CCBRS domain, the score of 'poor' was assigned the least frequently, with a range of one to nineteen patients per domain (Table 3). Most patients received a score of 'good' on seven out of the nine domains. Only in the 'consent' and 'chemical/alcohol abuse/dependence' domains did most patients receive a score of 'excellent'. Patients who underwent MBS were assigned higher scores in every domain, when compared to those who did not receive surgery.

Postoperative weight loss

Highest weight loss was attained eighteen months after surgery, with an average %TWL of 31.8 (±8.7, Figure 2) and mean change in BMI of 13.9 kg/m^2 *(±4.3). Five years after surgery this percentage had decreased to a mean %TWL of 25.8 (±9.9) and mean change in BMI of 11.0* kg/m^2 *(±4.6).*

Table 3 The assigned scores of all included patients for each CCBRS domain. Presented as number (%).

CCBRS domain	Population	CCBRS score				
		Poor	Guarded	Fair	Good	Excellent
1. Consent (includes capacity to consent, possible cognitive impairment, understanding of risks, benefits, alternative treatment)	Total	11 (0.9)	59 (4.8)	247 (20.0)	459 (37.1)	460 (37.2)
	Surgery	9 (0.8)	46 (4.2)	203 (18.7)	409 (37.7)	419 (38.6)
	No surgery	2 (1.3)	13 (8.7)	44 (29.3)	50 (33.3)	41 (27.3)
2. Expectations (includes realistic nature of surgery, recovery, early transition, weight loss goals, effect on relationships, quality of life, long-term outcome)	Total	1 (0.1)	44 (3.6)	285 (23.1)	632 (51.1)	274 (22.2)
	Surgery	0	30 (2.8)	231 (21.3)	573 (52.8)	252 (23.2)
	No surgery	1 (0.7)	14 (9.3)	54 (36.0)	59 (39.3)	22 (14.7)
3. Social support (includes spouse or significant other, children, family members, friends, employer, co-workers; also includes past conversations with bariatric patients, attendance at support groups)	Total	5 (0.4)	70 (5.7)	228 (18.4)	610 (49.4)	323 (26.1)
	Surgery	3 (0.3)	52 (4.8)	188 (17.3)	547 (50.4)	296 (27.3)
	No surgery	2 (1.3)	18 (12.0)	40 (26.7)	63 (42.0)	27 (18.0)
4. Mental health (includes psychiatric diagnosis and severity and duration of diagnosis; determination should be based on effect of illness on cognitive capacity, present stability/instability of illness, current treatment, adherence to treatment recommendations, psychosocial stresses that could affect illness and patient insight)	Total	14 (1.1)	101 (8.2)	318 (25.7)	494 (40.0)	308 (24.9)
	Surgery	8 (0.7)	80 (7.4)	272 (25.0)	445 (41.0)	280 (25.8)
	No surgery	6 (4.0)	21 (14.0)	46 (30.7)	49 (32.7)	28 (18.7)
5. Chemical/alcohol abuse/dependence (includes use, abuse, and dependence on alcohol, prescription drugs, and illicit drugs; include history and present use in determination; if history positive, consider period of sobriety and relapse risk; weigh tobacco use/likelihood of quitting in assessment)	Total	4 (0.3)	37 (3.0)	197 (15.9)	415 (33.6)	583 (47.2)
	Surgery	3 (0.3)	29 (2.7)	164 (15.1)	363 (33.4)	527 (48.5)
	No surgery	1 (0.7)	8 (5.3)	33 (22.0)	52 (34.7)	56 (37.3)

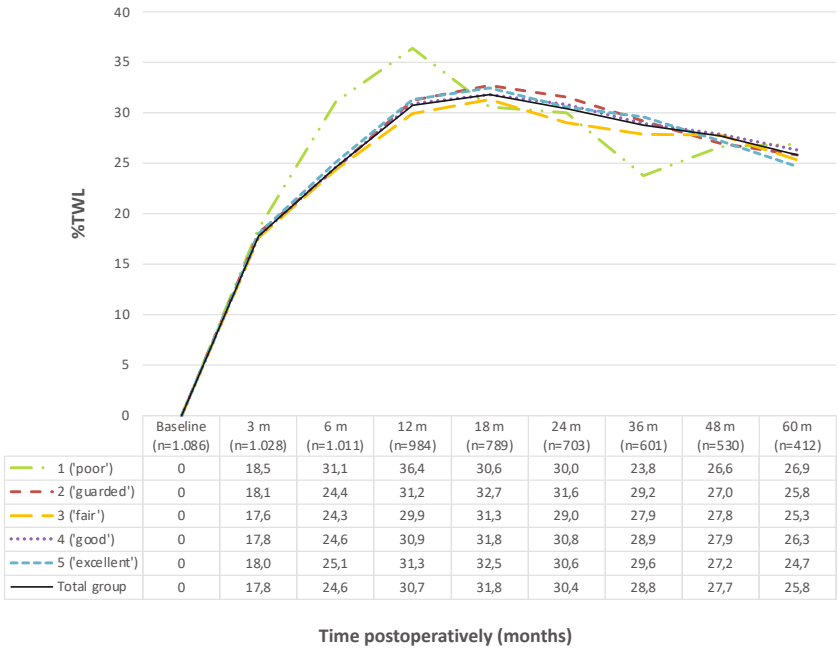
Table 3 The assigned scores of all included patients for each CCBRS domain. Presented as number (%). *(Continued)*

CCBRS domain	Population	CCBRS score				
		Poor	Guarded	Fair	Good	Excellent
6. Eating behaviors (includes binge eating behaviors, night eating behaviors, compensatory behaviors, history of eating disordered behaviors, and problematic outcomes from past dieting attempts; consider behaviors [eg, "grazing," high-calorie beverage consumption] that might affect outcome)	Total	19 (1.5)	135 (10.9)	498 (40.3)	545 (44.1)	39 (3.2)
	Surgery	12 (1.1)	109 (10.0)	429 (39.5)	501 (46.1)	35 (3.2)
	No surgery	7 (4.7)	26 (17.3)	69 (46.0)	44 (29.3)	4 (2.7)
7. Adherence (includes adherence during previous dieting attempts, adherence with past psychological/psychiatric interventions, adherence with medical recommendations, and likely adherence with tobacco prohibition and program protocol)	Total	13 (1.1)	79 (6.4)	414 (33.5)	587 (47.5)	142 (11.5)
	Surgery	11 (1.0)	59 (5.4)	351 (32.3)	531 (48.9)	133 (12.2)
	No surgery	2 (1.3)	20 (13.3)	63 (42.0)	56 (37.3)	9 (6.0)
8. Coping/stressors (includes an assessment of coping resources in the context of situational stressors)	Total	11 (0.9)	115 (9.3)	412 (33.3)	593 (48.0)	104 (8.4)
	Surgery	7 (0.6)	85 (7.8)	356 (32.8)	537 (49.4)	100 (9.2)
	No surgery	4 (2.7)	30 (20.0)	56 (37.3)	56 (37.3)	4 (2.7)
9. Overall impression	Total	12 (1.0)	110 (8.9)	365 (29.5)	596 (48.2)	150 (12.1)
	Surgery	7 (0.6)	76 (7.0)	307 (28.3)	548 (50.5)	145 (13.4)
	No surgery	5 (3.3)	34 (22.7)	58 (38.7)	48 (32.0)	5 (3.3)

Total population n=1,236, surgery n=1,086, no surgery n=150

Association between weight loss and CCBRS scores

The weight loss for each CCBRS score within the 'overall impression' domain is graphically presented in Figure 2. The CCBRS score category with the highest %TWL varied depending on the follow-up time point. The group categorized as 'poor' in this domain consisted of four patients at the six-month follow-up and two patients at the five-year follow-up.



	Baseline (n=1.086)	3 m (n=1.028)	6 m (n=1.011)	12 m (n=984)	18 m (n=789)	24 m (n=703)	36 m (n=601)	48 m (n=530)	60 m (n=412)
1 ('poor')	0	18,5	31,1	36,4	30,6	30,0	23,8	26,6	26,9
2 ('guarded')	0	18,1	24,4	31,2	32,7	31,6	29,2	27,0	25,8
3 ('fair')	0	17,6	24,3	29,9	31,3	29,0	27,9	27,8	25,3
4 ('good')	0	17,8	24,6	30,9	31,8	30,8	28,9	27,9	26,3
5 ('excellent')	0	18,0	25,1	31,3	32,5	30,6	29,6	27,2	24,7
Total group	0	17,8	24,6	30,7	31,8	30,4	28,8	27,7	25,8

Figure 2. Percentage Total Weight Loss (%TWL) for the CCBRS-score categories in the domain 'overall impression'.

m= months after surgery, n=number of patients

Crude and adjusted linear mixed models were performed for each domain of the CCBRS (Table 4). Adjusted linear mixed model analysis showed that patients with a 'fair' score had a lower %TWL over time compared to the reference group 'excellent' in the domains 'consent' (β -1.30; 95% CI [-2.41 – -0.19]) and 'mental health' (β -1.30; 95% CI [-2.41 – -0.19]). However, for none of these domains there were significant or clinically relevant differences with the other groups. For example, within the 'consent' domain, patients with a 'good' score did not exhibit greater weight loss compared to patients scoring 'poor' or 'guarded'. In the domain 'social support', the 'good' group had a lower %TWL over time compared to the reference group (β -1.12

[-2.05 – -0.19]). No statistically significant difference in %TWL over time was observed for any other groups and domains.

Table 4 Percentage total weight loss over time using linear mixed models for each CCBRS domain, with group 'excellent' used as the reference category for each model, presented as β-coefficient [95% confidence interval].

CCBRS-domain and groups	Crude model	Adjusted model†
1. Consent	27.23 [26.56 – 27.90]	19.47 [15.15 – 23.79]
Poor	0.96 [-3.99 – 5.91]	0.00 [-4.66 – 4.66]
Guarded	-0.15 [-2.33 – 2.02]	-0.20 [-2.25 – 1.84]
Fair	-1.52 [-2.70 – -0.34]*	-1.30 [-2.41 – -0.19]*
Good	-0.66 [-1.61 – 0.30]	-0.77 [-1.66 – 0.13]
2. Expectations	26.55 [25.68 – 27.42]	18.94 [14.59 – 23.29]
Poor	–	–
Guarded	-1.48 [-4.29 – 1.34]	-1.65 [-4.30 – 1.01]
Fair	0.13 [-1.13 – 1.39]	0.09 [-1.10 – 1.27]
Good	0.31 [-0.73 – 1.35]	0.09 [-0.89 – 1.07]
3. Social support	27.62 [26.83 – 28.42]	19.58 [15.24 –23.91]
Poor	5.09 [-4.39 – 14.56]	4.82 [-4.05 – 13.70]
Guarded	-1.58 [-3.69 – 0.53]	-1.41 [-3.39 – 0.57]
Fair	-1.20 [-2.49 – 0.96]	-0.91 [-2.13 –0.30]
Good	-1.29 [-2.27 – -0.30]*	-1.12 [-2.05 – -0.19]*
4. Mental health	27.23 [26.41 – 28.04]	19.64 [15.27 – 24.01]
Poor	1.78 [-3.88 – 7.43]	2.14 [-3.16 – 7.45]
Guarded	-0.37 [-2.15 – 1.40]	-0.69 [-2.36 –0.97]
Fair	-1.10 [-2.27 – 0.07]	-1.30 [-2.41 – -0.19]*
Good	-0.55 [-1.59 – 0.49]	-0.74 [-1.73 – 0.24]
5. Chemical/alcohol abuse/dependence	26.47 [25.87 – 27.07]	18.69 [14.39 – 23.00]
Poor	-6.72 [-14.69 – 1.26]	-3.89 [-11.41 – 3.64]
Guarded	1.48 [-1.15 – 4.10]	1.34 [-1.15 – 3.84]
Fair	0.37 [-0.89 – 1.62]	0.62 [-0.56 – 1.81]
Good	0.48 [-0.46 – 1.41]	0.43 [-0.45 – 1.31]
6. Eating behaviors	27.49 [25.21 – 29.78]	19.75 [15.05 – 24.45]
Poor	0.61 [-4.08 – 5.30]	1.17 [-3.23 – 5.58]
Guarded	0.11 [-2.54 – 2.77]	-0.30 [-2.81 – 2.20]
Fair	-1.03 [-3.41 – 1.36]	-1.11 [-3.35 – 1.14]
Good	-0.86 [-3.23 – 1.51]	-1.01 [-3.24 – 1.21]
7. Adherence	26.99 [25.80 – 28.18]	19.09 [14.67 – 23.51]
Poor	-4.45 [-9.17 – 0.27]	-2.12 [-6.59 – 2.34]

Table 4 Percentage total weight loss over time using linear mixed models for each CCBRS domain, with group 'excellent' used as the reference category for each model, presented as β-coefficient [95% confidence interval]. *(Continued)*

CCBRS-domain and groups	Crude model	Adjusted model†
Guarded	0.57 [-1.67 – 2.80]	0.23 [-1.87 – 2.34]
Fair	-0.86 [-2.26 – 0.54]	-0.77 [-2.10 – 0.55]
Good	0.03 [-1.30 – 1.35]	0.03 [-1.22 – 1.28]
8. Coping/stressors	27.18 [25.82 – 28.55]	19.52 [15.10 –23.94]
Poor	0.31 [-5.96 – 6.58]	0.43 [-5.46 – 6.31]
Guarded	-0.72 [-2.76 – 1.33]	-1.15 [-3.08 –0.78]
Fair	-0.92 [-2.47 – 0.64]	-1.23 [-2.70 – 0.23]
Good	-0.28 [-1.77 – 1.21]	-0.63 [-2.03 –0.77]
9. Overall impression	27.23 [26.09 – 28.36]	19.34 [14.95 – 23.72]
Poor	3.26 [-2.97 – 9.50]	4.11 [-1.74 – 9.96]
Guarded	-0.49 [-2.45 – 1.47]	-0.69 [-2.54 – 1.15]
Fair	-1.05 [-2.44 – 0.34]	-0.92 [-2.23 – 0.38]
Good	-0.41 [-1.69 – 0.86]	-0.71 [-1.91 – 0.49]

† Linear mixed model corrected for age at day of surgery, gender, type of surgery, redo surgery and preoperative BMI. * $p < 0.05$
CCBRS: Cleveland Clinic Behavioral Rating System

Association between attendance to follow-up and CCBRS scores

The attendance at the five-year follow-up after surgery was 37.9% (Table 5). Table 6 provides an overview of the number of yearly follow-up appointments attended per patient. Notably, 6.4% of patients attended none of the appointments during these five years, while 24.1% attended all five sessions. Table 7 presents the baseline characteristics of patients who attended and did not attend the five-year follow-up appointment. Those lost to follow-up were younger (42.8 years versus to 45.6 years on average) and had higher preoperative weight (126.1 kg versus to 121.1 kg) and BMI (44.1 kg/m^2 versus to 42.7 kg/m^2) compared to patients who attended the five-year follow-up. Crude and adjusted ordinal regression analyses were performed for each CCBRS domain (Table 8). The analyses illustrated that patients who scored 'poor' in the domains 'consent', 'coping/stressors', and 'overall impression' were less likely to attend the postoperative yearly sessions when compared to the reference group that scored 'excellent' in these domains (OR 0.15 [0.04 – 0.57], 0.19 [0.05 – 0.77] and 0.15 [0.04 – 0.60] respectively). In the 'adherence' domain, both the 'poor' and 'guarded' group were less likely to attend the follow-up appointments (OR 0.25 [0.08 – 0.76] and 0.48 [0.27 – 0.84]) and for the 'expectations' domain this was only the 'guarded'

group (OR 0.48 [0.24 – 0.99]). No statistically significant differences in attendance were observed for the other CCBRS scores or domains.

Table 5 Compliance to postoperative follow-up appointments, presented as number (%).

	Baseline	**3 months**	**6 months**	**12 months**	**18 months**
Present at follow-up	1.086 (100)	1.028 (94.7)	1.011 (93.1)	984 (90.6)	789 (72.7)

	Basline	**24 months**	**36 months**	**48 months**	**60 months**
Present at follow-up	1.086 (100)	703 (64.7)	601 (55.3)	530 (48.8)	412 (37.9)

Table 6 Odds ratio for compliance to follow-up five years after surgery using logistic regression analysis for each CCBRS domain, with group 'excellent' used as the reference category for each model, presented as OR [95% confidence interval].

CCBRS-domain and groups	Crude regression	Adjusted regression†
1. Consent		
Poor	0.19 [0.02 – 1.50]	0.16 [0.02 – 1.35]
Guarded	0.74 [0.39 – 1.42]	0.77 [0.40 – 1.51]
Fair	0.91 [0.65 – 1.29]	0.94 [0.66 – 1.33]
Good	0.88 [0.66 – 1.16]	0.87 [0.65 – 1.16]
2. Expectations		
Poor	-	-
Guarded	0.32 [0.12 – 0.85]*	0.29 [0.10 – 0.79]*
Fair	1.03 [0.72 – 1.49]	1.03 [0.71 – 1.50]
Good	0.99 [0.73 – 1.34]	0.90 [0.66 – 1.23]
3. Social support		
Poor	0.76 [0.07 – 8.48]	1.07 [0.07 – 17.46]
Guarded	0.76 [0.41 – 1.42]	0.75 [0.39 – 1.42]
Fair	0.91 [0.62 – 1.33]	0.99 [0.67 – 1.45]
Good	0.94 [0.70 – 1.25]	0.96 [0.71 – 1.29]
4. Mental health		
Poor	0.56 [0.11 – 2.80]	0.68 [0.12 – 3.78]
Guarded	0.93 [0.55 – 1.57]	0.89 [0.52 – 1.51]
Fair	0.96 [0.68 – 1.35]	0.99 [0.69 – 1.42]
Good	1.13 [0.83 – 1.54]	1.12 [0.82 – 1.54]
5. Chemical/alcohol abuse/dependence		
Poor	0.00 [0.00]	0.00 [0.00]
Guarded	0.70 [0.31 – 1.57]	0.68 [0.30 – 1.56]
Fair	0.68 [0.46 – 0.99]*	0.67 [0.45 – 0.98]*

Table 6 Odds ratio for compliance to follow-up five years after surgery using logistic regression analysis for each CCBRS domain, with group 'excellent' used as the reference category for each model, presented as OR [95% confidence interval]. *(Continued)*

CCBRS-domain and groups	Crude regression	Adjusted regression[†]
Good	1.10 [0.84 – 1.45]	1.10 [0.83 – 1.45]
6. Eating behaviors		
Poor	0.96 [0.24 – 3.84]	1.12 [0.27 – 4.62]
Guarded	0.68 [0.30 – 1.54]	0.86 [0.37 – 1.99]
Fair	1.16 [0.56 – 2.40]	1.47 [0.70 – 3.08]
Good	1.36 [0.66 – 2.79]	1.53 [0.74 – 3.19]
7. Adherence		
Poor	0.00 [0.00]	0.00 [0.00]
Guarded	0.42 [0.21 – 0.83]*	0.43 [0.21 –0.88]*
Fair	0.73 [0.49 – 1.10]	0.84 [0.55 – 1.27]
Good	0.85 [0.58 – 1.25]	0.90 [0.61 – 1.33]
8. Coping/stressors		
Poor	0.68 [0.13 – 3.69]	0.60 [0.11 – 3.34]
Guarded	0.91 [0.50 – 1.68]	0.98 [0.52 – 1.82]
Fair	0.94 [0.59 – 1.49]	1.04 [0.65 – 1.66]
Good	1.17 [0.75 – 1.81]	1.26 [0.80 – 1.97]
9. Overall impression		
Poor	0.66 [0.12 – 3.49]	0.63 [0.11 – 3.51]
Guarded	0.64 [0.35 – 1.17]	0.64 [0.34 – 1.18]
Fair	0.93 [0.62 –1.40]	1.03 [0.68 – 1.56]
Good	1.13 [0.78 – 1.65]	1.14 [0.78 – 1.68]

[†] Logistic regression analysis corrected for age at day of surgery, gender, type of surgery, redo surgery and preoperative BMI. * $p < 0.05$

Table 7 Baseline characteristics, comparing patients who were and were not scored with the CCBRS. Presented as mean ± standard deviation or n (%).

	All (n=2,190)	Scored with CCBRS (n=1,236)	Not scored with CCBRS (n=954)	P-value
Age at screening, years	43.6±11.8	43.3±11.7	44.0±12.0	.155
Sex				
Female	1657 (75.7)	935 (75.6)	722 (75.7)	.985
Weight, kg				
Preoperative screening	123.6±21.4	124.1±21.2	122.9±21.6	.207
Body Mass Index, kg/m²				
Preoperative screening	43.3±5.7	43.5±5.7	43.1±5.7	.181
Associated medical problems				
Hypertension	761 (34.7)	445 (36.0)	316 (33.1)	<.001
Type II diabetes	429 (19.6)	253 (20.5)	176 (18.4)	<.001
Dyslipidemia	429 (19.6)	239 (19.3)	190 (19.9)	<.001
Sleepapnea	365 (16.7)	200 (16.2)	165 (17.3)	<.001
Osteoarthritis	301 (13.7)	183 (14.8)	118 (12.4)	<.001

CCBRS: Cleveland Clinic Behavioral Rating System
CCBRS: Cleveland Clinic Behavioral Rating System

Discussion

The aim of the present study was to evaluate the predictive value of the CCBRS on weight loss and follow-up attendance up to five years after MBS. Postoperative weight loss and attendance were compared for different CCBRS scores in each domain separately. The findings revealed that the CCBRS did not predict weight loss, nor follow-up attendance up to five years after surgery in this study, which supports the continued need for a comprehensive and personalized approach.

Most patients in this study were rated as having a 'good' score across most of the domains assessed by the CCBRS, while only a small number of patients were classified as 'poor' in all domains. These findings are consistent with prior research, which reported that most patients received scores of 'fair' or 'good' across various domains, according to the CCBRS developers [4]. However, the proportion of patients receiving an 'excellent' rating in the present study was significantly higher than in previous research, ranging from 3.2% to 47.2%, depending on the domain assessed. This difference may be attributed to variations in the study population from different geographic regions, where cultural and social determinants may impact patients' health status and functional outcomes. Moreover, it should be

noted that the scoring of the CCBRS is subjective, and the observed differences could also be attributed to inter-rater variations between different regions.

The findings of the present study indicate that the predictive value of the CCBRS for weight loss up to five years after surgery was limited. In three out of nine domains, only one group demonstrated a statistically significant difference in postoperative weight loss when compared to the reference group. The observed differences in %TWL are considered not clinically significant, as they amount to only a small difference ranging from 1.21% to 1.30%. Considering the average preoperative weight of 124 kg, this difference in weight loss translates to a mere 1.5-1.6 kg, which will not to make a meaningful impact on a patient's weight or health outcomes. Furthermore, the beta coefficients observed in all nine domains did not consistently favor one of the CCBRS scores, which suggests that there is no clear association between the CCBRS score and postoperative weight loss. These findings are consistent with prior studies, reaffirming the ongoing limited prognostic value of preoperative psychological conditions in general in relation to weight loss after MBS [10, 11].

Only 24.1% of patients attended all five yearly follow-up appointments and 37.9% attended the five-year follow-up appointment. It is known that attendance to follow-up appointments after MBS is a challenge in most bariatric programs and research has consistently shown that attrition rates vary significantly across studies [12]. In addition, the 2018 Fourth IFSO Global Registry Report revealed that even at one-year follow-up, data for weight loss were available for less than half of the patients and that analyses relying on follow-up data should be interpreted bearing this consideration in mind [13]. To limit the impact of loss to follow-up, all available follow-up time points were included into the analysis. Linear mixed models and ordinal regression analyses were used to comprehensively analyze the data, instead of focusing on the outcomes solely five years after surgery. Moreover, baseline characteristics of patients who were lost to follow-up were largely comparable to those who attended the five-year appointment, except for differences in age and preoperative weight/BMI. This similarity suggests comparability between the groups, suggesting that the sample is representative and less susceptible to bias. Previous research also suggests that younger individuals are more likely to be lost to follow-up [14]. Nevertheless, the significant loss to follow-up must be considered when interpreting the results.

Previous research found that the CCBRS domains 'social support', 'coping' and 'overall impression' were associated with attendance to follow-up two years after MBS

[5], while in a more recent study the domain 'social support' was not associated with attendance up to two years after surgery [6]. The current study suggests that there is no clear association between CCBRS scores and attendance to follow-up. Few significant associations were found, though they were never observed across all groups within a single domain. These significant associations were predominantly in the 'poor' group, which is characterized by a small sample size in this cohort. The percentage of patients categorized as 'poor' ranged from 0.1% to 1.5% across the different domains, which is similar to the proportion reported in prior research, where 2.6% of patients were classified as 'poor' [4]. However, this low proportion may have negatively skewed the data and poses a challenge for making definitive statements regarding weight loss and attendance to follow-up, especially in this subgroup, as it increases the susceptibility of the results to individual variations in outcomes. Therefore, caution should be exercised when interpreting the results of this group. It is also important to note that the groups showing significant differences in attendance were different from the groups that showed differences in weight loss. The statistically significant differences observed in certain groups for weight loss and attendance could potentially be attributed to chance. The likelihood of accidentally identifying a significant difference increases as more analyses are conducted on a larger number of groups, even if such differences may not be clinically relevant. It is probable that if the analyses were repeated on a different cohort, other groups and domains would be found to be statistically different by chance alone.

The association between preoperative psychological factors and postoperative outcomes in MBS remains complicated. According to international guidelines, patients with severe psychological concerns should undergo thorough mental health evaluations and/or treatment before MBS [1]. Therefore, the absence of an association between CCBRS domains and outcomes after MBS could also suggest the success of preoperative treatment, making it difficult to establish an effect of the initial diagnosis on postoperative outcomes. Future research could consider conducting a follow-up assessment after preoperative treatment among patients with psychological concerns at initial screening. This reassessment could provide a more comprehensive understanding of the association between preoperative psychological conditions and postoperative outcomes.

Furthermore, it is important to note that the CCBRS specifically focuses on assessing psychological factors, while obesity is recognized as a chronic and multifaceted condition influenced by a wide array of other factors, including eating behaviors, physical activity, genetic risk, poor sleep patterns, health conditions, medication

usage, and the individuals' environment [15]. This complex interplay contributes to the development of obesity and consequently impacts weight loss following BMS. It is conceivable that the interaction among these factors makes the identification of isolated predictors of weight loss after BMS challenging.

Therefore, we recommend that future research should include other outcomes, as weight loss and attendance might not always represent the most critical aspects. For example, a previous study demonstrated the predictive value of the CCBRS on postoperative quality of life, depression, and anxiety [5]. Furthermore, alongside the CCBRS, other standardized preoperative assessment tools, such as the Bariatric Interprofessional Psychosocial Assessment of Suitability Scale (BIPASS) scale [16], have found to be predictive in assessing post-surgical binge eating symptomatology and mental health-related quality of life.

Despite the limitations in predicting weight loss and attendance in this study, the CCBRS remains valuable for conducting a systematic psychological evaluation of individuals seeking MBS and covers most of the recommendations outlined in the presurgical psychosocial evaluation guideline by Sogg et al., 2016 [2]. The CCBRS aids in identifying patients' strengths and areas for improvement, thereby facilitating enhanced interdisciplinary communication. Moreover, the CCBRS supports the ongoing implementation of a personalized approach to patient care.

One of the strengths of this study is the large sample size of 1,236 patients and a relatively long-term follow-up, in contrast to previous studies with only 179 to 415 included patients and two-year follow-up [4-6]. Only one prior study has investigated the association between each CCBRS domain and weight loss and attendance [5], whereas the other two previous studies only examined the domains of 'social support' and 'overall impression' in relation to weight loss and attendance [4, 6]. The analysis of each of the CCBRS domains separately allows for a more nuanced understanding of the relationship between weight loss and various aspects of patients' functioning, rather than treating patients' overall functioning as a single construct. For example, a patient may have good overall functioning but struggle with emotional eating, which could have a significant impact on their ability to lose weight. An additional limitation is that participants from only one clinic in The Netherlands were included, which limits the generalizability of the findings to other populations. The results may not be representative of experiences and behaviors in other cultures or regions, and the results might not align with previous research findings from different populations or settings. Another study limitation relates to

the self-reported bodyweight measurements necessitated by the COVID-19 pandemic. While acknowledging the potential for data bias, it is important to highlight that a recently published study, originating from the same clinic as well, uncovered a marginal mean difference of 0.75 – 1.17 kg between self-reported and clinic-measured weights [17]. This finding underscores the patients' accuracy in reporting their weight, which contributes to minimizing potential biases. An additional limitation is the lack of data on other variables that could influence weight loss such as postoperative short- and long-term complications. A final limitation of this study is the exclusion of 44% of study participants due to an inadvertent oversight by psychologists, who unintentionally did not administer the CCBRS after initial screening for almost half of the patients. This situation occurred randomly and without intentional bias, which is also reflected in the comparable baseline characteristics between these two groups and therefore decreases the chances of selection bias

Conclusion

The CCBRS did not predict weight loss or follow-up attendance up to five years after MBS in this cohort. It is important to acknowledge the study's limitations, such as considerable loss to follow-up. A comprehensive and personalized approach that incorporates various patient traits and factors is necessary to achieve optimal preoperative selection of patients and desirable outcomes after surgery. The CCBRS remains valuable for the preoperative psychological evaluation of individuals undergoing MBS. It promotes interdisciplinary communication by identifying the patients' strengths and areas for improvement, which aligns with its intended purpose.

References

1. 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. Obesity (Silver Spring). 2020;28(4):O1-o58.
2. Sogg S, Lauretti J, West-Smith L. Recommendations for the presurgical psychosocial evaluation of bariatric surgery patients. Surg Obes Relat Dis. 2016;12(4):731-49.
3. Marek RJ, Heinberg LJ, Lavery M, Merrell Rish J, Ashton K. A review of psychological assessment instruments for use in bariatric surgery evaluations. Psychol Assess. 2016;28(9):1142-57.
4. Heinberg LJ, Ashton K, Windover A. Moving beyond dichotomous psychological evaluation: the Cleveland Clinic Behavioral Rating System for weight loss surgery. Surg Obes Relat Dis. 2010;6(2):185-90.
5. Hilgendorf W, Butler A, Timsina L, et al. A behavioral rating system predicts weight loss and quality of life after bariatric surgery. Surg Obes Relat Dis. 2018;14(8):1167-72.
6. Hilgendorf W, Monfared S, Monfared SHB, et al. Can a brief assessment of social support predict outcomes after bariatric surgery? Clin Obes. 2021;11(1):e12419.
7. S.C.H. Hinnen; P.J. Daansen SS. Richtlijn Bariatrische Psychologie. Nederlands Instituut van Psychologen; 2014.
8. Tettero OM, Aronson T, Wolf RJ, Nuijten MAH, Hopman MTE, Janssen IMC. Increase in Physical Activity After Bariatric Surgery Demonstrates Improvement in Weight Loss and Cardiorespiratory Fitness. Obes Surg. 2018;28(12):3950-7.
9. Derogatis LR. The Brief Symptom Inventory. Clinical Psychometric Research. 1975.
10. Kalarchian MA, King WC, Devlin MJ, et al. Mental disorders and weight change in a prospective study of bariatric surgery patients: 7 years of follow-up. Surg Obes Relat Dis. 2019;15(5):739-48.
11. Kops NL, Vivan MA, Fülber ER, Fleuri M, Fagundes J, Friedman R. Preoperative Binge Eating and Weight Loss After Bariatric Surgery: A Systematic Review and Meta-analysis. Obes Surg. 2021;31(3):1239-48.
12. Moroshko I, Brennan L, O'Brien P. Predictors of attrition in bariatric aftercare: a systematic review of the literature. Obes Surg. 2012;22(10):1640-7.
13. Fourth IFSO Global Registry Report 2018 [Available from: https://www.ifso.com/pdf/4th-ifso-global-registry-report-last-2018.pdf.
14. Nijland LMG, Reiber BMM, Monpellier VM, et al. The association between patient attendance to a perioperative group-based lifestyle program and weight loss after bariatric surgery. Surg Obes Relat Dis. 2022;18(6):747-54.
15. Overweight and Obesity. Causes and Risk Factors: NIH, National Heart, Lung and Blood Institute; [updated March 24, 2022. Available from: https://www.nhlbi.nih.gov/health/overweight-and-obesity/causes.
16. Thiara G, Yanofksy R, Abdul-Kader S, et al. Toronto Bariatric Interprofessional Psychosocial Assessment Suitability Scale: Evaluating A New Clinical Assessment Tool for Bariatric Surgery Candidates. Psychosomatics. 2016;57(2):165-73.
17. Dijkhorst PJ, Makarawung DJS, Vanhommerig JW, et al. Predictors of improved psychological function after bariatric surgery. Surg Obes Relat Dis. 2023;19(8):872-81.

II

Preoperative prerequisites

4

Weight loss after bariatric surgery: a comparison between delayed and immediate qualification according to the last resort criterion

Anne Jacobs
Ronald S.L. Liem
Ignace M.C. Janssen
Rob A.E.M. Tollenaar
Valerie M. Monpellier
NOK Research Group

Surg Obes Relat Dis. 2021 Apr;17(4):718-725

Abstract

Introduction

In the Netherlands, patients only qualify for bariatric surgery when they have followed a 6-months mandatory weight loss program (MWP), also called the 'last resort' criterion. One of the rationales for this is that MWPs result in greater weight loss.

Objectives

To determine weight loss during MWPs and the effect of delayed versus immediate qualification on weight loss three years after bariatric surgery.

Settings

Outpatient clinic.

Methods

This is a nationwide, retrospective study with prospectively collected data. All patients who underwent a primary bariatric procedure in 2016 were included. We compared weight loss between patients who did not qualify according to the last resort criterion at screening (delayed group) with patients that qualified (immediate group).

Results

In total 2628 patients were included. Mean age was 44.4 years, 81.3% were female and baseline BMI was 42.3 kg/m2. Roux-en-Y gastric bypass (RYGB) was the most frequently performed surgery (77.0%), followed by sleeve gastrectomy (15.8%) and banded RYGB (7.3%). The delayed group (n=831, 32%) as compared with immediate group (n=1797, 68%), showed less percent total weight loss (%TWL) during the MWP (1.7% vs. 3.9%, $p<0.001$) and time between screening and surgery was longer (42.3 weeks vs. 17.5 weeks, $p<0.001$). Linear mixed model analysis showed no significant difference in %TWL at 18 ($p=0.291$, n=2077), 24 ($p=0.580$, n=1993) and 36 ($p=0.325$, n=1743) months follow-up.

Conclusion

This study shows that delayed qualification for bariatric surgery compared to immediate qualification does not have a clinically relevant impact on postoperative weight loss three years after bariatric surgery.

Introduction

According to the IFSO-criteria, patients only qualify for bariatric surgery when they have failed to lose weight or to maintain long-term weight loss despite appropriate medical care, which can be surgical and/or non-surgical [1]. In other words, bariatric surgery is considered a 'last resort' treatment. There is variation in how countries define the rules for implementation of this criterion. In several countries, such as the Netherlands, the United Kingdom and Canada, patients are required to follow a mandatory weight loss program (MWP) before they can undergo bariatric surgery [2-4].

The argument for MWPs is the assumption that they will induce preoperative weight loss, prepare patients for lifestyle changes and will therefore lead to a greater post-operative weight loss [5]. Previous studies have evaluated the effect of MWPs on various pre- and postoperative outcomes. However, research to substantiate the beneficial effect of MWPs on postoperative weight loss is still lacking.

A recent study of Schneider et al. found no significant difference in preoperative Body Mass Index (BMI) reduction, postoperative weight loss, rate of readmissions and reoperations, operative duration, hospital length and rate of follow-up between the MWP group and a control group [6]. Other studies that compared MWP groups to control groups also showed no increase in pre- and/or postoperative weight loss up to two years after surgery [7, 8]. Keith et al. even showed inferior weight loss at 24 months follow-up in the MWP group [9]. However, to our knowledge, none of these studies looked at weight loss during the MWP itself, neither did these studies have a follow-up time over 24 months and most of them had a relatively small study population (n=284 - 560).

The goal of this study is to assess weight loss during MWPs and the effect of delayed versus immediate qualification on three-year postoperative weight loss in a multi-center, nationwide bariatric population. We will compare patients who immediately qualified according to the last resort criterion because they had already followed a MWP program before, to patients who had delayed qualification and had not followed an MWP before. We will assess the differences in preoperative weight loss during the MWP and the duration of MWPs, as well as postoperative total weight loss between both study groups.

Methods

Standard treatment

The study population consisted of adult patients who were treated at the Nederlandse Obesitas Kliniek (NOK, Dutch Obesity Clinic) and underwent a bariatric procedure in one of the seven collaborative surgical centers (Groene Hart Hospital, Onze Lieve Vrouwen Gasthuis, Rode Kruis Hospital, Haaglanden Medical Center, Sint Antonius Hospital, Zuyderland Medical Center and Vitalys, part of Rijnstate). The NOK is the largest outpatient clinic for the treatment of obesity in the Netherlands, with currently nine locations throughout the country, treating about 4000 patients surgically each year.

The pre- and postoperative counselling program at the NOK is led by an interdisciplinary team, consisting of a dietician, psychologist, physical therapist and medical doctor. These teams work together with the bariatric teams in the hospitals. Before patients can enter this program, a screening is performed by the team to evaluate if patients qualify for surgery according to the IFSO-criteria. Patients can only enter the counselling program if they qualify.

The counselling program is identical in all locations. The majority of patients follow group counselling; patients only receive individual counselling when a group is not feasible, for example with a language barrier or certain psychological disorders. The group counselling consists of a total of 19 sessions. It entails six group visits during the six weeks prior to surgery in order to prepare patients for surgery, and a comprehensive lifestyle change program of 13 sessions until 15 months after surgery [(10)]. In addition, patients have individual medical consultations with the physician and attend a yearly follow-up until five years after surgery.

This study was approved by the Medical Ethical committee (METCZ20190097).

Last resort criterion

In the Netherlands patients qualify according to the last resort criterion if they have followed a weight loss program at a dietician, general- or nurse practitioner, internist or lifestyle coach for at least six months in the past five years [(11)]. Although patients have to meet this criterion in order to get reimbursed by the health insurance companies, this is not a prerequisite for a screening for bariatric surgery at the bariatric clinics. Whether a patient qualifies according to the last resort criterion is evaluated during screening.

At the screening patients are asked whether they followed a program and if so, they have to hand over a report from the counselor (dietician, nurse, physician, lifestyle coach). Based on this report, the multidisciplinary team of the clinic decides if the patient qualifies according to the last resort criterion. If the patient qualifies, she/he will start with the preoperative counselling program (the immediate group, Figure 1).

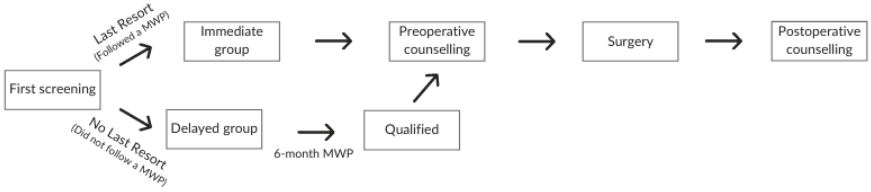


Figure 1. Flow of patients from first screening until postoperative counselling.

If the last resort criterion is not met at screening, the patient is referred to a dietician outside the clinic for a MWP and the start of the preoperative counselling program is postponed. When the patient completes the six months MWP, the report of the MWP is evaluated by the clinic. If the patient then qualifies according to the last resort criterion, the preoperative counselling is initiated (the delayed group). Thus, the immediate group consists of patients who followed a weight loss program on their own initiative, while for the delayed group a MWP is made mandatory, in order to qualify for surgery. An exception to this last resort criterion is when patients have a BMI equal to or higher than 50 kg/m^2. These patients qualify directly, despite not having followed a MWP.

Study population

This study is a retrospective analysis of prospectively collected data of all patients in treatment at all the NOK clinics. Patients were selected from the database when they underwent a primary Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG) or banded Roux-en-Y gastric bypass (RYGB + band) in 2016 and were treated in the preoperative group counselling program at the NOK clinic. Data was collected from May 2009 up to March 2020. Patients were excluded if they had a BMI ≥50 kg/m^2, because these patients qualified based on their BMI. Patients were also excluded if they were pregnant during the MWP or were unjustly granted as last resort although not having followed a MWP.

Body weight and height

Body weight and height were assessed preoperatively at first screening and at start of the preoperative counselling (baseline, BL). Postoperatively, body weight was assessed at 3, 6, 9, 12, 18, 24, 36 months after surgery. Weight loss was calculated and reported according to the most recent guidelines: BMI in kg/m^2, change in BMI ((*ΔBMI = current BMI – preoperative BMI*)) and percent total weight loss (%TWL). For calculating %TWL, the following formula was used:

$$\%TWL = ((preoperative\ weight\ (BL) - current\ weight) / preoperative\ weight\ (BL)) * 100\%.$$

For this analysis %TWL at 3, 6, 12, 18, 24 and 36 months follow up was calculated, using the weight at start of the preoperative counselling as baseline weight.

Body weight and duration MWP

Body weight at start and end of the MWP and duration of guidance was retrospectively collected from the patients' official dietary reports.

Other measurements

Gender, age at surgery, surgical method, treatment location and the preoperative presence of comorbidities (hypertension, diabetes, dyslipidemia, obstructive sleep apnea and osteoarthritis) were also collected from the database.

Statistical analysis

Descriptive statistics were used to summarize patients' baseline characteristics. Data were checked for normality and subsequent compatible tests were used. Two study groups were formed, based on qualifying according to the last resort criterion directly at first screening (immediate group) or having a delayed approval (delayed group). Baseline characteristics of both the immediate and delayed groups were compared using independent t-tests for continuous variables and chi-square tests for nominal and ordinal variables. Skewed data were first log-transformed in order to use compatible tests. All above analyses were performed using SPSS software, version 23 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, version 23.0. Armonk, NY: IBM Corp.).

A linear mixed model was used to assess in %TWL over time and to assess differences in %TWL between both study groups up to 36 months after surgery. Gender, age at surgery, baseline BMI, baseline comorbidities, treatment location and surgical method were added to the model as confounders. Plots were created

to visualize the changes in body weight across time since operation between the two groups. The linear mixed model analyses were performed using STATA, version 16 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC.).

Findings with a p-value of <0.05 were considered statistically significant.

Results

Study population

A total of 3019 patients were operated in 2016 and selected from the database, 382 patients were excluded based on a BMI ≥50 kg/m^2 at initial screening, six patients due to pregnancy during their MWP and three because of a false positive last resort.

Patient characteristics

A total of 2628 patients were eligible and included for analysis. Of this population, 1797 patients (68.4%) qualified according to the last resort criterion at first screening (immediate group), meaning they had followed a MWP for at least six months in the past five years. A total of 831 patients (31.6%) did not qualify at first screening and still had to follow a MWP first (delayed group). Mean age was significantly higher in the immediate group (45.0 years versus 43.2 years, p<0.001); there was no significant difference in sex (Table 1). Obesity-related comorbidities were more frequently seen in the immediate than in the delayed group: hypertension (39% versus 33%, p=0.002), diabetes (26% versus 12%, p<0.001), dyslipidemia (22% versus 15%, p<0.001), sleep apnea (14% versus 11%, p=0.030) and osteoarthritis (14% versus 12%, p=0.078).

Table 1. Baseline characteristics of the included population, presented as mean ± standard deviation or n (%).

Age, years	All (n=2628)	Immediate (n=1797)	Delayed (n=831)	P-value
	44.4 ± 11.2	45.0 ± 11.1	43.2 ± 11.4	<0.001[a]
Sex				
Female	2136 (81.3)	1461 (81.3)	675 (81.2)	0.964[b]
Male	492 (18.7)	336 (18.7)	156 (18.8)	
Comorbidities				
Hypertension	971 (36.9)	699 (38.9)	272 (32.7)	0.002[b]
Type II diabetes	574 (21.8)	473 (26.3)	101 (12.2)	<0.001[b]
Dyslipidemia	512 (19.5)	390 (21.7)	122 (14.7)	<0.001[b]
Sleep apnea	353 (13.4)	259 (14.4)	94 (11.3)	0.030[b]
Osteoarthritis	352 (13.4)	255 (14.2)	97 (11.7)	0.078[b]

[a] student's *t* test; [b] χ^2 test;

Results Mandatory Weight Loss Program

Average duration of the MWP was 36.7 weeks in the immediate group and 23.0 weeks in the delayed group (p<0.001; Table 2). Patients in the immediate group lost on average 5.0 kg during their MWP and patients in the delayed group 2.3 kg (p<0.001). Weight loss per week during the MWP was 0.14 kg in the immediate group and 0.10 kg in the delayed group (p<0.001). When looking at weight change between first screening and start of the preoperative counselling, patients in the immediate group gained on average 0.5 kg (±2.8) and those in the delayed group gained 0.1 kg (±6.1, p=0.028). Patients in the delayed group had a significantly longer time between screening and start of the preoperative counselling (33.4±2.0 versus 9.7±1.8 weeks, p<0.001) and between screening and surgery (42.3±1.8 versus 17.5±1.4 weeks, p<0.001).

Table 2. Perioperative data, presented as mean ± standard deviation or n (%).

	All (n=2628)	Immediate (n=1797)	Delayed (n=831)	P-value
Mandatory weight loss program				
Duration, weeks	30.8 ± 2.2	36.7 ± 2.4	23.0 ± 1.5	<0.001 [a]
Weight change during MWP, kg	-4.0 ± 7.9	-5.0 ± 8.8	-2.3 ± 5.9	<0.001 [a]
Weight change per week MWP, kg	-0.13 ± 0.3	-0.14 ± 0.3	-0.10 ± 0.3	<0.001 [a]
%TWL during MWP	3.1 ± 6.4	3.9 ± 7.2	1.7 ± 4.5	<0.001 [a]
First screening				
Weight, kg	121.7 ± 15.8	121.7 ± 15.8	121.7 ± 15.7	0.986 [a]
BMI, kg/m^2	42.1 ± 3.6	42.1 ± 3.6	42.3 ± 3.5	0.205 [a]
Time screening to start preoperative counselling, weeks	14.3 ± 2.3	9.7 ± 1.8	33.4 ± 2.0	<0.001 [a]
Time screening to surgery, weeks	23.1 ± 1.8	17.5 ± 1.4	42.3 ± 1.8	<0.001 [a]
Start preoperative counselling				
Weight, kg	122.0 ± 16.2	122.2 ± 16.1	121.8 ± 16.5	0.594 [a]
BMI (Baseline), kg/m^2	42.3 ± 3.8	42.3 ± 3.7	42.4 ± 4.0	0.680 [a]
Weight change since screening, kg	0.4 ± 4.2	0.5 ± 2.8	0.1 ± 6.1	0.028 [a]
%TWL since screening	-0.3 ± 3.4	-0.4 ± 2.3	-0.1 ± 5.0	0.052 [a]
ΔBMI since screening, kg/m^2	0.1 ± 1.4	0.2 ± 1.0	0.0 ± 2.1	0.033 [a]
Time start counselling to surgery, weeks	7.3 ± 1.9	7.3 ± 1.8	7.4 ± 2.1	0.102 [a]
Surgical method				0.055 [b]
RYGB	2023 (77.0)	1366 (76.0)	657 (79.1)	
SG	414 (15.8)	286 (15.9)	128 (15.4)	
Banded RYGB	191 (7.3)	145 (8.1)	46 (5.5)	

MWP = mandatory weight loss program; BMI = body mass index; %TWL = percent total weight loss; ΔBMI = change in BMI;RYGB = Roux-en-Y gastric bypass; SG = sleeve gastrectomy.
[a] student's t test; [b] χ2 test

Follow-up

Follow-up rate was only comparable at the 3-month follow-up moment (Table 3). At all other follow-up moments, patients in the immediate group had significantly higher follow-up rates. The highest follow-up rate for both groups was at 6 months follow-up (immediate: 98.4% versus delayed: 97.0%, p=0.010). Follow-up decreased in both groups over time to respectively 68.6% versus 61.4% at 36 months after surgery (p<0.001). Patients lost to follow-up, were on average younger (42.1±11.5 years) compared with followed patients (45.6±10.9 years, p<0.001) and more males than females were lost to follow-up (38.2% versus 32.5%, p=0.016).

Table 3. Postoperative results, presented as mean ± standard deviation or n (%).

	Follow-up	%TWL	ΔBMI
3 months follow-up			
Immediate	1717 (95.5)	19.3 ± 4.0	-8.1 ± 1.8
Delayed	790 (95.1)	18.5 ± 4.1	-7.8 ± 1.9
6 months follow-up			
Immediate	1768 (98.4)	26.3 ± 5.2	-11.1 ± 2.4
Delayed	806 (97.0)*	25.7 ± 5.1	-10.9 ± 2.5
9 months follow-up			
Immediate	1758 (97.8)	31.2 ± 6.5	-13.2 ± 3.1
Delayed	799 (96.1)*	30.7 ± 6.4	-13.0 ± 3.1
12 months follow-up			
Immediate	1724 (95.9)	32.8 ± 7.0	-13.9 ± 3.4
Delayed	776 (93.4)*	32.3 ± 6.9	-13.7 ± 3.4
18 months follow-up			
Immediate	1458 (81.1)	33.6 ± 8.0	-14.3 ± 3.8
Delayed	619 (74.5)*	33.4 ± 7.9	-14.1 ± 3.8
24 months follow-up			
Immediate	1410 (78.5)	32.9 ± 8.3	-13.9 ± 3.9
Delayed	583 (70.2)*	32.9 ± 8.6	-13.9 ± 4.1
36 months follow-up			
Immediate	1233 (68.6)	30.8 ± 8.9	-13.1 ± 4.2
Delayed	510 (61.4)*	31.3 ± 8.8	-13.2 ± 4.2

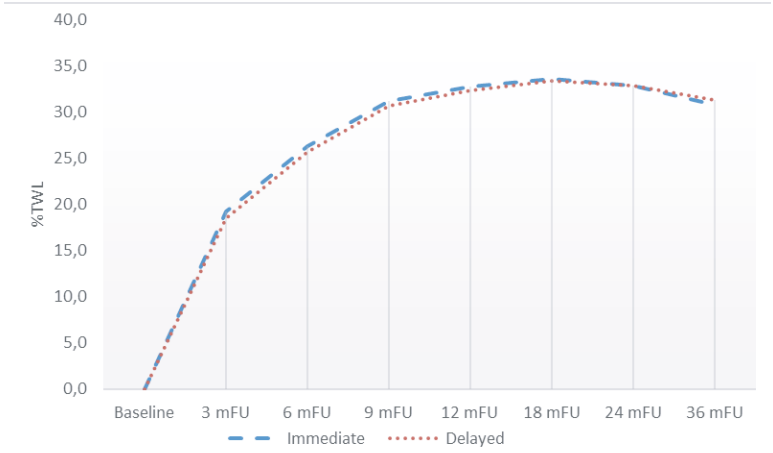
%TWL = percent total weight loss; ΔBMI = change in BMI
* Significant difference in follow-up rate compared to immediate group with χ^2 test

Postoperative weight loss

There were no significant differences in baseline BMI and surgical method between the two groups (Table 2). Postoperative weight loss for both study groups (calculated as %TWL) showed a similar pattern at all follow-up moments (Figure 2). Greatest weight loss was achieved at 18 months follow-up in both groups.

Unadjusted linear mixed model analysis showed patients in the immediate group had a significantly lower %TWL over time, compared to patients in the delayed group (β=-0.159, 95% CI=-0.277 – -0.041, p=0.008). Then the model was adjusted for gender, age at surgery, baseline BMI, type of surgery, comorbidities and treatment location. Each follow-up moment was compared with baseline. This second model showed that %TWL was significantly higher in the immediate group up to 12 months follow-up. The highest difference was 3 months after surgery: β 0.651, 95% CI 0.186 – 1.116, p=0.006 (Table 4). After that the differences were smaller. At 18, 24

and 36 months follow-up, the differences between the groups were not statistically significant (Table 4).



	Baseline	3 mFU	6 mFU	9 mFU	12 mFU	18 mFU	24 mFU	36 mFU
Observed cases: immediate group	1792	1717	1768	1758	1724	1458	1410	1233
Observed cases: delayed group	829	790	806	799	776	619	583	510

Figure 2. Percent total weight loss (%TWL) over time, measured at specific follow-up moments.

mFU: months follow-up

Table 4. Difference in total weight loss (%TWL) for immediate and delayed qualification with adjusted linear mixed model analysis.

	β-coefficient	95% CI (lower bound – upper bound)	P-value*
3 months follow-up			
Immediate	0.651	0.186 – 1.116	0.006
Delayed	Reference group		
6 months follow-up			
Immediate	0.592	0.130 – 1.054	0.012
Delayed	Reference group		
9 months follow-up			
Immediate	0.497	0.034 – 0.959	0.036
Delayed	Reference group		
12 months follow-up			
Immediate	0.497	0.030 – 0.963	0.037
Delayed	Reference group		
18 months follow-up			
Immediate	0.268	-0.230 – 0.765	0.291
Delayed	Reference group		
24 months follow-up			
Immediate	0.143	-0.363 – 0.649	0.580
Delayed	Reference group		
36 months follow-up			
Immediate	-0.265	-0.794 – 0.263	0.325
Delayed	Reference group		

CI: confidence interval
* Adjusted for gender, age at surgery, baseline BMI, type of surgery, comorbidities and treatment location.

Discussion

The goal of this study was to determine weight loss during MWPs and the effect of MWPs on postoperative weight loss up to three years after bariatric surgery. We compared patients that had already followed a MWP at first screening and therefore immediately qualified according to the last resort criterion (immediate group) to those who did not yet qualify and still had to follow a MWP before they qualified for surgery (delayed group).

Our results show that there was no clinically relevant difference in TWL up to 36 months after surgery. Patients in the immediate group had a statistically significant greater weight loss up to 12 months follow-up, however these differences were not clinically relevant (maximum difference 0.65 %TWL). Moreover, weight

loss at 18, 24 and 36 months follow-up was comparable (not statically significant, nor clinically relevant) in both groups. Patients in the immediate study group lost on average more weight during the MWP than patients in the delayed group. This is likely explained by the fact that the total duration of the MWP was also longer in the immediate group. Average time between first screening and surgery was more than twice as long for the delayed group (42.3 weeks), compared to 17.5 weeks in the immediate group.

Previous studies evaluating the effect of MWPs on weight loss also could not ascertain a beneficial effect of MWPs on postoperative weight loss [6-9, 12]. However, these study populations were relatively small and follow-up was mostly short (one year). Our results show that in a very large, nationwide bariatric population, there is no difference in three-year weight loss if patients are referred to a MWP directly before they undergo bariatric surgery. This is a great addition to a very recent study by Talishinskiy et al., which evaluated the effect of MWPs on postoperative weight loss in over 3000 patients one year after sleeve gastrectomy [13]. They reaffirmed the current thought that MWPs do not lead to superior postoperative weight loss.

A possible explanation why we saw only very small differences in postoperative weight loss up to 36 months, is that weight loss during a MWP is not the same as preoperative weight loss. Patients may regain the weight they lost during the MWP before the surgery itself takes place. In this study patients lost on average 4.0 kg during their MWP, however, this weight loss completely vanished when they started the preoperative counselling. On average, patients then even gained weight. This suggests that weight loss during a MWP is only for very short term and will therefore not result in greater postoperative weight loss. To our knowledge, this is the first study to study weight loss during the MWPs, so we cannot compare these results to other studies.

Some differences in baseline characteristics were observed between the study groups. The difference in the presence of comorbidities between the study groups can be explained by the Dutch medical guidelines. Lifestyle interventions are always the first step in the treatment for obesity and its related comorbidities [14]. Patients who suffer from these comorbidities, seem to be referred sooner by their general practitioner or medical doctor for a dietary intervention than patients without comorbidities.

The significant delay in adequate treatment we saw in this study, results in patients suffering from obesity and its related comorbidities even longer. Many patients who suffered from obesity-related comorbidities at screening, did not directly qualify according to the last resort criterion and were therefore delayed for surgery. Studies show that delaying surgery leads to a reduced survival and higher costs compared with prompt surgery [15, 16]. Furthermore, several studies have shown that this delay may lead to an increased surgery dropout [17, 18]. This insinuates that the current setup of the MWPs does not improve treatment outcome.

Remarkably, compliance to follow-up in this study was significantly higher in the immediate group. A possible explanation for this could be that behaviour preoperative is a predictor for behaviour postoperative. Patients that followed a non-surgical weight loss program on their own initiative, might be more compliant to the surgical program. However, previous studies that determined predictors for a high postoperative compliance to follow-up, did not evaluate the effect of dietary history [19-21]. Therefore, this hypothesis can neither be affirmed nor rejected. Predictors that were found to be associated with compliance to follow-up were older age, higher preoperative BMI and the female gender [19-21]. In our study, we saw higher compliance to follow-up for patients with an older age and for women, but not for patients with a higher preoperative BMI, although the difference in BMI was small.

Our study has the benefit of assessing weight loss during MWPs in a large, multicenter, bariatric population. However, there is a limitation that might affect interpretation of the results. We compared two study groups that both followed a MWP on different moments. It would have been more optimal if we compared a MWP group to a non-MWP group. Unfortunately, this was not feasible, as following a MWP is a nationwide criterion for bariatric surgery in The Netherlands. A second limitation is the fact that we only evaluated weight loss and did not include comorbidity resolution or quality of life. Lastly, it is important to address that, despite the use of a linear mixed model, there could still be some residual confounding of factors that were not measured. Despite these limitations, we think our findings still contribute to the growing belief that delaying surgery and referral to a dietician does not lead to greater postoperative weight loss.

As stated in the introduction, the argument for MWPs is the assumption that they will induce preoperative weight loss, prepare patients for lifestyle changes and will therefore lead to higher postoperative weight loss. Based on this study and previous

studies, MWPs in its present form do not seem to improve pre- or postoperative weight loss [6-9].

Studies do show that weight loss prior to bariatric surgery is associated with a reduction of postoperative complications as well as sustained improved postoperative weight loss [22, 23]. Moreover, preoperative cognitive behavioral programs can result in improvement of weight loss, eating behavior and depressive symptoms [24]. This suggests that the goal of MWPs is valid, but the current form of the MWPs does not result in the proposed goals. An ideal MWP should be developed based on the current knowledge of the effects of preoperative weight loss and cognitive behavioral therapy on outcomes after bariatric surgery. We would recommend additional observational studies to evaluate the effect of new MWPs in terms of weight loss, comorbidity resolution and quality of life to further optimize care.

In addition, the current qualification for a last resort can be discussed. In line with the recent policy change of one of the largest insurance companies in the United States and the previous position statement of the ASMBS, we therefore recommend insurance companies and other policymakers in other parts of the world to renounce the current definition of MWPs as a criterion for bariatric surgery and let the healthcare professional determine the need for additional care before bariatric surgery. This will make bariatric surgery more accessible.

Conclusion

Our study shows that delayed qualification for bariatric surgery does not lead to weight loss before starting a bariatric program and does not lead to greater postoperative weight loss up to three years after bariatric surgery, when compared to patients who followed a weight loss program a longer time before surgery.

References

1. Fried M, Yumuk V, Oppert JM, et al. Interdisciplinary European guidelines on metabolic and bariatric surgery. Obes Surg. 2014;24(1):42-55.
2. Bariatrische chirurgie: DSW zorgverzekeraar; 2020 [Available from: https://www.dsw.nl/Consumenten/Vergoedingen/Bariatrische-chirurgie.
3. National Institute for Health and Clinical Excellence: Guidance. Obesity: Identification, Assessment and Management of Overweight and Obesity in Children, Young People and Adults: Partial Update of CG43. London: National Institute for Health and Care Excellence (UK), Copyright (c) National Clinical Guideline Centre, 2014.; 2014.
4. Medical Coverage Policy. Bariatric Surgery and Procedures. Cigna Companies; 2019.
5. Tewksbury C, Williams NN, Dumon KR, Sarwer DB. Preoperative Medical Weight Management in Bariatric Surgery: a Review and Reconsideration. Obes Surg. 2017;27(1):208-14.
6. Schneider A, Hutcheon DA, Hale A, Ewing JA, Miller M, Scott JD. Postoperative outcomes in bariatric surgical patients participating in an insurance-mandated preoperative weight management program. Surg Obes Relat Dis. 2018;14(5):623-30.
7. Kuwada TS, Richardson S, Chaar ME, et al. Insurance-mandated medical programs before bariatric surgery: do good things come to those who wait? Surgery for Obesity and Related Diseases. 2011;7(4):526-30.
8. Horwitz D, Saunders JK, Ude-Welcome A, Parikh M. Insurance-mandated medical weight management before bariatric surgery. Surgery for Obesity and Related Diseases. 2016;12(3):496-9.
9. Keith CJ, Jr., Goss LE, Blackledge CD, Stahl RD, Grams J. Insurance-mandated preoperative diet and outcomes after bariatric surgery. Surg Obes Relat Dis. 2018;14(5):631-6.
10. Tettero OM, Aronson T, Wolf RJ, Nuijten MAH, Hopman MTE, Janssen IMC. Increase in Physical Activity After Bariatric Surgery Demonstrates Improvement in Weight Loss and Cardiorespiratory Fitness. Obesity Surgery. 2018;28(12):3950-7.
11. Selective purchasing policy bariatric surgery. Justification report 2019.: CZ-groep; 2019.
12. Kim JJ, Rogers AM, Ballem N, Schirmer B. ASMBS updated position statement on insurance mandated preoperative weight loss requirements. Surgery for Obesity and Related Diseases. 2016;12(5):955-9.
13. Talishinskiy T, Blatt M, Nyirenda T, Eid S, Schmidt H, Ewing D. Insurance-Mandated Medical Weight Management Programs in Sleeve Gastrectomy Patients Do Not Improve Postoperative Weight Loss Outcomes at 1 Year. Obesity Surgery. 2020.
14. NHG-Standard Obesity. Dutch General Practitioner Society; 2019.
15. Flanagan E, Ghaderi I, Overby DW, Farrell TM. Reduced Survival in Bariatric Surgery Candidates Delayed or Denied by Lack of Insurance Approval. Am Surg. 2016;82(2):166-70.
16. Cohen RV, Luque A, Junqueira S, Ribeiro RA, Le Roux CW. What is the impact on the healthcare system if access to bariatric surgery is delayed? Surgery for Obesity and Related Diseases. 2017;13(9):1619-27.
17. Love KM, Mehaffey JH, Safavian D, et al. Bariatric surgery insurance requirements independently predict surgery dropout. Surg Obes Relat Dis. 2017;13(5):871-6.
18. Jamal MK, DeMaria EJ, Johnson JM, et al. Insurance-mandated preoperative dietary counseling does not improve outcome and increases dropout rates in patients considering gastric bypass surgery for morbid obesity. Surgery for Obesity and Related Diseases. 2006;2(2):122-7.
19. Moroshko I, Brennan L, O'Brien P. Predictors of Attrition in Bariatric Aftercare: A Systematic Review of the Literature. Obesity Surgery. 2012;22(10):1640-7.
20. Khorgami Z, Zhang C, Messiah SE, de la Cruz-Muñoz N. Predictors of Postoperative Aftercare Attrition among Gastric Bypass Patients. Bariatr Surg Pract Patient Care. 2015;10(2):79-83.
21. Larjani S, Spivak I, Hao Guo M, et al. Preoperative predictors of adherence to multidisciplinary follow-up care postbariatric surgery. Surgery for Obesity and Related Diseases. 2016;12(2):350-6.

22. Anderin C, Gustafsson UO, Heijbel N, Thorell A. Weight loss before bariatric surgery and postoperative complications: data from the Scandinavian Obesity Registry (SOReg). Ann Surg. 2015;261(5):909-13.

23. Gerber P, Anderin C, Gustafsson UO, Thorell A. Weight loss before gastric bypass and postoperative weight change: data from the Scandinavian Obesity Registry (SOReg). Surg Obes Relat Dis. 2016;12(3):556-62.

24. Cheroutre C, Guerrien A, Rousseau A. Contributing of Cognitive-Behavioral Therapy in the Context of Bariatric Surgery: a Review of the Literature. Obes Surg. 2020;30(8):3154-66.

5

Preoperative weight gain is not related to lower postoperative weight loss, but to lower total weight loss up to three years after bariatric-metabolic surgery

Anne Jacobs[†]
May al Nawas[†]
Laura N. Deden
Lea M. Dijksman
Evert-Jan G. Boerma
Ahmet Demirkiran
Eric J. Hazebroek
M. (René) Wiezer
Wouter J.M. Derksen
Valerie M. Monpellier

[†] Authors A. Jacobs and M. Al Nawas have contributed equally to this work

Obes Surg. 2023 Dec;33(12):3746-3754

Abstract

Introduction

Weight loss prior to bariatric-metabolic surgery (BMS) is recommended in most bariatric centers. However, there is limited high-quality evidence to support mandatory preoperative weight loss. In this study we will evaluate whether weight gain prior to primary BMS is related to lower postoperative weight loss.

Methods

A retrospective analysis of prospectively collected data was performed. Preoperative weight loss (weight loss from start of program to day of surgery), postoperative weight loss (weight loss from day of surgery to follow-up) and total weight loss (weight loss from start of program to follow-up) were calculated. Five groups were defined based on patients' preoperative weight change: preoperative weight loss of >5 kg (group I), 3-5 kg (group II), 1-3 kg (group III), preoperative stable weight (group IV) and preoperative weight gain >1 kg (group V). Linear mixed models were used to compare the post-operative weight loss between group V and the other four groups (I-IV).

Results

A total of 1,928 patients were included. Mean age was 44 years, 78.6% were female, and preoperative BMI was 43.7 kg/m^2. Analysis showed significantly higher postoperative weight loss in group V, compared to all other groups at 12, 24 and 36 months follow-up. Up to three years follow-up, highest total weight loss was observed in group I.

Conclusion

Weight gain before surgery should not be a reason to withhold a bariatric-metabolic operation. However, patients with higher preoperative weight loss have higher total weight loss. Therefore, preoperative weight loss should be encouraged prior to bariatric surgery.

Introduction

Bariatric-metabolic surgery (BMS) is the most effective treatment for severe obesity. It results in significant weight loss and resolution of obesity-related medical problems [1, 2]. To improve post-bariatric outcomes, some advocate (mandatory) preoperative weight loss. Furthermore, many insurance companies require adherence to a preoperative weight loss program or a specific amount of weight loss as a prerequisite for approval for BMS [3, 4]. However, it is unclear whether preoperative weight loss is related to postoperative weight loss after BMS and if patients with weight gain prior to surgery have lower postoperative weight loss.

Preoperative weight loss has been hypothesized to be a marker to identify patients who are compliant to the treatment program [3]. Patients who achieve weight loss before surgery are believed to be more motivated and adapted to the new postoperative lifestyle, and thus, more successful in reaching and sustaining satisfactory postoperative weight loss [5-9].

Since the concept of preoperative weight loss was first introduced by the National Institutes of Health consensus panels in the 1990's, studies have reported conflicting and inconsistent results on the effects of preoperative weight loss on post-bariatric weight loss [8-13]. The most important reason for this is that the definition of preoperative weight loss is often unclear and differs between studies [14-19]. Preoperative weight loss is often included in the calculation of total postoperative weight loss, making it impossible to study the exact relationship between preoperative weight loss and postoperative weight loss [20-22]. Moreover, there is heterogeneity of the study designs and often a relatively small number of patients is included [3, 8-13]. Lastly, most studies focus only on short term weight loss (12 months follow-up point) [6-8, 10]. Hence, there is limited high-quality evidence to support or refute mandatory preoperative weight loss for patients who will undergo BMS.

In this study we analyze data of a large multicenter cohort with prospectively collected data up to three years after surgery. We aim to evaluate whether weight gain prior to primary BMS is related to lower postoperative weight loss.

Methods

Study design

A retrospective analysis of prospectively collected data was performed to evaluate the effect of preoperative weight loss in patients undergoing elective BMS. This study was approved by the Medical Ethical Committee Zuyderland & Zuyd (METCZ20190097) and the Local Ethics Committees in the participating bariatric centers. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for cohort studies [23].

Setting

The cohort consisted of patients who underwent primary BMS between January 1st and December 31st of 2017 in one of the following hospitals, all located in The Netherlands: St. Antonius hospital Nieuwegein, Rijnstate hospital Arnhem, Rode Kruis hospital Beverwijk and Zuyderland Medical Center Heerlen. All patients followed a pre- and postoperative interdisciplinary program at the Nederlandse Obesitas Kliniek (Dutch Obesity Clinic, NOK). The NOK is the largest outpatient clinic center in the Netherlands for the treatment of obesity. At the NOK care centers patients follow an interdisciplinary treatment program [24]. The preoperative program consists of six group sessions spread over six weeks, where all patients were advised to aim for a weight loss of 3-5 kilograms (kg). The postoperative program included a comprehensive one-year lifestyle change program. Postoperative follow-up visits are attended yearly until five years after surgery.

Patient population

All patients were screened according to International Federation for the Surgery of Obesity criteria [25] and underwent one of the following primary laparoscopic BMS procedures: Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG), or banded Roux-en-Y gastric bypass (bRYGB). Patients with a medical history of BMS and patients who took part in an individual treatment program (e.g. because of linguistic barriers or psychopathology) were excluded. Cases missing weight data at the start of the preoperative care program or at the day of surgery were also excluded.

Data source

Patients were included from the database of the NOK. Data was collected from the NOK patient files, the hospital patient files and was linked to the Dutch national registry Dutch Audit of Treatment of Obesity (DATO). The DATO is a mandatory

registry containing patients' data from all hospitals performing BMS in The Netherlands since January 2015 [26].

Variables

Data was collected until January 2021. Study data collected from the NOK database include patient demographics (age and gender), surgical procedure, preoperative obesity-associated medical problems (diabetes mellitus, hyperlipidemia, hypertension, and obstructive sleep apnea), and the weight measured at the clinic at the start of the preoperative care program as well as at follow-up appointments up to three years after surgery (3, 6, 12, 18, 24, and 36 months).

The preoperative American Society of Anesthesiologists (ASA) physical status classification, weight measured in the hospital at the day of surgery, perioperative complications and severe short term <30 days postoperative complications according to the Clavien-Dindo Classification of Surgical Complications grade ≥III [27] were collected from the hospital patient files and DATO database.

Preoperative weight change

Preoperative weight change (PWC) was defined as the difference in kilograms between the weight at the start of the preoperative care program (first group session) and the weight measured at the day of the bariatric procedure:

$$\mathrm{PWC} = \mathrm{weight}_{\text{day of surgery}} - \mathrm{weight}_{\text{start preoperative care program}}.$$

Based on their PWC, patients were stratified into five groups: those who lost >5 kg (group I), those who lost 3-5 kg (group II), those who lost 1-3 kg (group III), those who had a stable weight with a range of 1 kg (group IV), and those who gained more than 1 kg (group V). These cut-offs were believed to be clinically relevant, since patients are advised to not gain weight, and to lose 3-5 kg. This results in five groups with an equal range of 2 kg between the groups.

Outcome measures

Weight loss was calculated as percentage total weight loss (%TWL) and absolute change in body mass index (ΔBMI). Figure 1 provides an overview of the used definitions of weight loss.

Figure 1. Overview of the used definitions of weight loss.

Postoperative TWL was defined as the percentage of weight difference between the weight at the day of surgery and follow-up weight:

$$\text{postTWL} = [(\text{weight}_{\text{day of surgery}} - \text{weight}_{\text{follow up}}) / \text{weight}_{\text{day of surgery}}\}] \text{ x } 100\%.$$

Total TWL was defined as the percentage of weight difference between weight at the start of the preoperative care program and follow-up weight:

$$\text{totalTWL} = [(\text{weight}_{\text{start care program}} - \text{weight}_{\text{follow up}}) / \text{weight}_{\text{start care program}}\}] \text{ x } 100\%.$$

Total ΔBMI was defined as the difference in BMI points between the BMI at the start of the preoperative care program and follow-up BMI:

$$\Delta\text{BMI} = \text{BMI}_{\text{follow up}} - \text{BMI}_{\text{start preoperative care program}}.$$

Statistical analysis

Descriptive statistics were used to summarize baseline characteristics. Categorical data were expressed as number (percentages). Continuous data were expressed as mean ± standard deviation when normally distributed, otherwise as median [inter-quartile range]. Baseline differences between the PWC groups were evaluated by using analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables.

Linear mixed model analysis was used to compare the change in postTWL over time in the five groups. The groups were included as covariates in the fixed part, where group V (> 1kg weight gained) was used as reference group. After determining the best-fitting model with random intercept and/or slope, only a random intercept for subject (patient) was added in the crude model (model 1). Age at baseline, sex, BMI at start of the preoperative care program, and (natural logarithm of) time between start preoperative care program and day of surgery were considered as important confounders and were included as covariates in model 2. Model 3 included the following additional confounders: preoperative ASA score, number of associated medical problems at baseline, type of BMS, and the bariatric center where the patients were treated. The results of the models for 12, 24 and 36 months postTWL were reported as (adjusted) regression coefficients (β) with 95% confidence interval (95% confidence intervals, CI) and the p-value.

Statistical analysis was performed using SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Weight changes were presented in graphs, created by using the package 'ggplot2' in R (R Foundation for Statisical Computing, Vienna, Austria. URL https://www.R-project.org). All statistical tests were two-tailed, and $p<.05$ was considered statistically significant.

Results

Study population

A total of 1,945 patients underwent primary BMS in one of the participating bariatric centers in 2017 and followed a perioperative care program at the NOK. Seventeen patients (0.9%) were excluded due to missing weight data at the start of the treatment program and/or the day of surgery. A total of 1,928 patients were included.

Baseline characteristics

The majority of patients was female (78.6%) and mean age was 44.1±11.4 years (Table 1). Median time interval between the start of the preoperative care program and BMS was 7.3 weeks [6.1–9.1]. The most frequently performed BMS was RYGB (n=1229, 63.7%), followed by SG (n=446, 23.1%) and bRYGB (n=253, 13.1%). A total of 34 (1.7%) patients had a perioperative (n=10, 0.5%) or severe short-term (n=24, 1.2%) complication within 30 days after surgery. There was no mortality in this cohort.

Table 1 Demographic characteristics of the total population (n=1928) presented as mean ± standard deviation or number (percentage)

Variable	*Value*
Age, years	44.1 ± 11.4
Female sex	1517 (78.6)
Bariatric surgery type	
Roux-en-Y gastric bypass	1229 (63.7)
Sleeve Gastrectomy	446 (23.1)
Banded Roux-en-Y gastric bypass	253 (13.1)
ASA score	
2	1040 (53.9)
3	866 (44.9)
4	15 (0.8)
Associated medical problems	
Hypertension	663 (34.4)
Type 2 diabetes	394 (20.4)
Dyslipidemia	383 (19.9)
Obstructive sleep apnea syndrome	338 (17.5)
BMI, kg/m^2	
Start of preoperative care program	43.7 (±5.6)
Day of surgery	43.1 (±5.6)

ASA American Society of Anaesthesiologists physical status classification, BMI body mass index.

Comparison between groups

In total, 296 patients were included in group I, 263 in group II, 447 in group III, 623 in group IV and 299 in group V. An overview of all characteristics is shown in table 2. The groups were comparable for most characteristics, though some differences were observed. Age was lower in group V compared to all other groups (p=.02). In group I and II the percentage of people undergoing a banded RYGB was higher compared to the other groups (p<0.01). The frequency of type II diabetes was higher in group II and IV as compared to the other groups (p<0.01).

Weight and preoperative weight change

The mean BMI at the start of the preoperative care program was 43.7±5.6 kg/m^2 and BMI at the day of surgery was 43.1±5.6 kg/m^2 (Table 1). In group I, BMI at the start of the preoperative care program was higher as compared to group III and group IV (44.6±6.8 versus 43.2±5.1 and 43.5±5.2 kg/m^2 respectively (Table 2, p=.01). In the total population, mean preoperative weight change was -1.7±3.4 kg. In group I median weight loss was -6.8kg [-5.9 to -8.5] and group V gained median +2.2 kg [1.5 to 3.7] between the start of the preoperative care program and the day of surgery.

Table 2 Comparison of the groups according to preoperative weight change before bariatric surgery presented as mean ± standard deviation, median interquartile range] or number (percentage)

	Group I Weight loss (>5 kg)	Group II Weight loss (3-5 kg)	Group III Weight loss (1-3 kg)	Group IV Stable weight (-1 to +1 kg)	Group V Weight gain (>1 kg)	P-value
Number of patients	296	263	447	623	299	
Age, years	44.8 ± 10.4	45.0 ± 11.4	44.9 ± 11.1	43.6 ± 11.8	42.6 ± 12.0	0.02
Female	222 (75.0)	205 (77.9)	370 (82.8)	496 (79.6)	224 (74.9)	0.04*
Bariatric surgery type						<0.01*
Roux-en-Y gastric bypass	141 (47.6)	158 (60.1)	314 (70.2)	437 (70.1)	179 (59.9)	
Sleeve Gastrectomy	38 (12.8)	59 (17.5)	96 (21.5)	152 (24.4)	101 (33.8)	
Banded Roux-en-Y gastric bypass	117 (39.5)	46 (22.4)	37 (8.3)	34 (5.5)	19 (6.4)	
ASA score						<0.01*
2	142 (48.0)	110 (41.8)	250 (55.9)	373 (55.9)	165 (55.2)	
3	147 (49.7)	151 (47.4)	193 (43.2)	242 (38.8)	133 (44.5)	
4	7 (2.7)	1 (0.4)	2 (0.4)	4 (0.6)	1 (0.3)	
Associated medical problems						
Hypertension	99 (33.4)	96 (36.5)	154 (34.5)	215 (34.5)	99 (33.1)	0.93
Type 2 diabetes	46 (15.5)	60 (22.8)	95 (21.3)	143 (23.0)	50 (16.7)	0.03*
Dyslipidemia	60 (20.3)	56 (21.3)	93 (20.8)	116 (18.6)	58 (19.4)	0.87
OSAS	58 (19.6)	52 (19.8)	80 (17.9)	96 (15.4)	52 (17.4)	0.44
BMI, kg/m²						
Start preoperative care program	44.6 ± 6.8	43.9 ± 5.5	43.2 ± 5.1	43.5 ± 5.2	44.0 ± 5.6	0.01*
Day of surgery	42.0 ± 6.6	42.5 ± 5.5	42.5 ± 5.1	43.5 ± 5.2	45.0 ± 5.7	<0.01*
Preoperative weight change						
Weight change before surgery, kg	-6.8 [-5.9 – -8.5]	-4.0 ± 0.6	-2.0 ± 0.6	0.0 ± 0.6	2.2 [1.5 – 3.7]	<0.01*
Weight change before surgery, %TWL	-5.8 [-5.0 – -7.2]	-3.3 ± 0.7	-1.6 ± 0.5	0.0 ± 0.5	1.7 [1.2 – 2.8]	<0.01*

ASA American Society of Anesthesiologists physical status classification, OSAS obstructive sleep apnea syndrome, BMI body mass index, TWL total weight loss* significant differences between groups.

Total weight loss

The weight change of the total bariatric program from the start of the preoperative care program until three years after BMS is presented in Figure 2 (%TWL) and 3 (BMI), and Supplementary table 1. The weight loss pattern was similar in all five groups, with a largest weight loss achieved at 18 months follow-up. At three years follow-up, mean totalTWL was 33.7±8.2 %, 32.6±8.6%, 31.7±8.7%, 31.1±8.8 % and 32.1±8.5 % for the groups I, II, III, IV and V respectively. Mean ΔBMI was also highest in group I, -15.1±4.9 compared to -14.3±4.6, -13.8±4.4, -13.4±4.2 and -14.3±4.4 for respectively group II, III, IV and V. Loss to follow-up was 30.5% at three years follow-up (Supplementary table 1).

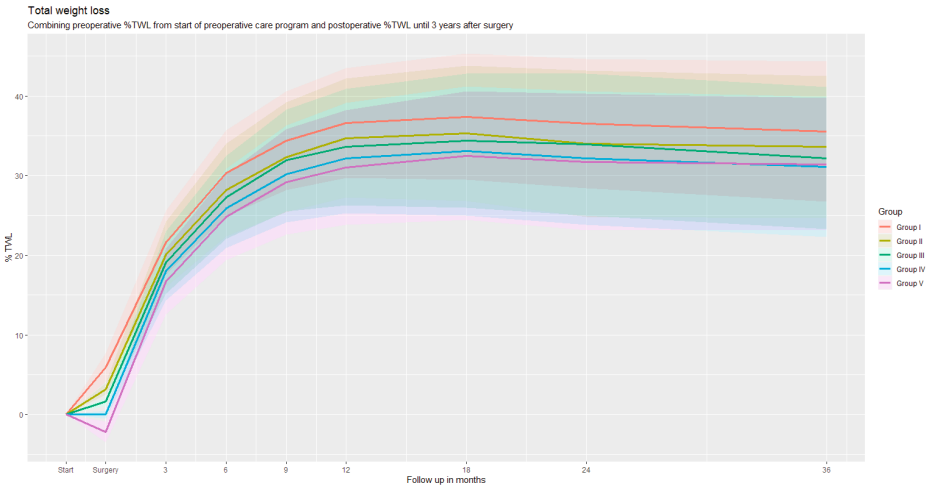


Figure 2. Preoperative weight change and postoperative total weight loss over time for each of the study groups

Postoperative weight loss

Highest postTWL at three years follow-up was observed in group V (33.5±8.3%) compared to group I (29.6±8.8), group II (30.4±9.0), group III (30.6±8.9), and group IV 31.1±8.8 (Figure 2 and Supplementary table 1). Adjusted for potential confounders, group V had a significant higher postTWL at 12, 24, and 36 months follow-up, compared to all other groups ($p<0.01$, Table 3). For example, adjusted for all potential confounders, BMS lead to a 4.03% lower postTWL in group I (lost >5 kg) compared to group V (gain > 1 kg) (β -4.03; 95% CI -5.21 to -2.85, $p<0.01$).

Table 3 Mixed models analysis for the percentage postoperative total weight loss (postTWL), group V (weight gain >1 kg) is the reference group

	12 months			24 months			36 months		
	β	*95% CI*	*P-value*	β	*95% CI*	*P-value*	β	*95% CI*	*P-value*
Group I Weight loss >5 kg									
Model 1[a]	-2.42	-3.55 – -1.30	<0.01	-3.05	-4.20 – -1.89	<0.01	-3.71	-4.91 – -2.52	<0.01
Model 2[b]	-2.76	-3.86 – -1.67	<0.01	-3.39	-4.51 – -2.27	<0.01	-4.07	-5.23 – -2.91	<0.01
Model 3[c]	-2.76	-3.87 – -1.64	<0.01	-3.36	-4.50 – -2.22	<0.01	-4.03	-5.21 – -2.85	<0.01
Group II Weight loss 3-5 kg									
Model 1[a]	-1.68	-2.84 – -0.52	0.01	-2.92	-4.12 – -1.71	<0.01	-2.43	-3.67 – -1.19	<0.01
Model 2[b]	-1.96	-3.01 – -0.84	<0.01	-3.20	-4.37 – -2.03	<0.01	-2.72	-3.93 – -1.52	<0.01
Model 3[c]	-1.60	-2.70 – -0.49	0.01	-2.83	-3.99 – -1.68	<0.01	-2.35	-3.54 – -1.16	<0.01
Group III Weight loss 1-3 kg									
Model 1[a]	-1.07	-2.10 – -0.05	0.04	-1.44	-2.50 – -0.39	0.01	-2.09	-3.18 – -0.99	<0.01
Model 2[b]	-1.26	-2.25 – -0.26	0.01	-1.62	-2.65 – -0.60	<0.01	-2.27	-3.34 – -1.21	<0.01
Model 3[c]	-1.33	-2.29 – -0.37	0.01	-1.69	-2.68 – -0.69	<0.01	-2.32	-3.35 – -1.29	<0.01
Group IV Stable weight									
Model 1[a]	-0.94	-1.90 – 0.03	0.06	-1.69	-2.69 – -0.69	<0.01	-1.97	-3.01 – -0.94	<0.01
Model 2[b]	-0.92	-1.85 – 0.01	0.05	-1.66	-2.63 – -0.70	<0.01	-1.96	-2.96 – -0.96	<0.01
Model 3[c]	-1.00	-1.90 – -0.09	0.03	-1.73	-2.67 – -0.80	<0.01	-2.02	-3.00 – -1.05	<0.01

β = Coefficient of regression, e.g. difference in % postTWL between group V (reference group) and the other groups; 95% CI: 95% confidence interval

[a] Crude model, [b] Model adjusted for age, sex, preoperative BMI, time between start preoperative program and day of surgery [c] Model adjusted for covariates in model 2 plus hospital, ASA score, comorbidities (0, 1, 2, 3, or 4 conditions), and type of bariatric surgery (RYGB, GS, bRYGB)

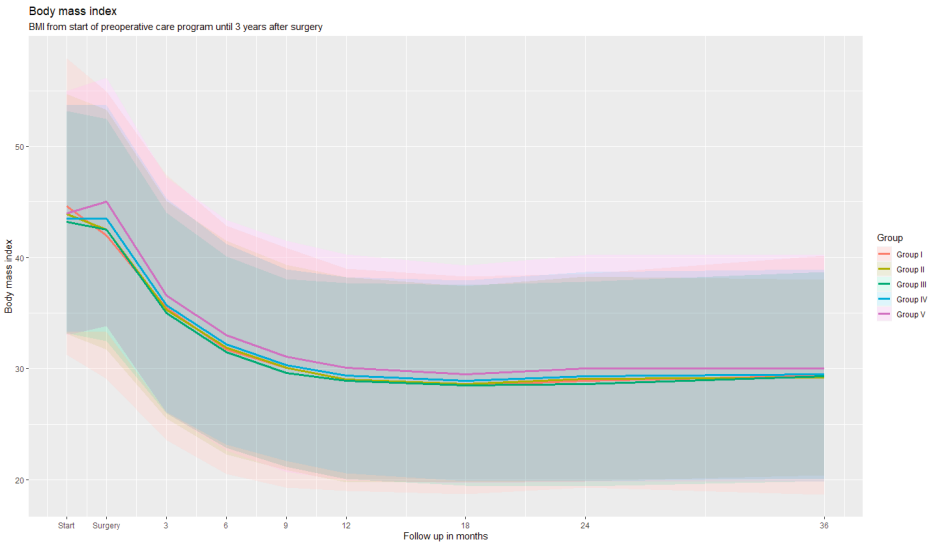


Figure 3. Body mass index over time for each of the study groups

Discussion

In this large retrospective cohort study, the goal was to study if patients with weight gain prior to primary BMS had lower postoperative weight loss. Our data show that the highest postoperative weight loss was observed in the group with preoperative weight gain, with a difference at 36 months of 4.03% when compared to the group that had the highest preoperative weight loss. Therefore, preoperative weight gain should not be used as a negative "indicator" for postoperative weight loss and patients should not be denied BMS, solely based on their preoperative weight change. Total weight loss (combination of pre- and postoperative) was highest in the group of patients with the highest preoperative weight loss (maximum difference 2.5%). The higher total weight loss seems to be entirely attributed to the weight lost before surgery.

Previous (systematic) reviews and meta-analyses addressing this issue, also concluded there was no evidence that weight loss prior to surgery improved weight loss [9, 10, 12, 13, 28]. Thus, the assumption that more preoperative weight loss indicates a greater level of motivation and leads to better weight loss after surgery appears to be unfounded. Our finding that higher total weight loss was observed in patients with the highest preoperative weight loss suggests that preoperative weight loss

may give patients a "head start" in their weight loss journey. Therefore, preoperative weight loss should still be encouraged to all patients applying for BMS.

A key implication is that clear and accurate definitions of outcome measurements for weight loss are essential. In the current study there were strict definitions of preoperative weight loss, postoperative weight loss and total weight loss. Often there are no clear definitions of preoperative and postoperative weight loss; the studies might have investigated total weight loss, instead of postoperative weight loss [20-22].

The strength of the current study is its strict and specific definitions of preoperative weight loss, postoperative weight loss, and total weight loss and the large multicentre patient group with high follow-up rates at 36 months after surgery. A limitation of the current study is that the main outcomes were limited to weight loss. Preoperative weight loss may also affect other BMS outcomes, such as the risk of perioperative complications. Finally, due to the retrospective design the current study does not provide information on which treatments or patient characteristics are associated with preoperative weight change.

Conclusion

Preoperative weight gain is not related to lower postoperative weight loss up to three years after BMS and should not be a reason to deny patients access to treatment. However, patients who lose weight before surgery have higher total weight loss, because of the weight lost before the procedure. Therefore, preoperative weight loss should be encouraged prior to bariatric surgery.

References

1. Akalestou E, Miras AD, Rutter GA, le Roux CW. Mechanisms of Weight Loss After Obesity Surgery. Endocr Rev. 2022;43(1):19-34.
2. Chang SH, Stoll CR, Song J, Varela JE, Eagon CJ, Colditz GA. The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012. JAMA Surg. 2014;149(3):275-87.
3. Kushner BS, Eagon JC. Systematic Review and Meta-Analysis of the Effectiveness of Insurance Requirements for Supervised Weight Loss Prior to Bariatric Surgery. Obes Surg. 2021;31(12):5396-408.
4. Kim JJ, Rogers AM, Ballem N, Schirmer B. ASMBS updated position statement on insurance mandated preoperative weight loss requirements. Surg Obes Relat Dis. 2016;12(5):955-9.
5. Romaen IFL, Jense MTF, Palm-Meinders IH, et al. Higher Preoperative Weight loss Is Associated with Greater Weight Loss up to 12 Months After Bariatric Surgery. Obes Surg. 2022;32(9):2860-8.
6. Alami RS, Morton JM, Schuster R, et al. Is there a benefit to preoperative weight loss in gastric bypass patients? A prospective randomized trial. Surg Obes Relat Dis. 2007;3(2):141-5; discussion 5-6.
7. Hutcheon DA, Hale AL, Ewing JA, et al. Short-Term Preoperative Weight Loss and Postoperative Outcomes in Bariatric Surgery. J Am Coll Surg. 2018;226(4):514-24.
8. Livhits M, Mercado C, Yermilov I, et al. Does weight loss immediately before bariatric surgery improve outcomes: a systematic review. Surg Obes Relat Dis. 2009;5(6):713-21.
9. Gerber P, Anderin C, Thorell A. Weight loss prior to bariatric surgery: an updated review of the literature. Scand J Surg. 2015;104(1):33-9.
10. Cassie S, Menezes C, Birch DW, Shi X, Karmali S. Effect of preoperative weight loss in bariatric surgical patients: a systematic review. Surg Obes Relat Dis. 2011;7(6):760-7; discussion 7.
11. Chinaka U, Fultang J, Ali A, Rankin J, Bakhshi A. Pre-specified Weight Loss Before Bariatric Surgery and Postoperative Outcomes. Cureus. 2020;12(12):e12406.
12. Kim JJ. Evidence Base for Optimal Preoperative Preparation for Bariatric Surgery: Does Mandatory Weight Loss Make a Difference? Curr Obes Rep. 2017;6(3):238-45.
13. Tewksbury C, Williams NN, Dumon KR, Sarwer DB. Preoperative Medical Weight Management in Bariatric Surgery: a Review and Reconsideration. Obes Surg. 2017;27(1):208-14.
14. Mocanu V, Marcil G, Dang JT, Birch DW, Switzer NJ, Karmali S. Preoperative weight loss is linked to improved mortality and leaks following elective bariatric surgery: an analysis of 548,597 patients from 2015-2018. Surg Obes Relat Dis. 2021;17(11):1846-53.
15. Abbott S, Lawson J, Singhal R, Parretti HM, Tahrani AA. Weight loss during medical weight management does not predict weight loss after bariatric surgery: a retrospective cohort study. Surg Obes Relat Dis. 2020;16(11):1723-30.
16. Anderin C, Gustafsson UO, Heijbel N, Thorell A. Weight loss before bariatric surgery and postoperative complications: data from the Scandinavian Obesity Registry (SOReg). Ann Surg. 2015;261(5):909-13.
17. Alger-Mayer S, Polimeni JM, Malone M. Preoperative weight loss as a predictor of long-term success following Roux-en-Y gastric bypass. Obes Surg. 2008;18(7):772-5.
18. Benotti PN, Still CD, Wood GC, et al. Preoperative weight loss before bariatric surgery. Arch Surg. 2009;144(12):1150-5.
19. Kourounis G, Kong CY, Logue J, Gibson S. Weight loss in adults following bariatric surgery, a systematic review of preoperative behavioural predictors. Clin Obes. 2020;10(5):e12392.
20. Lodewijks Y, Akpinar E, van Montfort G, Nienhuijs S. Impact of Preoperative Weight Loss on Postoperative Weight Loss Revealed from a Large Nationwide Quality Registry. Obes Surg. 2022;32(1):26-32.
21. Ali MR, Baucom-Pro S, Broderick-Villa GA, et al. Weight loss before gastric bypass: feasibility and effect on postoperative weight loss and weight loss maintenance. Surg Obes Relat Dis. 2007;3(5):515-20.

22. Mrad BA, Stoklossa CJ, Birch DW. Does preoperative weight loss predict success following surgery for morbid obesity? Am J Surg. 2008;195(5):570-3; discussion 3-4.

23. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg. 2014;12(12):1495-9.

24. Tettero OM, Aronson T, Wolf RJ, Nuijten MAH, Hopman MTE, Janssen IMC. Increase in Physical Activity After Bariatric Surgery Demonstrates Improvement in Weight Loss and Cardiorespiratory Fitness. Obes Surg. 2018;28(12):3950-7.

25. De Luca M, Angrisani L, Himpens J, et al. Indications for Surgery for Obesity and Weight-Related Diseases: Position Statements from the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO). Obes Surg. 2016;26(8):1659-96.

26. Poelemeijer YQM, Liem RSL, Nienhuijs SW. A Dutch Nationwide Bariatric Quality Registry: DATO. Obes Surg. 2018;28(6):1602-10.

27. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240(2):205-13.

28. Ochner CN, Dambkowski CL, Yeomans BL, Teixeira J, Xavier Pi-Sunyer F. Pre-bariatric surgery weight loss requirements and the effect of preoperative weight loss on postoperative outcome. Int J Obes (Lond). 2012;36(11):1380-7.

Supplementary table 1 Overview preoperative weight change, postoperative weight and total weight loss up to 36 months after surgery for the groups, presented as mean ± standard deviation, and overview of missing data per follow-up moment (percentage)

	Group I Weight loss (>5 kg)	**Group II Weight loss (3-5 kg)**	**Group III Weight loss (1-3 kg)**	**Group IV Stable weight (-1 to +1 kg)**	**Group V Weight gain (>1 kg)**	*Missing data*
Weight loss, %						
Preoperative	5.9 ± 1.8	3.2 ± 0.7	1.6 ± 0.5	0.0 ± 0.5	-2.2 ± 1.3	*0.0*
Postoperative 3 months	15.7 ± 4.0	16.9 ± 4.1	17.5 ± 3.9	18.0 ± 3.7	18.8 ± 4.0	*1.2*
Postoperative 6 months	24.4 ± 5.3	25.0 ± 5.7	25.7 ± 5.2	25.8 ± 5.0	27.0 ± 5.4	*2.5*
Postoperative 9 months	28.5 ± 6.1	29.1 ± 6.8	30.1 ± 6.5	30.2 ± 6.1	31.3 ± 6.5	*10.0*
Postoperative 12 months	30.7 ± 6.8	31.5 ± 7.5	32.0 ± 7.3	32.2 ± 6.9	33.1 ± 7.2	*5.6*
Postoperative 18 months	31.6 ± 7.8	32.1 ± 8.6	32.8 ± 8.4	33.1 ± 8.1	34.6 ± 8.0	*16.9*
Postoperative 24 months	30.7 ± 8.1	30.8 ± 9.3	32.2 ± 9.0	32.1 ± 8.4	33.8 ± 8.5	*19.0*
Postoperative 36 months	29.6 ± 8.8	30.4 ± 9.0	30.6 ± 8.9	31.1 ± 8.8	33.5 ± 8.3	*30.5*
Total 36 months	33.7 ± 8.2	32.6 ± 8.6	31.7 ± 8.7	31.1 ± 8.8	32.1 ± 8.5	*30.5*
Δ BMI, kg/m²						
Preoperative	-2.6 ± 0.9	-1.4 ± 0.2	-0.7 ± 0.2	0.0 ± 0.2	0.9 ± 0.6	*0.0*
Postoperative 3 months	-9.2 ± 1.9	-8.5 ± 1.9	-8.1 ± 1.8	-7.8 ± 1.7	-7.5 ± 1.9	*1.2*
Postoperative 6 months	-12.8 ± 2.7	-12.0 ± 2.8	-11.6 ± 2.5	-11.2 ± 2.5	-11.1 ± 2.5	*2.5*
Postoperative 9 months	-14.6 ± 3.3	-13.8 ± 3.4	-13.5 ± 3.2	-13.1 ± 3.1	-13.2 ± 3.2	*10.0*
Postoperative 12 months	-15.5 ± 3.8	-14.8 ± 3.9	-14.3 ± 3.7	-14.0 ± 3.5	-14.0 ± 3.6	*5.6*
Postoperative 18 months	-15.9 ± 4.5	-15.0 ± 4.3	-14.7 ± 4.3	-14.4 ± 4.1	-14.8 ± 4.3	*16.9*
Postoperative 24 months	-15.5 ± 4.6	-14.4 ± 4.6	-14.4 ± 4.5	-14.0 ± 4.1	-14.5 ± 4.5	*19.0*
Postoperative 36 months	-15.1 ± 4.9	-14.3 ± 4.6	-13.8 ± 4.4	-13.4 ± 4.2	-14.3 ± 4.4	*30.5*

III

Food and health literacy

6

Food and health literacy in patients awaiting metabolic-bariatric surgery

Anne Jacobs
Leontien M.G. Nijland
Ingrid H.M. Steenhuis
Ruben N. van Veen
Ronald S.L. Liem
Hanno Pijl
Lies ter Beek
Rob A.E.M. Tollenaar
Valerie M. Monpellier

Obes Facts. 2024 Oct 3:1-9

Abstract

Introduction

Specialized lifestyle programs for patients undergoing metabolic-bariatric surgery (MBS) are provided to facilitate adjustment and adherence to a healthy lifestyle after surgery. However, pre-program food and health literacy in MBS patients are often unknown. In the general population, approximately three-quarters of people exhibit sufficient health literacy. This study aimed to examine food and health literacy of patients awaiting MBS and to identify patient specific factors associated with these literacies.

Methods

Patients awaiting MBS completed questionnaires on food literacy (Self-Perceived Food Literacy scale) and health literacy (European Health Literacy Survey Questionnaire-16) at the start of a preoperative lifestyle program. Linear and logistic regression analyses were used to identify associations between multiple variables and preoperative food and health literacy.

Results

Among 216 patients, the preoperative mean food literacy score was 3.49±0.44, on a five-point scale. Furthermore, 96.3% of patients showed sufficient health literacy, with scores of 13 or more out of 16. Patients with sufficient health literacy had higher food literacy scores (β 0.508; 95% CI: 0.208 – 0.809, p<.001).

Conclusion

This study among people living with obesity awaiting MBS suggests that food literacy is comparable, and health literacy is higher than in the general population. These findings emphasize the complexity of the aetiology of obesity, due to factors that extend beyond food and health literacy.

Introduction

According to international guidelines, lifestyle adjustment forms the cornerstone for the treatment of obesity [1, 2]. It is essential for the effectiveness of treatments, whether applying conservative methods involving cognitive and behavioral treatments, utilizing obesity management medication like GLP-1 agonists, or opting for metabolic-bariatric surgery (MBS) in cases of severe obesity. Therefore, most bariatric centres offer perioperative lifestyle programs that focus on behavioural change, nutritional knowledge, dietary skills, physical activity, and psychological support [3-5]. However, it remains uncertain whether patients undergoing MBS have adequate nutritional and health literacy skills, which are assumed conditional for behavior change in the context of obesity.

Previously, the assessment of these skills was challenging, but two emerging concepts—food literacy and health literacy—now enable measurement through validated questionnaires. Food literacy is defined as "*a collection of interrelated knowledge, skills and behaviours required to plan, manage, select, prepare and eat food to meet needs and determine food intake*" [6]. Health literacy, which has evolved over time, is now described as "*the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others*" according to the CHC's 2020 definition [7]. It is important to understand that food and health literacy include more than just knowledge. They also involve skills and behaviours, including the ability to apply this health information effectively. For example, food literacy involves knowing how to prepare a meal using more than five fresh ingredients, and health literacy includes assessing the reliability of media sources. These examples illustrate the practical application of both literacies in everyday actions.

Prior research in the general population suggests a link between better food and health literacy and healthier eating habits [8-10]. During the validation process of the Self-Perceived Food Literacy scale, (SPFL) used in this study, the SPFL showed a positive correlation with self-control and a negative correlation with impulsiveness. Participants who demonstrated higher food literacy reported consuming fruits, vegetables, and fish more frequently and in larger portions compared to those with lower food literacy levels [8]. Additionally, another study found that higher SPFL scores were associated with better overall diet quality [11]. Limited health literacy has been linked to several health-related outcomes, including poor general health, increased mortality, elevated health costs and reduced medication compliance

[12-14]. Furthermore, it was also found that limited health literacy is associated with unhealthy lifestyle behaviours [15]. Limited health literacy is more prevalent in specific demographic groups, such as those with a lower socioeconomic status and minority groups [12, 16]. Furthermore, low alphabetical and numerical literacy may also contribute to limited health literacy [17].

To our knowledge, food literacy has not previously been investigated in patients awaiting MBS. Health literacy in patients awaiting MBS has been studied a few times and was found to be adequate in most patients [18-21]. There were associations between patients' race/ethnicity and their health literacy [18], as well as an inverse relationship between higher preoperative BMI and health literacy scores [19].

Despite existing research on food and health literacy in diverse populations, a significant knowledge gap remains, particularly on food literacy within the specific group of patients awaiting MBS [22]. Therefore, this study aims to examine food and health literacy in patients awaiting MBS and to identify patient-specific factors associated with these literacies.

Methods

Patient and data selection

In this prospective cohort study, patients were invited to participate when they were eligible for MBS after screening according to the IFSO criteria and started a preoperative lifestyle program at the Nederlandse Obesitas Kliniek (NOK, Dutch Obesity Clinic) locations in Amsterdam, Beverwijk and Hoogeveen. The invitation was sent to patients within their first week of enrolment in the preoperative lifestyle program. Patients with a documented history of any type of MBS or those who failed to complete the preoperative questionnaires despite three reminders were excluded. The process of patient inclusion continued until the desired sample size (200 completed questionnaires) was achieved. This study is part of a prospective cohort study that incorporates follow-up assessments up to two years after MBS.

This study was approved by the Medical Research Ethics Committees United, located in Nieuwegein, The Netherlands (reference number W22.073).

Standard treatment

All patients were screened for MBS eligibility by a multidisciplinary team, following the latest International Federation for the Surgery of Obesity (IFSO) criteria and nutritional guidelines [23]. All patients awaiting MBS were enrolled in a pre- and postoperative counselling program at the NOK, which is identical across all locations. This program is led by a multidisciplinary team consisting of a medical doctor, dietician, psychologist and exercise expert. Most patients participate in a group counselling program. Individual guidance is only provided when group sessions are not feasible, for example, due to a language barrier or specific psychological disorders. The group counselling program comprises a total of 17 sessions, with five sessions in the five weeks prior to MBS and twelve sessions throughout the first postoperative year. Following the first year, patients attend annual follow-up sessions up to five years post-surgery.

Questionnaires

Following enrolment in the study, all participants were provided with the questionnaires through Castor EDC, an electronic study management program [24]. The initial questionnaire was a self-developed questionnaire, including two questions: educational level and ethnic background (assessed by the birth country of the patient and their parents). The level of education was categorized into three groups: higher education (university or higher vocational education), intermediate education (senior general secondary and pre-university education, senior secondary vocational education, or secondary vocational education), and the lower education group (lower vocational education, primary education, or no diploma).

The assessment of food literacy in this study was conducted using the SPFL, which comprises 29 items [8]. The scale has been rewritten into simpler language to align with the Common European Framework of Reference (CEFR) at level B1 [8]. This questionnaire, validated in the Dutch population, assesses the self-perceived food literacy among adults, with respect to healthy eating. Its validation included individuals with underweight, normal weight, overweight, and obesity [8]. The scoring of the SPFL is conducted using a five-point Likert scale, where a score of five represents "Yes, always" and a score of one indicates "No, never" and vice versa for the eight questions that are subjected to reversed scoring. The scores are reported as the mean score, ranging from a minimum of one to a maximum of five, wherein a higher score corresponds to a higher level of food literacy. There is no predefined threshold to classify scores as either indicative of sufficient or limited food literacy.

The European Health Literacy Survey Questionnaire (HLS-EU-Q16) was used to evaluate health literacy. The HLS-EU-Q16 is a validated, modified version derived from the original HLS-EU-Q47 tool consisting of 16 items [25]. Although the original questionnaire was not initially developed based on the CEFR-level B1, it has been rewritten by researchers from the Erasmus MC in Rotterdam, The Netherlands, to align with this language proficiency level. The CEFR-level B1 version of the questionnaire was utilized in this study and the scoring method for HLS-EU-Q16 has been applied according to the guidelines [25]. It is scored on a four-point Likert scale, where a score of one represents the lowest level of health literacy and a score of four the highest level. To simplify the scoring process, the scores are transformed into a binary format. Scores of one "very difficult" and two "difficult" are assigned a value of zero, while scores of three "easy" and four "very easy" are assigned a value of one. The individual scores are then summed, and three categories are established based on the total score. A score ranging from 0 to 8 indicates inadequate health literacy, a score of 9 to 12 indicates limited health literacy and a score from 13 to 16 indicates sufficient health literacy [25].

Other measurements

Height and weight were measured at preoperative screening and at the start of the preoperative lifestyle program, as part of standard care at the NOK. Baseline characteristics, including gender, age, type of surgery, and associated medical conditions, were obtained from the electronic patients' records at the NOK.

Statistical analysis

Continuous data were reported as mean ± standard deviation for normally distributed data, and as median (interquartile range) for non-normally distributed data. Categorical data were presented as number (percentage). To investigate the factors associated with the preoperative level of food literacy, univariate linear regression analyses were conducted. For continuous variables, when linearity assumptions were not met, log transformation was applied. If linearity was still not achieved, quadratic or higher-order terms were added. In cases where the assumptions were not met even after these transformations, the variables were categorized based on quartiles and included in the model. The results were reported as β-coefficients with corresponding 95% confidence intervals (CI). To assess the factors associated with health literacy, univariate logistic regression analyses were performed (sufficient versus insufficient health literacy). The results were presented as odds ratios (OR) with corresponding 95% CI.

The statistical analyses were carried out using IBM SPSS Statistics for Mac, version 27.0. A p-value of less than 0.05 was considered statistically significant.

Results

Study population

A total of 500 consecutive patients were invited to participate in the study between June 2023 and December 2023. Of the invited patients, a total of 291 individuals agreed to receive baseline questionnaires. Of these, 216 participants (74%) completed the questionnaires and were subsequently included in the study. The median age of the study population was 44.0 [21.0] years, with 80.1% of the participants being female (Table 1). Most patients had an intermediate level of education.

Table 1 Baseline characteristics of the included study population. Presented as mean ± standard deviation, median [interquartile range] or number (%).

	Included population
	(n=216)
Age at screening, years	44.0 [21.0]
Sex	
Female	173 (80.1)
Body mass index, kg/m²	42.5 [7.2]
Preoperative screening	42.5 [7.3]
Start preoperative counselling program	
Associated medical problems	
Hypertension	59 (27.3)
Type II diabetes	24 (11.1)
Dyslipidemia	25 (11.6)
Sleepapnea	41 (19.0)
Osteoarthritis	27 (12.5)
Country of birth	
The Netherlands	170 (78.7)
Other	46 (21.3)
Level of education	
Higher education	64 (29.6)
Intermediate education	135 (62.6)
Lower education	17 (7.8)
Type of perioperative counselling	
Group	198 (91.7)
Individual	18 (8.3)

Food and health literacy

Preoperative mean food literacy score was 3.49±0.44 (Table 2). Health literacy scores indicated sufficient (≥13 out of 16 points) in 208 patients (96.3%), limited health literacy (9-12 points) in five patients (2.3%), and inadequate health literacy (≤8 points) in three patients (1.4%). The distribution of scores within each category is also detailed in Table 2. Due to the small sizes of the limited and inadequate health literacy groups, for further analysis, these groups were combined into a single "insufficient" group. Patients with sufficient health literacy skills exhibited a significantly higher food literacy score compared to those with insufficient health literacy skills (β 0.508; 95% CI: 0.208 – 0.809, p<0.001, Table 3).

Table 2 Preoperative food and health literacy scores. Presented as mean ± standard deviation or number (%).

	Included population
	(n=216)
Food literacy score	3.49 ± 0.44
Health literacy score categories	
Sufficient	208 (96.3)
Limited	5 (2.3)
Inadequate	3 (1.4)
Total health literacy score	
3	1 (0.5)
5	1 (0.5)
8	1 (0.5)
9	1 (0.5)
10	1 (0.5)
11	2 (0.9)
12	1 (0.5)
13	16 (7.4)
14	28 (13.0)
15	39 (18.1)
16	125 (57.9)

Associations with food literacy

The results of the univariate regression analyses revealed several significant associations. Females demonstrated a significantly higher food literacy score compared to males (β 0.202; 95% CI: 0.059 – 0.346, p=0.006, Table 3). Furthermore, patients with hypertension had a lower food literacy score compared to patients without hypertension (β -0.152; 95% CI: -0.281 – -0.023, p=0.021). However, age, preoperative

BMI, level of education, country of birth, type of perioperative counselling and other associated medical problems did not show significant associations with preoperative food literacy.

Table 3 Food literacy scores for different predictors, using univariate linear regression, presented as β-coefficient [95% confidence intervals].

Independent variables	Intercept	Univariate model	P-value
Age at screening, quartiles			
< 33 years	3.553	Ref.	
33-44 years		-0.115 [-0.276 – 0.045]	0.158
44-54 years		-0.112 [-0.275 – 0.052]	0.179
> 54 years		-0.039 [-0.206 – 0.129]	0.651
Sex			
Male	3.323	Ref.	0.006
Female		0.202 [0.059 – 0.346]	
BMI start preoperative counselling, quartiles			
< 39.4 kg/m^2	3.482	Ref.	
39.4-42.49 kg/m^2		0.047 [-0.118 – 0.213]	0.573
42.49-46.66 kg/m^2		-0.028 [-0.192 – 0.137]	0.741
> 46.66 kg/m^2		-0.006 [-0.171 – 0.159]	0.945
Baseline health literacy score			
Insufficient (limited+inadequate)	3.504	Ref.	
Sufficient		0.508 [0.208 – 0.809]	<0.001
Associated medical problems			
Hypertension	3.529	-0.152 [-0.281 – -0.023]	0.021
Type II diabetes	3.507	-0.170 [-0.354 – 0.013]	0.069
Dyslipidemia	3.493	-0.051 [-0.232 – 0.131]	0.583
Sleepapnea	3.506	-0.095 [-0.243 – 0.052]	0.205
Osteoarthritis	3.480	0.059 [-0.117 – 0.234]	0.510
Country of birth			
The Netherlands	3.472	Ref.	
Other		0.062 [-0.079 – 0.204]	0.386
Level of education			
Higher education	3.522	Ref.	
Intermediate education		-0.037 [-0.166 – 0.093]	0.576
Lower education		-0.169 [-0.401 – 0.064]	0.155
Type of perioperative counselling			
Group	3.482	Ref.	
Individual		0.037 [-0.174 – 0.247]	0.730

BMI: Body Mass Index

Associations with health literacy

Univariate logistic regression analyses illustrated that females had higher odds of having sufficient health literacy skills compared to males, with an OR of 4.333 [1.038 – 18.089] p=0.044 (Table 4). The presence of type II diabetes and dyslipidaemia prior to surgery reduced the likelihood of having sufficient health literacy, with odds ratios of 0.188 [0.042 – 0.844] p=0.029 and 0.198 [0.044 – 0.887] p=0.034, respectively. No significant associations were found between health literacy and age, preoperative BMI, level of education, country of birth, type of perioperative counselling or other associated medical problems.

Table 4 Odds ratio for sufficient versus insufficient (limited+inadequate) preoperative health literacy scores using univariate logistic regression analysis, presented as odds ratio [95% confidence interval]. The non-sufficient group is used as reference category.

Independent variables	Univariate model	P-value
Age at screening	0.981 [0.926 – 1.040]	0.522
Sex		
Male	Ref.	0.044
Female	4.333 [1.038 – 18.089]	
Preoperative BMI	0.950 [0.852 – 1.058]	0.349
Associated medical problems		
Hypertension	0.618 [0.143 – 2.672]	0.519
Type II diabetes	0.188 [0.042 – 0.844]	0.029
Dyslipidemia	0.198 [0.044 – 0.887]	0.034
Sleepapnea	0.375 [0.086 – 1.636]	0.192
Osteoarthritis	-*	
Country of birth		
The Netherlands	Ref.	
Other	0.434 [0.100 – 1.889]	0.266
Level of education		
Higher education	Ref.	
Intermediate education	1.279 [0.296 – 5.524]	0.742
Lower education		
Type of perioperative counselling		
Group		
Individual	Ref.	
	0.250 [0.047– 1.341]	0.106

* All individuals within the osteoarthritis and low education group exhibited sufficient health literacy, making the analysis not feasible.
BMI: Body Mass Index

Discussion

The aim of this study was to investigate the food and health literacy of people awaiting MBS, and to identify patient-specific factors associated with these literacies. The results show that 96.3% of patients awaiting MBS had sufficient health literacy. On a five-point scale measuring food literacy, the patients achieved an average score of 3.49 ± 0.44. Additionally, patients with sufficient health literacy demonstrated higher food literacy scores. Females demonstrated higher scores in both food literacy and health literacy, compared to males. Preoperative BMI, age, country of birth, and level of education were not associated with food or health literacy scores.

In this study, preoperative mean food literacy score was 3.49±0.44. By comparison, in previous Dutch cohort studies with individuals across the BMI spectrum (from underweight to obesity), the average food literacy score of the general population was 3.83 ± 0.41 and 3.37 ± 0.47, and a group of dieticians scored 3.99 ± 0.30 [8] [9]. Both studies also used the SPFL questionnaire so, when considering that the mean scores overlap within two times the standard deviation, the average food literacy scores of our and the general population appear similar.

Our data shows 96.3% of patients awaiting MBS have adequate health literacy skills, contrasting with previous studies using the same questionnaire reporting 60.9-78.7% [20, 21]. Methodological differences, like digital survey distribution in our study versus face-to-face in others, could skew results due to potential selection bias among those with lower digital literacy. Consequently, this might have led to an overestimation of the proportion of patients with sufficient health literacy in our cohort.

The current study showed higher health literacy scores compared to a previous study in the general Dutch population, where only 75.5% showed sufficient health literacy [26]. This could be due to the fact that patients in the current study recently sought help for their obesity, leading them to perceive themselves as having sufficient health literacy. Furthermore, this cohort likely includes individuals who are more proactive in seeking medical help, which potentially introduces a bias towards higher perceived health literacy. Additionally, evidence suggests a self-selection bias, as patients with better literacy are more likely to undergo MBS [18, 20].

The self-reported nature of both questionnaires used in this study may be sensitive to social desirability. Since patients in the current study had already undergone screening, were eligible for MBS, and were participating in the preoperative counseling program, their responses to the questionnaires did not influence the indication for MBS. Nonetheless, some patients might have felt compelled to provide responses they perceived as supportive of their decision to pursue surgery or to justify MBS as their last resort after attempting other lifestyle changes, potentially influencing their answers towards more socially desirable responses.

This study found no significant correlation between BMI categories and food or health literacy scores. Previous research in patients undergoing MBS showed mixed results, with one study finding no BMI-nutrition literacy association [27] and another study observing an inverse BMI-health literacy association [19]. Studies in the general population also show conflicting results: some report lower food or health literacy linked to higher BMI, [28, 29], while others find no such association between these literacies and BMI [9, 30]. Thus, the relationship between BMI and food or health literacy appears complex or might not exist and needs further exploration through more comprehensive and longitudinal studies.

Previous studies have not examined food literacy in patients awaiting MBS, but one study with a smaller sample size (n=112) found no significant link between sex and nutritional knowledge [27]. In the general population, women often exhibit higher food and health literacy scores compared to men [9, 10, 31, 32], consistent with our findings. This gender gap may stem from societal roles where women typically manage meal planning, shopping, and cooking [33], along with their tendency to be more health-conscious and proactive in seeking health information [34]. Consequently, women may have greater exposure to nutritional and health information and skills, resulting in higher literacy scores.

Lastly, this study found a strong correlation between food and health literacy. Patients with sufficient health literacy had significantly higher food literacy scores than those with insufficient health literacy. This finding aligns with previous research that also demonstrated a positive association between these two forms of literacy [9, 10]. This interrelationship suggests that individuals with insufficient health literacy may face challenges in understanding and making informed decisions regarding healthy eating.

These observations strengthen the understanding that the cause of obesity is multifactorial, with the complex pathophysiology influenced by numerous factors such as genetics, behaviour, the gut microbiome and the external (food) environment, and is not solely the result of low food or health literacy [35-38]. To comprehensively understand the role of food and health literacy in obesity treatment, it is important to distinguish between knowledge, skills, behaviours and behavioural change. As mentioned previously, food and health literacy involve skills and behaviours that go beyond mere knowledge, including the application of information. Additionally, health literacy is just one contributor to health outcomes; other factors such as life skills and executive functions also improve health [39]. Moreover, behaviour is influenced by multiple determinants beyond skills, including attitudes, self-efficacy and social influence such as social support [40, 41]. These factors collectively determine the ability to translate knowledge into actionable behaviours and drive behavioural change, a critical consideration in the context of obesity treatment. Future studies should therefore also examine these additional behavioural determinants.

Strengths and limitations

This study significantly contributes to the understanding of food and health literacy and associated factors in patients awaiting MBS. The strengths of the study include the study size with 216 participants and the use of validated questionnaires at CEFR-level B1, which improves reliability. Nevertheless, certain limitations must be acknowledged. First, selection bias could have occurred because participation was voluntary, favouring individuals who were more confident in their food and health literacy and, therefore, more willing to participate; 26% of patients did not complete the questionnaires despite reminders, potentially favouring the inclusion of those with sufficient literacy. Additionally, digital administration of questionnaires may have introduced selection bias by inadvertently excluding individuals with limited digital literacy. Secondly, the small size of the group with insufficient health literacy (8 patients) necessitates a careful interpretation of the results, as this can strongly influence the correlations with other variables. To reduce such biases in future studies, incorporating printed and voice-assisted questionnaires should be considered, which may also increase completion rates. Lastly, it is important to highlight that although these questionnaires are validated and both better food literacy and health literacy have been linked to healthier diet and lifestyle behaviours (as described in the introduction), they were validated within the general population. Therefore, the results may not be directly applicable, one-to-one, to the study population.

Conclusion

This study of people living with obesity and awaiting MBS suggests that self-reported food literacy is comparable to and health literacy is higher than that of the general population. Women reported greater food and health literacy, and no correlation was found between BMI and these literacies. The findings underline the complexity of obesity as a chronic disease, influenced by many factors beyond food and health literacy. Future studies should also examine additional behavioural determinants, such as self-efficacy, executive functions and life skills, as these are crucial for effectively engaging in health-related behaviours.

References

1. Garvey WT, Mechanick JI, Brett EM, et al. AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS AND AMERICAN COLLEGE OF ENDOCRINOLOGY COMPREHENSIVE CLINICAL PRACTICE GUIDELINES FOR MEDICAL CARE OF PATIENTS WITH OBESITY. Endocr Pract. 2016;22 Suppl 3:1-203.
2. Wharton S, Lau DCW, Vallis M, et al. Obesity in adults: a clinical practice guideline. Cmaj. 2020;192(31):E875-e91.
3. Fried M, Yumuk V, Oppert JM, et al. Interdisciplinary European guidelines on metabolic and bariatric surgery. Obes Surg. 2014;24(1):42-55.
4. Richtlijn morbide obesitas - Richtlijnendatabase 2011 [Available from: https://richtlijnendatabase.nl/richtlijn/morbide_obesitas.
5. Melissas J. IFSO guidelines for safety, quality, and excellence in bariatric surgery. Obes Surg. 2008;18(5):497-500.
6. Vidgen HA, Gallegos D. Defining food literacy and its components. Appetite. 2014;76:50-9.
7. Health.gov. Health Literacy in Healthy People 2030 2021 [updated August 24th 2021. Available from: https://health.gov/our-work/national-health-initiatives/healthy-people/healthy-people-2030/health-literacy-healthy-people-2030.
8. Poelman MP, Dijkstra SC, Sponselee H, et al. Towards the measurement of food literacy with respect to healthy eating: the development and validation of the self perceived food literacy scale among an adult sample in the Netherlands. Int J Behav Nutr Phys Act. 2018;15(1):54.
9. Sponselee HCS, Kroeze W, Poelman MP, Renders CM, Ball K, Steenhuis IHM. Food and health promotion literacy among employees with a low and medium level of education in the Netherlands. BMC Public Health. 2021;21(1):1273.
10. Lee Y, Kim T, Jung H. The Relationships between Food Literacy, Health Promotion Literacy and Healthy Eating Habits among Young Adults in South Korea. Foods. 2022;11(16).
11. Murakami K, Shinozaki N, Okuhara T, McCaffrey TA, Livingstone MBE. Self-perceived food literacy in relation to the quality of overall diet and main meals: A cross-sectional study in Japanese adults. Appetite. 2024;196:107281.
12. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. Ann Intern Med. 2011;155(2):97-107.
13. Dewalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. Literacy and health outcomes: a systematic review of the literature. J Gen Intern Med. 2004;19(12):1228-39.
14. Eichler K, Wieser S, Brügger U. The costs of limited health literacy: a systematic review. Int J Public Health. 2009;54(5):313-24.
15. Wieczorek M, Meier C, Kliegel M, Maurer J. Relationship Between Health Literacy and Unhealthy Lifestyle Behaviours in Older Adults Living in Switzerland: Does Social Connectedness Matter? Int J Public Health. 2023;68:1606210.
16. van der Heide I, Wang J, Droomers M, Spreeuwenberg P, Rademakers J, Uiters E. The relationship between health, education, and health literacy: results from the Dutch Adult Literacy and Life Skills Survey. J Health Commun. 2013;18 Suppl 1(Suppl 1):172-84.
17. Sørensen K, Van den Broucke S, Fullam J, et al. Health literacy and public health: a systematic review and integration of definitions and models. BMC Public Health. 2012;12:80.
18. Hecht L, Cain S, Clark-Sienkiewicz SM, et al. Health Literacy, Health Numeracy, and Cognitive Functioning Among Bariatric Surgery Candidates. Obes Surg. 2019;29(12):4138-41.
19. Erdogdu UE, Cayci HM, Tardu A, Demirci H, Kisakol G, Guclu M. Health Literacy and Weight Loss After Bariatric Surgery. Obes Surg. 2019;29(12):3948-53.
20. Cayci HM, Erdogdu UE, Demirci H, Ardic A, Topak NY, Taymur İ. Effect of Health Literacy on Help-seeking Behavior in Morbidly Obese Patients Agreeing to Bariatric Surgery. Obes Surg. 2018;28(3):791-7.

21. Köhler H, Dorozhkina R, Gruner-Labitzke K, de Zwaan M. Specific Health Knowledge and Health Literacy of Patients before and after Bariatric Surgery: A Cross-Sectional Study. Obes Facts. 2020;13(2):166-78.

22. Sherf Dagan S, Keidar A, Raziel A, et al. Do Bariatric Patients Follow Dietary and Lifestyle Recommendations during the First Postoperative Year? Obes Surg. 2017;27(9):2258-71.

23. 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 & Bariatric Surgery, Obesity Medicine Association, and American Society of Anesthesiologists. Surg Obes Relat Dis. 2020;16(2):175-247.

24. Castor EDC. Castor Electronic Data Capture. [2023.3.2.2:[Available from: https://castoredc.com.

25. Storms H, Claes N, Aertgeerts B, Van den Broucke S. Measuring health literacy among low literate people: an exploratory feasibility study with the HLS-EU questionnaire. BMC Public Health. 2017;17(1):475.

26. Anouk Willems MH, Anne Brabers, Jany Rademakers. Gezondheidsvaardigheden in Nederland: factsheet cijfers 2021. NIVEL; 2021.

27. Alkhaldy A, Alshehri B, Albalawi N, et al. General and Postbariatric Nutritional Knowledge among Patients Undergoing Bariatric Surgery. J Nutr Metab. 2019;2019:6549476.

28. Trieste L, Bazzani A, Amato A, Faraguna U, Turchetti G. Food literacy and food choice – a survey-based psychometric profiling of consumer behaviour. British Food Journal. 2021;123(13):124-41.

29. Toçi E, Burazeri G, Kamberi H, et al. Health literacy and body mass index: a population-based study in a South-Eastern European country. J Public Health (Oxf). 2021;43(1):123-30.

30. Zare-Zardiny MR, Abazari F, Zakeri MA, Dastras M, Farokhzadian J. The association between body mass index and health literacy in high school Students: A cross-sectional study. J Educ Health Promot. 2021;10:431.

31. van der Heide I, Rademakers J, Schipper M, Droomers M, Sørensen K, Uiters E. Health literacy of Dutch adults: a cross sectional survey. BMC Public Health. 2013;13:179.

32. Lee HY, Lee J, Kim NK. Gender Differences in Health Literacy Among Korean Adults: Do Women Have a Higher Level of Health Literacy Than Men? Am J Mens Health. 2015;9(5):370-9.

33. Flagg LA, Sen B, Kilgore M, Locher JL. The influence of gender, age, education and household size on meal preparation and food shopping responsibilities. Public Health Nutr. 2014;17(9):2061-70.

34. Ek S. Gender differences in health information behaviour: a Finnish population-based survey. Health Promot Int. 2015;30(3):736-45.

35. Dalle Molle R, Fatemi H, Dagher A, Levitan RD, Silveira PP, Dubé L. Gene and environment interaction: Is the differential susceptibility hypothesis relevant for obesity? Neurosci Biobehav Rev. 2017;73:326-39.

36. Sun X, Li P, Yang X, Li W, Qiu X, Zhu S. From genetics and epigenetics to the future of precision treatment for obesity. Gastroenterol Rep (Oxf). 2017;5(4):266-70.

37. Qasim A, Turcotte M, de Souza RJ, et al. On the origin of obesity: identifying the biological, environmental and cultural drivers of genetic risk among human populations. Obes Rev. 2018;19(2):121-49.

38. Yanovski SZ, Yanovski JA. Toward Precision Approaches for the Prevention and Treatment of Obesity. Jama. 2018;319(3):223-4.

39. Sponselee HCS, Ter Beek L, Renders CM, et al. Letting people flourish: defining and suggesting skills for maintaining and improving positive health. Front Public Health. 2023;11:1224470.

40. Albarracín D, Fayaz-Farkhad B, Granados Samayoa JA. Determinants of behaviour and their efficacy as targets of behavioural change interventions. Nature Reviews Psychology. 2024;3(6):377-92.

41. Holloway A, Watson HE. Role of self-efficacy and behaviour change. Int J Nurs Pract. 2002;8(2):106-15.

IV

Overarching framework

7

General discussion and summary

Over the past decades, the global prevalence of overweight and obesity has reached epidemic proportions. Consequently, effective interventions such as metabolic and bariatric surgery (MBS) are essential for achieving substantial weight loss and reducing the elevated health risk associated with obesity. Nonetheless, it is important to acknowledge the significant variability in weight loss outcomes among individuals after these surgical procedures. This thesis presents a comprehensive exploration and analysis of various factors that could potentially affect weight loss after MBS. We have shown that predicting postoperative weight loss after MBS based on preoperative factors remains very difficult. In this concluding chapter, we take a closer look at the results presented in previous chapters, place them in a broader perspective and try to translate the results into daily practice and discuss possible directions for future research.

Weight loss after metabolic and bariatric surgery

Weight loss after MBS of course depends on the time at which it is measured after surgery. The data presented in **Chapters 4 and 5** show that nadir weight occurs at the 18-month follow-up moment, with an average percent total weight loss (%TWL) of about 33%. After nadir is reached, it is not unusual for patients to experience recurrent weight gain and then stabilize. Three years after surgery, the average %TWL in our study was approximately 31%, as detailed in **Chapters 4 and 5**. These findings are consistent with existing literature, which reports that maximum weight loss occurs within one to two years after surgery, with an average %TWL of 32% for Roux-en-Y gastric bypass (RYGB) [1]. The weight then stabilizes and an average %TWL of 25% is reached, up to more than ten years after RYGB, as shown by the key results from the Swedish Obese Subject study, which is the largest non-randomized observational study in this field [1].

Identification of factors that could impact outcomes after surgery

– PART I –

Psychological factors

As outlined in the introduction, psychological problems are commonly observed in individuals who undergo MBS, particularly eating disorders such as binge eating disorder, depression and anxiety. Despite recent guidelines, the impact of preoperative psychological issues on postoperative weight loss remains a topic of debate,

with research yielding inconsistent findings. This inconsistency makes it difficult for clinicians to accurately predict patient outcomes and to determine the best treatment plan. To address this uncertainty, we conducted a systematic review and meta-analysis, detailed in **Chapter 2**, aiming to bring together multiple studies examining how psychological factors affect weight loss following MBS. Additionally, the study described in **Chapter 3** evaluated the predictive ability of a preoperative psychological assessment tool, the Cleveland Clinic Behavioral Rating System (CCBRS), in determining weight loss and compliance to follow-up after MBS.

The systematic review and meta-analysis in **Chapter 2** evaluated the following factors: compliance to follow-up, physical activity, binge eating, depressive symptoms, anxiety, body image, and quality of life (QoL). It revealed that preoperative depressive symptoms and binge eating, problems that are often a reason to refuse patients for surgery, did not significantly impact weight loss after MBS. Although no meta-analysis was feasible for anxiety symptoms due to data limitations, the review also suggests no substantial association between preoperative anxiety and weight loss after MBS. However, postoperatively, individuals with symptoms of binge eating disorder and those who showed up less often for a follow-up appointment, had less weight loss.

As detailed in **Chapter 3**, psychologists in this study assessed patients with the CCBRS, alongside the standard preoperative screening. The CCBRS consists of nine psychological domains: consent, expectations, social support, adherence, coping/stressors, mental health, substance use/abuse/dependence, eating behaviors, and overall impression. The findings revealed that none of these domains were predictive of weight loss or compliance up to five years after MBS.

Outline of (international) guidelines

A critical aspect to take into mind when interpreting the results from **Chapter 2 and 3**, is that there are certain psychological contra-indications for MBS according to international guidelines as well as the Dutch guideline.

The Canadian guidelines state contraindications for MBS are unstable psychiatric illness, (changes in psychiatric medications in the last six months), recent substance abuse (alcohol or drugs) or an inability to adhere to long-term follow-up, due to a high risk of short- and long-term complications [2, 3].

The guideline from the European Association for Endoscopic Surgery (EAES) states that psychological evaluation can be considered before MBS and that a previous diagnosis of binge eating or depression is no absolute contraindication for MBS [4]. Most mental disorders (mood, anxiety, bipolar disorder, eating disorders etcetera) might be considered as a contraindication for MBS if severe and undertreated [4].

The Dutch guideline states that individuals who are not willing to adhere to lifestyle changes and patients with unstable, chronic psychiatric psychopathology, such as bipolar disorder or psychotic episodes, should not be considered for MBS [5]. Additionally, anyone showing signs of certain psychiatric conditions needs further evaluation and possibly treatment by a psychologist or psychiatrist. These conditions include severe depression with vital signs or suicidal thoughts, severe anxiety disorder lasting at least six months, acute post-traumatic stress disorder lasting more than a month, and current or recent (within the past year) alcohol addiction. However, if a patient has been free from addiction for over a year, it does not exclude them from surgery. The guideline is stricter about psychological issues and requires that anyone with a suspected or confirmed eating disorder, depression, problems with impulse control or emotional instability, should be referred to a psychologist for assessment and treatment before undergoing MBS [5].

The overlap between the guidelines lies in the importance of assessing psychiatric conditions such as depression, anxiety disorders, substance abuse, and eating disorders before proceeding with surgery. All guidelines agree that unstable, severe or undertreated mental illnesses are a contra indication for MBS. Recent alcohol/substance abuse are described as contra indications in the Dutch and Canadian guidelines. However, differences exist in the specific criteria and thresholds for exclusion. For instance, the Canadian and Dutch guidelines highlight challenges with long-term follow-up as contraindication. The Dutch guideline outlines a specific exclusion criterion: a suspected or confirmed eating disorder, depression, problems with impulse control or emotional instability, referral and treatment by a psychologist must also precede surgery. Meanwhile, the European guideline suggests that previous diagnoses of binge eating, or depression may not be absolute contraindications, but can be if untreated or severe.

Clinical implications before surgery

The clinical implications of the findings from **Chapters 2 and 3**, as compared to existing guidelines, suggest a more nuanced approach to assessing and managing psychological factors in patients undergoing MBS. Firstly, our research indicates

that not all preoperative psychological symptoms are necessarily predictive of adverse weight loss outcomes after surgery. Contrary to the stricter point of view taken in some guidelines, particularly the Dutch guideline requiring treatment for any eating disorder and depression before surgery, our findings are more in line with the European guideline. This guideline not immediately disqualifies patients for MBS if they have such symptoms. Since our studies found no association between preoperative psychological factors and weight loss after MBS, the Dutch guideline could describe these conditions as contraindications only if severe or untreated. This approach could provide more personalized care and help ensure that patients who may not face negative outcomes after MBS due to their psychological symptoms are not denied surgery.

Clinical implications after surgery

As described in **Chapter 2**, our results underscore the importance of postoperative monitoring and early detection of binge eating disorder symptoms in bariatric care. Individuals diagnosed with binge eating disorder tended to experience less weight loss after surgery. Therefore, we strongly advise bariatric care providers to be attentive to signs of postoperative binge eating and to address them to optimize weight loss outcomes. This is already described in the guidelines on postoperative monitoring [5, 6].

The relationship between attendance to follow-up and weight loss remains somewhat unclear. It is uncertain whether attendance to follow-up appointments leads to more significant weight loss or if patients who experience greater weight loss are more likely to attend these appointments. While the direct impact on weight loss may be uncertain, consistent follow-up remains important for overall patient outcomes, including monitoring for potential complications such as vitamin deficiencies, adjusting medications, and addressing any issues related to changes in weight [5, 6]. Therefore, we recommend that both bariatric centers and patients prioritize attending follow-up appointments to the best of their abilities.

Limitations and future research

Determining the impact of severe or unstable preoperative depression, anxiety, or (binge) eating disorders on postoperative weight loss presents challenges as these patients are typically not included into research due to the psychological contraindications for surgery. This preoperative selection of patients may have led to a selection bias. Thus, the absence of associations between preoperative symptoms

and weight loss in our study, might also suggest effective preoperative selection and treatment, rather than the absence of effects on weight loss.

The exclusion of patients with severe psychological symptoms prevents us from concluding whether these individuals would also experience less weight loss. Therefore, we recommend that patients with severe psychological symptoms continue to undergo formal psychological screening and treatment before undergoing surgery. This recommendation is important not only for optimizing weight loss outcomes but also for addressing potential psychological complications following MBS.

However, beyond just screening, tailored care is crucial. Collaboration with the patient's psychiatrist is essential to determine the optimal timing for surgery. This process cannot be captured by a single questionnaire. Instead, it requires a good understanding of the patient's psychological and physical condition. Knowing the patient well enough to make informed decisions is key to ensure the best outcomes. Furthermore, it is important to consider whether slightly less weight loss should be a reason to withhold surgery. For example, a previous study from the Dutch Obesity Clinic found that patients with a current DSM IV Axis 1 or 2 diagnosis had only 3.7% lower maximum TWL compared to patients without such a diagnosis, and 6.5% lower TWL four years after surgery [7].

To overcome the limitation of excluding these patients, future research would have to include these populations to enable more accurate clinical decision-making and achieve a comprehensive understanding postoperative outcomes. However, one could argue about the ethical considerations involved, as including patients with severe psychological symptoms may raise concerns about their well-being. Research might address this by including patients with severe symptoms only if it is determined that their obesity significantly impedes their access to effective psychological support, thereby worsening their symptoms. This approach could ensure that the inclusion of such patients is justified by the potential benefits of addressing both their obesity and psychological distress.

Additionally for future research, when employing psychological screening tools for research purposes, doing retesting after psychological treatment would be insightful in distinguishing the effects of psychological treatment from those of the disorder itself. This approach could provide valuable insights into the effectiveness of interventions and help refine screening protocols for enhanced patient care.

– PART II –

Preoperative prerequisites

According to international guidelines, patients should undergo thorough screening prior to MBS [8]. Several preoperative prerequisites are implemented by guidelines, clinics and insurance companies to assess if patients are eligible for MBS. Examples of these criteria include mandatory preoperative weight loss or meeting the "last resort" criterion. The latter often involves completing a mandatory weight loss program (MWP) before MBS, as was formerly a standard requirement before reimbursement was approved by insurance companies [9]. This requirement was based on the assumption that they will induce preoperative weight loss, prepare patients for the necessary lifestyle changes, and therefore lead to greater postoperative weight loss [10]. However, there is ongoing discussion whether these preoperative prerequisites are beneficial and associated with better weight loss outcomes after MBS. To address this debate, the study reported in **Chapter 4** evaluated whether meeting the "last resort" criterion was associated with weight loss following MBS. Additionally, the study presented in **Chapter 5** describes whether preoperative weight loss related with weight loss outcomes after MBS.

The cohort study described in **Chapter 4** revealed no difference in weight loss outcomes after MBS between patients who qualified at screening according to the last resort criterion and those who did not meet this criterion initially, necessitating a MWP before MBS. Furthermore, the results showed that any weight lost during the MWP phase was typically regained before surgery, indicating that this preoperative weight loss had only short-term effects and did not contribute to substantial postoperative weight loss. Additionally, referring patients to a MWP after screening resulted in a significant delay in surgical treatment.

The study reported in **Chapter 5** assessed the association between preoperative weight change and weight loss outcomes after MBS. Five distinct groups were defined based on patients' preoperative weight changes, ranging from weight gain to weight loss. The analysis showed a positive association between weight loss prior to MBS and greater overall weight loss (from initial screening to follow-up). However, patients who experienced weight gain before surgery, did not have less postoperative weight loss (from surgery to follow-up).

Outline of (previous) guidelines

At the time of the study described in **Chapter 4**, MWPs were still a strict prerequisite for surgery, mainly due to insurance requirements [9, 11]. The previous Dutch "Guideline Morbid Obesity," established in 2011, recommended attempting weight loss prior to MBS, preferably within an intensive counseling program [12]. This recommendation was based on the potential benefits of reducing surgical risks such as blood loss, complications, conversions, and operating time, and possibly improving postoperative outcomes [13].

However, in 2016, the American Society for Metabolic and Bariatric Surgery (ASMBS) released a position statement on insurance-mandated preoperative weight loss [11]. This document underscores the absence of solid evidence to support the effectiveness of these weight loss programs mandated by insurers. Consequently, it is advised that the decision to exclude patients from MBS based solely on their inability to lose weight through preoperative diets is not recommended. The statements argue that such requirements can lead to increased dropout rates prior to surgery, delay of receiving potentially life-saving treatments, worsening of obesity-associated medical conditions, and increased healthcare costs [11]. This practice is deemed unethical and is suggested to be discontinued. Personalized treatment is essential, with decisions adapted to each patient's specific circumstances, allowing treatment teams to choose the most suitable treatment options. The results from **Chapter 4** and personal communication with Dr. Mitchell Roslin, an associate editor of the ASMBS scientific journal, reinforced the ASMBS's position on this topic.

In addition, the updated Dutch guideline for the surgery of obesity, updated in 2020, now explicitly states that preoperative weight loss or multiple weight loss attempts are unnecessary requirements for undergoing MBS [5]. Instead, the guideline offers several options to assess the current lifestyle of patients seeking MBS. These criteria include undergoing a weight loss attempt under the guidance of a healthcare professional such as a general practitioner or dietitian, demonstrating a serious commitment to weight loss, and having obesity for at least five years [5]. However, these criteria are recommendations and are no longer mandatory prerequisites. The guideline also states that preoperative weight loss may help in reducing complications, but the impact is so minimal that it is not justifiable to require all patients to adhere to a preoperative diet [5].

Clinical implications

Despite updated guidelines, some clinics and insurance companies continue to prescribe preoperative MWPs as a criterion on their websites [14, 15]. We encourage those who continue to enforce preoperative weight loss or MWPs as a prerequisite for MBS to reevaluate this approach. Rather than considering it a requirement, clinics should follow existing guidelines which recommend using previously described factors such as previous weight loss attempts, duration of obesity and participation in a MWP as part of the personalized advice during screening [5]. There is insufficient scientific evidence to support this, as described in **Chapter 4**. Preoperative weight loss is still encouraged due to its association with greater overall weight loss, as detailed in **Chapter 5**. However, preoperative weight gain should not deny patients from surgery, as it is not associated with lower postoperative weight loss.

Limitations and future research

In research, it is important to differentiate between causation and association. Causation is a direct cause-and-effect relationship between two or more variables. Association is a statistical relationship without having direct causality. Different research designs affect the whether causation can be assumed. For example, randomized controlled trials can show causation because they are well-controlled and randomized, while observational studies generally only show associations. In this thesis, most studies were retrospective, which limits the ability to make causal conclusions. Despite these limitations, it is important to note that no significant associations were found between many preoperative factors -like psychological problems, preoperative weight loss and recently following a MWP- and weight loss after MBS. This lack of associations suggests that these preoperative factors might not play a significant role in predicting postoperative outcomes, although causality cannot be definitively determined because of the retrospective nature of these studies.

Another limitation of this thesis is that it only focuses on weight loss as an outcome after MBS. While many studies primarily use weight loss as main outcome, it is not the only important indicator. Other outcomes, such as the resolution or improvement of obesity-associated medical conditions, amount of medication usage, and quality of life, as well as societal outcomes like absenteeism and premature death, can be considered equally or maybe even more important. Therefore, it is crucial for future research to have more attention to these outcomes of MBS, preferably in large prospective trials so causal relationships can be studied.

– PART III –

Food and health literacy

Food literacy is defined as the combination of knowledge, skills, and behaviors necessary for planning, managing, selecting, preparing, and consuming food to meet dietary needs and determine food intake [16]. Health literacy refers to individuals' ability to locate, comprehend, and utilize information and services to make informed decisions and take actions concerning health, both for themselves and others [17]. Food and health literacy are frequently studied in the general population. However, research on food and health literacy in individuals undergoing MBS is limited. Therefore, **Chapter 6** of this thesis aimed to investigate food and health literacy among patients awaiting MBS, as well as to explore the factors associated with these literacies.

The prospective cohort study outlined in **Chapter 6** revealed that food literacy in patients awaiting MBS was comparable to that of the general population, while health literacy appeared to be even higher. Additionally, the study identified that women exhibited higher scores in both food and health literacy. Interestingly, no significant association was observed between BMI and either food or health literacy. These findings underscore the multifaceted nature of obesity as a condition influenced by various factors beyond mere knowledge and skills related to food and health. Additionally, behavior is influenced by various factors beyond just skills, such as attitudes, self-efficacy, and social influences, which collectively impact the ability to turn knowledge into effective actions and drive behavioral change, also in obesity treatment [18, 19].

Outline of guidelines

Both the Dutch guideline for obesity surgery and a Dutch clinic specializing in MBS recommend postponing surgery if a patient lacks sufficient knowledge of healthy eating [5, 20]. They then advise undergoing dietary sessions first to better prepare for the surgery. However, the guidelines do not specify the methods for assessing this knowledge or define what constitutes inadequate knowledge of healthy eating.

Clinical implications

Currently, formally assessing food and health literacy is not standard practice in clinical care, even though guidelines suggest that inadequate knowledge about healthy eating could prompt dietary counseling and postpone surgery. To improve this, it could be beneficial to incorporate validated questionnaires, like those used

in **Chapter 6**, into clinics' standard treatment protocols. This would create a consistent way to evaluate patients. It is important to clarify that the intention is not to introduce a new preoperative prerequisite. Instead, it would provide guidance to clinicians during preoperative screening and assessment and to enable them to offer personalized advice to each patient based on their individual needs.

Limitations and future research

It is crucial to recognize that the used questionnaires rely on patients reporting their own literacy. There is a potential bias where patients might feel pressured to provide overly positive responses, especially if they perceive it could impact their readiness for surgery, which could impact the reliability of the results. To address this, these questionnaires could be used as tools, similar to how clinics use surveys for psychology and physical activity, to guide conversations with patients during screening. This approach could enable more accurate assessments of food and health literacy among those being considered for MBS.

In **Chapter 6**, however, when the food and health literacy questionnaires were administered, patients were already screened and deemed eligible for MBS as part of the preoperative counseling program. Therefore, there may be less pressure on patients to provide socially desirable responses, because their readiness for surgery was not influenced by their questionnaire answers. However, it cannot be completely ruled out that patients still may have given more favorable responses and thus cause bias. It is important to note that these questionnaires remain self-reported, which reflects how patients perceive their own literacy levels and experiences.

The study described in **Chapter 6** is ongoing and will also explore the relationship between food and health literacy and weight loss after MBS. If an association is found between preoperative food or health literacy or changes in these literacies during perioperative counseling and subsequent weight loss, it would be worthwhile to investigate whether interventions aimed at enhancing these literacies could also improve weight loss outcomes. Additionally, future studies should include a larger sample of individuals with lower literacy levels, as **Chapter 6** had only a few participants from this group, making it challenging to draw definitive conclusions. Providing questionnaires in paper or verbal formats, in addition to digital ones, might help reduce selection bias and better represent patients with varying literacy levels.

The future of obesity care

This thesis has shown that predicting weight loss after MBS based on preoperative factors is very difficult. It raises the question whether preoperative screening in its current form remains the best method for determining surgical eligibility. Instead, a more holistic approach that considers the complex interplay of factors influencing both the development of obesity and weight loss after MBS may be more effective. Tailored care, rather than strict screening criteria, should guide decision-making.

Furthermore, it is important to move beyond weight loss as the primary outcome measure for MBS. Improvements of obesity-associated medical conditions, quality of life, and overall well-being should be equally important when evaluating the success of MBS. For instance, is a slightly lower expected total weight loss of 20-25% in a patient with psychological conditions a valid reason to deny treatment? Only when the risks, such as exacerbation of psychological conditions outweigh the benefits of surgery should it be considered. This exemplifies the importance of personalized, patient-centered care.

As we learn more about the mechanisms underlying obesity, including the roles of genetics and gut hormones, treatment strategies are expected to become more tailored to each person's needs. The development of new obesity management medications —though beyond the scope of this thesis— will also shape future obesity treatment options and influence the role of MBS.

References

1. Sjöström L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. J Intern Med. 2013;273(3):219-34.
2. Glazer S, Biertho L. Canadian Adult Obesity Clinical Practice Guidelines: Bariatric Surgery: Selection & Pre-Operative Workup. 2020 [Accessed February 16th 2024]. Available from: https://obesitycanada.ca/guidelines/preop.
3. Biertho L, Hong D, Gagner M. Adult Obesity Clinical Practice Guidelines: Bariatric Surgery: Surgical Options and Outcomes. 2020 [Accessed February 16th 2024]. Available from: https://obesitycanada.ca/guidelines/surgeryoptions/.
4. Di Lorenzo N, Antoniou SA, Batterham RL, et al. Clinical practice guidelines of the European Association for Endoscopic Surgery (EAES) on bariatric surgery: update 2020 endorsed by IFSO-EC, EASO and ESPCOP. Surg Endosc. 2020;34(6):2332-58.
5. Chirurgische behandeling van Obesitas - Richtlijn - Richtlijnendatabase [Internet] 2020 [Accessed 16th February 2024]. Available from: https://richtlijnendatabase.nl/richtlijn/chirurgische_behandeling_van_obesitas/startpagina_-_chirurgische_behandeling_van_obesitas.html.
6. Shiau J, Biertho L. Canadian Adult Obesity Clinical Practice Guidelines: Bariatric Surgery: Postoperative Management. 2020 [Accessed February 16th 2024]. Available from: https://obesitycanada.ca/guidelines/postop/.
7. Vermeer KJ, Monpellier VM, Cahn W, Janssen IMC. Bariatric surgery in patients with psychiatric comorbidity: Significant weight loss and improvement of physical quality of life. Clin Obes. 2020;10(4):e12373.
8. 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 & BARIATRIC SURGERY, OBESITY MEDICINE ASSOCIATION, AND AMERICAN SOCIETY OF ANESTHESIOLOGISTS - EXECUTIVE SUMMARY. Endocr Pract. 2019;25(12):1346-59.
9. Jacobs A, Liem RSL, Janssen IMC, Tollenaar R, Monpellier VM. Weight loss after bariatric surgery: a comparison between delayed and immediate qualification according to the last resort criterion. Surg Obes Relat Dis. 2021;17(4):718-25.
10. Tewksbury C, Williams NN, Dumon KR, Sarwer DB. Preoperative Medical Weight Management in Bariatric Surgery: a Review and Reconsideration. Obes Surg. 2017;27(1):208-14.
11. Kim JJ, Rogers AM, Ballem N, Schirmer B. ASMBS updated position statement on insurance mandated preoperative weight loss requirements. Surg Obes Relat Dis. 2016;12(5):955-9.
12. Heelkunde NVv. Richtlijn Morbide Obesitas. 2011.
13. Livhits M, Mercado C, Yermilov I, et al. Does weight loss immediately before bariatric surgery improve outcomes: a systematic review. Surg Obes Relat Dis. 2009;5(6):713-21.
14. Leeuwarden MC. Kom ik in aanmerking? 2024 [Available from: https://www.mcl.nl/afdelingen/centrum-obesitas-noord-nederland/kom-ik-in-aanmerking.
15. Zorgverzekeraar SH. Bariatrische chirurgie 2024 [Available from: https://www.stadholland.nl/consumenten/vergoedingen/bariatrische-chirurgie.
16. Vidgen HA, Gallegos D. Defining food literacy and its components. Appetite. 2014;76:50-9.

17. Health.gov. Health Literacy in Healthy People 2030 2021 [updated August 24th 2021. Available from: https://health.gov/our-work/national-health-initiatives/healthy-people/healthy-people-2030/health-literacy-healthy-people-2030.

18. Albarracín D, Fayaz-Farkhad B, Granados Samayoa JA. Determinants of behaviour and their efficacy as targets of behavioural change interventions. Nature Reviews Psychology. 2024;3(6):377-92.

19. Holloway A, Watson HE. Role of self-efficacy and behaviour change. Int J Nurs Pract. 2002;8(2):106-15.

20. Vitalys. Wanneer komt uw patiënt in aanmerking voor een bariatrische operatie 2024 [3-7-2024]. Available from: https://www.vitalys.nl/voor-verwijzers/criteria-en-aanmelden/criteria-voor-bariatrische-chirurgie/.

8

Nederlandse samenvatting

In de afgelopen decennia is het aantal mensen met overgewicht en obesitas wereldwijd sterk gestegen. Hierdoor is er steeds meer behoefte aan behandelingen die kunnen helpen bij het verliezen van gewicht en het verlagen van de gezondheidsrisico's. Metabole-bariatrische chirurgie (metabolic and bariatric surgery, MBS), zoals een maagverkleining, is een belangrijke manier om mensen te ondersteunen bij het afvallen. Toch blijken de resultaten na zo'n operatie erg verschillend: de één valt veel af, de ander minder. In dit proefschrift is onderzocht welke factoren invloed kunnen hebben op dat gewichtsverlies. Het blijkt lastig te voorspellen wie er na de operatie veel of juist weinig zal afvallen. In dit laatste hoofdstuk worden alle bevindingen uit de onderzoeken besproken, in een breder verband geplaatst en vertaald naar de praktijk. Ook worden mogelijke richtingen voor verder onderzoek besproken.

Gewichtsverlies na metabole-bariatrische chirurgie

Het gewichtsverlies na MBS varieert afhankelijk van het moment waarop het gemeten wordt. Uit **Hoofdstukken 4 en 5** blijkt dat het laagste gewicht meestal na 18 maanden wordt bereikt, met een gemiddeld gewichtsverlies van ongeveer 33% ten opzichte van het gewicht vóór de operatie. Na dit punt is het normaal dat patiënten weer wat aankomen en vervolgens stabiliseren. Drie jaar na de operatie was het gemiddelde gewichtsverlies in onze studie ongeveer 31%. Dit sluit aan bij andere onderzoeken, waaruit blijkt dat het gewicht meestal één tot twee jaar na een gastric bypass (maagomleiding) het laagste punt bereikt (gemiddeld 32% gewichtsverlies) [(1)]. Op de lange termijn stabiliseert dit gewichtsverlies op ongeveer 25%, zelfs meer dan tien jaar na de operatie, zoals een grote Zweedse studie laat zien [(1)].

Vaststellen welke factoren het resultaat van de operatie kunnen beïnvloeden

– DEEL I –

Psychologische factoren

Een deel van de mensen die MBS ondergaan, heeft psychische klachten, zoals eetbuistoornissen, depressie of angst. Het is echter nog onduidelijk in hoeverre deze klachten invloed hebben op het gewichtsverlies na de operatie, omdat onderzoeken hierover tegenstrijdige resultaten geven. Om hierin meer inzicht te krijgen, is in **Hoofdstuk 2** een systematische review en meta-analyse uitgevoerd, waarin meerdere studies zijn samengevoegd die keken naar de rol van psychologische factoren bij gewichtsverlies na MBS. In **Hoofdstuk 3** is vervolgens de voorspellende waarde onderzocht van een psychologische test vóór de operatie (het Cleveland Clinic

Behavioral Rating System, CCBRS) voor zowel het gewichtsverlies als de therapietrouw (het komen naar de controleafspraken) na de operatie.

In **Hoofdstuk 2** is in een systematische review en meta-analyse gekeken naar allerlei factoren die een rol kunnen spelen bij gewichtsverlies na MBS, zoals therapietrouw, lichamelijke activiteit, eetbuien, depressie, angst, lichaamsbeeld en kwaliteit van leven. De resultaten lieten zien dat depressieve klachten en eetbuien vóór de operatie geen duidelijke invloed hadden op het gewichtsverlies na MBS. Voor angstklachten was er te weinig informatie om een meta-analyse te doen, maar de beschikbare gegevens wezen er niet op dat angst vóór de operatie een grote rol speelt bij gewichtsverlies achteraf. Tegelijkertijd bleek dat mensen die na de operatie eetbuistoornissen hadden of minder vaak naar hun controleafspraken gingen, uiteindelijk wel minder gewicht verloren.

In de studie uit **Hoofdstuk 3** voerden psychologen een beoordeling uit met de CCBRS, naast de gebruikelijke screening voor de operatie. De CCBRS is een meetinstrument om psychische aandachtspunten in kaart te brengen vóór de operatie en richt zich op negen gebieden: toestemming, verwachtingen, sociale steun, therapietrouw, omgaan met stress, mentale gezondheid, middelengebruik of -misbruik, eetgedrag en een algemene indruk. Uit de resultaten bleek dat geen enkel onderdeel van deze schaal een voorspellende waarde had voor gewichtsverlies of therapietrouw tot vijf jaar na de operatie.

Overzicht van (internationale) richtlijnen

Een belangrijk punt om te onthouden bij het interpreteren van de resultaten uit **Hoofdstukken 2 en 3** is dat er volgens internationale en Nederlandse richtlijnen bepaalde psychologische redenen zijn om MBS niet uit te voeren.

Volgens de Canadese richtlijnen gelden een instabiele psychiatrische aandoening (zoals recente veranderingen in psychiatrische medicatie in de afgelopen zes maanden), recent middelenmisbruik (alcohol of drugs) of het niet kunnen volgen van langdurige nazorg als redenen om geen MBS uit te voeren [2, 3]. Dit komt door het hoge risico op complicaties op zowel de korte als lange termijn.

De richtlijn van de European Association for Endoscopic Surgery (EAES) geeft aan dat een psychologische beoordeling vóór MBS kan worden overwogen en dat een eerdere diagnose van eetbuien of depressie geen absolute contra-indicatie vormt voor de operatie [4]. Bij ernstige, onbehandelde psychische stoornissen, zoals

stemmings-, angst- of bipolaire stoornissen en eetstoornissen, kan MBS echter wel worden afgeraden [4].

De Nederlandse richtlijn stelt dat gebrek aan bereidheid om de levensstijl aan te passen en ernstige, instabiele psychische aandoeningen (bijvoorbeeld een bipolaire stoornis of psychotische episodes) redenen zijn om MBS niet uit te voeren [5]. Daarnaast vereisen bepaalde psychische klachten, zoals ernstige depressie met vitale symptomen of zelfmoordgedachten, een ernstige angststoornis die minstens zes maanden aanhoudt, acute posttraumatische stressstoornis die langer dan een maand duurt, en huidige of recente alcoholverslaving (binnen het afgelopen jaar), beoordeling en behandeling door een psycholoog. Na een jaar zonder verslaving is een operatie niet uitgesloten. De richtlijn is strikt ten aanzien van psychische problemen en schrijft voor dat iedere verdenking of bevestiging van een eetstoornis, depressie, impulscontroleproblemen of emotionele instabiliteit eerst moet worden beoordeeld en behandeld door een psycholoog voordat iemand voor MBS in aanmerking komt [5].

De richtlijnen zijn het er allemaal over eens dat instabiele, ernstige of onbehandelde psychische aandoeningen een reden zijn om geen MBS uit te voeren. Recent alcohol- of middelenmisbruik wordt specifiek genoemd als een contra-indicatie in de Nederlandse en Canadese richtlijnen. Er zijn echter verschillen in de precieze criteria en drempels voor uitsluiting. Zo benadrukken de Canadese en Nederlandse richtlijnen de uitdagingen van langdurige follow-up als contra-indicatie. De Nederlandse richtlijn voegt een specifiek uitsluitingscriterium toe: bij vermoedens of bevestiging van eetstoornissen, depressie, impulscontroleproblemen of emotionele instabiliteit, moet er eerst verwijzing en behandeling door een psycholoog plaatsvinden vóór de operatie. De Europese richtlijn daarentegen stelt dat eerdere diagnoses van eetbuien of depressie niet per se een absolute contra-indicatie vormen, tenzij ze onbehandeld of ernstig zijn.

Klinische consequenties vóór de operatie

De bevindingen uit **Hoofdstukken 2 en 3** laten zien dat psychische factoren bij mensen die MBS ondergaan, mogelijk anders moeten worden beoordeeld en behandeld dan wat de huidige richtlijnen suggereren. Onze resultaten tonen dat niet alle psychische klachten vóór de operatie zorgen voor minder gewichtsverlies achteraf. In tegenstelling tot de strengere Nederlandse richtlijn, die bij elke eetstoornis of depressie eerst behandeling verplicht, sluiten deze bevindingen beter aan bij de Europese richtlijn. Die sluit mensen niet automatisch uit van de operatie wanneer

er sprake is van zulke klachten. Omdat in onze studies geen verband werd gevonden tussen psychische klachten vóór de operatie en het gewichtsverlies daarna, zou de Nederlandse richtlijn alleen strenge eisen moeten stellen bij ernstige of onbehandelde problemen. Op die manier is er meer ruimte voor gepersonaliseerde zorg, waardoor mensen niet onnodig worden uitgesloten van MBS als hun psychische klachten geen invloed hebben op het resultaat van de operatie.

Klinische consequenties na de operatie

Na de operatie is het belangrijk om alles goed in de gaten te houden en zo vroeg mogelijk eetbuistoornissen te herkennen, zoals in **Hoofdstuk 2** wordt benadrukt. Mensen die na de operatie eetbuistoornissen hadden of minder vaak naar controleafspraken gingen, vielen vaak minder af. Daarom is het raadzaam dat zorgverleners alert blijven op signalen van eetbuien en deze snel behandelen, zodat het gewichtsverlies optimaal kan zijn. Dit sluit aan bij de bestaande richtlijnen voor nazorg na een operatie [5, 6].

Het is nog niet helemaal duidelijk of het bijwonen van controleafspraken zorgt voor meer gewichtsverlies of dat mensen die meer afvallen juist vaker naar die controles gaan. Hoe dan ook blijven deze afspraken belangrijk om eventuele problemen op tijd op te merken, zoals tekorten aan vitaminen, de noodzaak om medicatie aan te passen en andere klachten die kunnen ontstaan door gewichtsveranderingen [5, 6]. Daarom is het advies aan zowel bariatrische centra als patiënten om de controleafspraken zo goed mogelijk na te komen.

Beperkingen en toekomstig onderzoek

Het is moeilijk vast te stellen in hoeverre een ernstige of instabiele depressie, angst of eetstoornis vóór de operatie van invloed is op het gewichtsverlies na de operatie. Dat komt doordat patiënten met zulke klachten vaak niet in onderzoek worden meegenomen, omdat ze volgens de richtlijnen geen goede kandidaten zijn voor een operatie. Hierdoor kan er sprake zijn van een vertekend beeld in de geselecteerde groep. Het feit dat er in de studie geen verband werd gevonden tussen psychische klachten vóór de operatie en gewichtsverlies, zou ook kunnen betekenen dat de selectie en behandeling vooraf goed hebben gewerkt, in plaats van dat die klachten helemaal geen invloed hebben op het gewichtsverlies.

Het uitsluiten van patiënten met ernstige psychologische klachten maakt het moeilijk om te zeggen of zij minder gewicht zouden verliezen. Daarom adviseren we dat deze patiënten wel psychologische screening en behandeling krijgen vóór de

operatie. Dit is belangrijk, niet alleen om het gewichtsverlies te verbeteren, maar ook om mogelijke psychologische problemen na de operatie aan te pakken.

Passende zorg gaat verder dan alleen een psychologische screening. Een vragenlijst is daarbij niet genoeg: een grondig inzicht in zowel de psychische als de lichamelijke situatie van de patiënt is nodig om weloverwogen keuzes te maken en zo de beste resultaten te behalen. Een goede samenwerking met de psychiater van de patiënt is onmisbaar om te bepalen wanneer het beste moment is voor de operatie. Daarnaast is het belangrijk om je af te vragen of iets minder gewichtsverlies een reden moet zijn om niet te opereren. Uit een onderzoek van de Nederlandse Obesitas Kliniek blijkt bijvoorbeeld dat patiënten met een DSM IV As 1- of 2-diagnose (een psychiatrische diagnose) gemiddeld slechts 3,7% minder gewichtsverlies hadden dan patiënten zonder zo'n diagnose, en na vier jaar was dat verschil 6,5% [7].

Om beter te begrijpen hoe patiënten met ernstige psychische klachten reageren op MBS, is het belangrijk om hen wél mee te nemen in toekomstig onderzoek. Dit kan helpen om betere beslissingen te nemen in de zorg en de uitkomsten na de operatie beter te begrijpen. Tegelijkertijd roept dit ethische vragen op: het deelnemen aan onderzoek kan risico's meebrengen voor het welzijn van deze patiënten. Een mogelijke oplossing is om deze groep alleen te includeren als hun overgewicht hen belemmert bij het krijgen van goede psychologische hulp, waardoor hun klachten verergeren. Op die manier zijn de mogelijke voordelen – het behandelen van zowel hun overgewicht als hun psychische problemen – groter dan de risico's van een operatie.

Een waardevolle stap in toekomstig onderzoek naar psychologische screeningsmethoden is om mensen opnieuw te beoordelen nadat zij psychologische behandelingen hebben afgerond. Zo kan worden vastgesteld wat het effect van de behandeling is, onafhankelijk van de oorspronkelijke stoornis. Deze werkwijze kan belangrijke inzichten opleveren over hoe effectief de behandelingen zijn en helpt bij het verfijnen van de screeningsprotocollen, wat uiteindelijk leidt tot betere zorg voor patiënten.

– DEEL II –

Eisen vóór de operatie

Als je MBS wilt ondergaan, moet je volgens internationale regels eerst goed worden nagekeken of je daar geschikt voor bent [8]. Klinieken, verzekeraars en richtlijnen stellen verschillende voorwaarden voordat je die operatie mag ondergaan. Bijvoorbeeld dat je eerst een bepaald aantal kilo's moet afvallen of dat je moet voldoen aan het "laatste redmiddel"-criterium. Dat laatste houdt in dat je een speciaal gewichtsverliesprogramma moet volgen voordat je wordt goedgekeurd voor de operatie. Vroeger eisten verzekeraars dit altijd [9]. Het idee daarachter was dat je door het volgen van zo'n programma beter voorbereid bent op de veranderingen in je leefstijl, zodat je uiteindelijk ook na de operatie meer gewicht verliest [10]. Maar er bestaat discussie over of deze voorwaarden wel echt nut hebben en leiden tot betere resultaten. In **Hoofdstuk 4** van de studie is daarom gekeken of het "laatste redmiddel"-criterium verband houdt met gewichtsverlies na de operatie. In **Hoofdstuk 5** is vervolgens onderzocht of vooraf afvallen samenhangt met hoeveel gewicht je na de operatie kwijtraakt.

In **Hoofdstuk 4** is gekeken of er verschil is in gewichtsverlies na MBS tussen patiënten die meteen een operatie mochten ondergaan (omdat ze aan het "laatste redmiddel"-criterium voldeden) en patiënten die eerst nog zo'n gewichtsverliesprogramma moesten volgen om aan dit criterium te voldoen. Uit de studie bleek dat er geen verschil was: beide groepen vielen na de operatie ongeveer evenveel af. Bovendien kwamen patiënten die dat verplichte afvalprogramma volgden, het gewicht dat ze tijdens het programma kwijtraakten vaak weer aan voordat ze geopereerd werden. Met andere woorden: het preoperatieve gewichtsverlies hielp uiteindelijk niet bij extra gewichtsverlies na de operatie. Daarnaast veroorzaakte het doorverwijzen naar een afvalprogramma een flinke vertraging in het moment waarop patiënten uiteindelijk geopereerd konden worden.

In **Hoofdstuk 5** is gekeken naar het effect van aankomen of afvallen vóór de operatie op het gewichtsverlies erna. De deelnemers werden in vijf groepen verdeeld, afhankelijk van hoeveel ze vóór de operatie waren aangekomen of afgevallen. De resultaten lieten zien dat mensen die vóór de operatie al gewicht kwijt waren, van eerste screening tot aan de follow-up meer gewicht waren verloren. Mensen die vóór de operatie juist aankwamen, bleken na de operatie echter niet minder af te vallen dan de andere groepen.

Overzicht van (eerdere) richtlijnen

Toen de studie uit **Hoofdstuk 4** werd uitgevoerd, moesten mensen verplicht eerst een programma volgen om af te vallen voordat ze een operatie kregen, vooral omdat zorgverzekeraars dat eisten [9, 11]. In de Nederlandse "Richtlijn Morbide Obesitas" van 2011 stond ook dat je eerst moest proberen af te vallen, bij voorkeur onder intensieve begeleiding [12]. De reden hiervoor was dat het vooraf afvallen mogelijk kan helpen bij het verminderen van risico's tijdens de operatie (zoals bloedverlies en complicaties) en de kans op een goed resultaat na de operatie misschien kan vergroten [13].

In 2016 publiceerde de American Society for Metabolic and Bariatric Surgery (ASMBS) haar standpunt over verplichte afvalprogramma's die verzekeraars vaak eisen [11]. Daarin wordt benadrukt dat er weinig bewijs is dat zulke programma's echt helpen. Daarom raadt de ASMBS aan om patiënten niet te weigeren voor een operatie alleen omdat ze niet genoeg afvallen met een dieet vooraf. Volgens de ASMBS kunnen deze verplichte programma's ervoor zorgen dat meer mensen voortijdig afhaken, dat levensreddende behandelingen vertraging oplopen, dat aandoeningen door obesitas verergeren en dat de zorgkosten stijgen [11]. De ASMBS noemt dit onethisch en wil dat deze eis wordt afgeschaft. In plaats daarvan is een behandeling op maat nodig, waarbij wordt gekeken wat het beste past bij de situatie van elke patiënt. De uitkomsten van **Hoofdstuk 4** en persoonlijk contact met Dr. Mitchell Roslin, redacteur van het ASMBS-tijdschrift, sluiten aan bij dit standpunt.

De Nederlandse richtlijn voor obesitaschirurgie uit 2020 geeft nu aan dat vooraf afvallen of meerdere pogingen om gewicht te verliezen niet langer verplicht zijn voor MBS [5]. In plaats daarvan noemt de richtlijn verschillende opties om de leefstijl van patiënten die een operatie overwegen te beoordelen. Denk aan een begeleide afvalpoging via een huisarts of diëtist, het laten zien van een serieuze inzet om gewicht te verliezen en het minstens vijf jaar hebben van obesitas [5]. Hoewel deze voorwaarden worden aanbevolen, zijn ze niet langer verplicht. De richtlijn erkent dat vooraf afvallen kan helpen om complicaties te verminderen, maar benadrukt dat de voordelen hiervan zo klein zijn dat het niet voor alle patiënten verplicht hoeft te zijn [5].

Klinische consequenties

Hoewel de richtlijnen zijn aangepast, blijven sommige klinieken en verzekeraars op hun websites preoperatieve gewichtsverliesprogramma's als verplichte voorwaarde stellen [14, 15]. Het wordt aanbevolen dat zij deze aanpak heroverwegen. In plaats

van deze programma's verplicht te stellen, zouden zij de huidige richtlijnen moeten volgen. Deze adviseren om tijdens de screening rekening te houden met factoren zoals eerdere pogingen om af te vallen, de duur van obesitas en deelname aan een gewichtsverliesprogramma, zonder deze als eis op te leggen [5]. Deze verandering wordt geadviseerd omdat er onvoldoende wetenschappelijk bewijs is dat verplichte afvalprogramma's voordelen opleveren, zoals ook in **Hoofdstuk 4** is beschreven. Hoewel vooraf afvallen wordt aangemoedigd vanwege de positieve samenhang met meer gewichtsverlies op de lange termijn (zoals uitgelegd in **Hoofdstuk 5**), mag een gewichtstoename vóór de operatie geen reden zijn om patiënten uit te sluiten van chirurgie. Dit heeft namelijk geen negatieve invloed op het gewichtsverlies na de operatie.

Beperkingen en toekomstig onderzoek

Bij onderzoek is het belangrijk om het verschil te begrijpen tussen oorzaak en verband. Oorzaak (causatie) betekent dat de ene factor direct de andere veroorzaakt, terwijl verband (associatie) alleen aangeeft dat er een relatie is tussen twee dingen, zonder dat duidelijk is of het een het ander veroorzaakt. Sommige onderzoeksmethoden kunnen aantonen of iets echt een oorzaak is. Bijvoorbeeld, gerandomiseerde onderzoeken zijn zo opgezet dat ze kunnen laten zien of er sprake is van een oorzaak-gevolgrelatie. Observationele studies, daarentegen, laten meestal alleen zien of er een verband is.

In dit proefschrift waren de meeste studies gebaseerd op gegevens uit het verleden (retrospectief). Daardoor is het lastig om zeker te weten of iets echt een oorzaak is. Toch blijkt uit het onderzoek dat er geen sterke verbanden zijn gevonden tussen verschillende factoren, zoals psychische problemen, vooraf afvallen of deelname aan een afvalprogramma, en hoeveel gewicht mensen verliezen na MBS. Dit kan erop wijzen dat deze factoren niet veel invloed hebben op het resultaat na de operatie. Maar omdat de studies retrospectief waren, kunnen we hier geen definitieve uitspraken over doen.

Een andere beperking van dit onderzoek is dat het alleen kijkt naar gewichtsverlies als resultaat na MBS. Hoewel veel studies dit als de belangrijkste uitkomst zien, is het niet het enige dat telt. Andere resultaten, zoals het verbeteren van medische problemen door obesitas, minder medicijnen nodig hebben, een betere kwaliteit van leven en maatschappelijke effecten zoals minder ziekteverzuim en een lager risico op vroegtijdig overlijden, zijn net zo belangrijk of zelfs belangrijker.

Toekomstig onderzoek zou daarom ook naar deze aspecten moeten kijken. Idealiter gebeurt dit in grote onderzoeken die vooruitkijken (prospectieve studies), zodat beter kan worden onderzocht welke factoren leiden tot welke resultaten.

– DEEL III –

Voedsel- en gezondheidsvaardigheden

Voedselvaardigheden zijn de kennis, vaardigheden en het gedrag die mensen nodig hebben om te plannen, kiezen, klaarmaken en eten wat ze nodig hebben, zodat aan de voedingsbehoeften wordt voldaan en de voedselinname wordt bepaald [16]. Gezondheidsvaardigheden gaan over het vermogen om informatie en hulp te vinden, te begrijpen en te gebruiken om goede keuzes te maken en actie te ondernemen voor je eigen gezondheid of die van anderen [17]. Hoewel deze vaardigheden vaak worden onderzocht bij de algemene bevolking, is er weinig bekend over hoe mensen die MBS ondergaan hiermee omgaan. Daarom richtte **Hoofdstuk 6** van dit onderzoek zich op het bekijken van de voedsel- en gezondheidsvaardigheden van mensen die wachten op MBS en het onderzoeken welke factoren hiermee samenhangen.

De studie uit **Hoofdstuk 6** liet zien dat mensen die op MBS wachten ongeveer dezelfde voedselvaardigheden hebben als de algemene bevolking. Hun gezondheidsvaardigheden waren zelfs hoger. Vrouwen scoorden beter op beide gebieden dan mannen. Opmerkelijk genoeg was er geen verband tussen iemands BMI en hun voedsel- of gezondheidsvaardigheden. Dit benadrukt dat obesitas een ingewikkelde aandoening is, die door meer wordt beïnvloed dan alleen kennis en vaardigheden over voeding en gezondheid. Gedrag wordt bijvoorbeeld ook bepaald door houding, vertrouwen in eigen kunnen (zelfeffectiviteit) en sociale invloeden. Deze factoren zijn belangrijk bij het omzetten van kennis in actie en bij het veranderen van gedrag [18, 19]. Dit is belangrijk om mee te nemen in de behandeling van obesitas.

Overzicht van de richtlijnen

Zowel de Nederlandse richtlijn voor MBS als een Nederlandse kliniek die hierin gespecialiseerd is, raden aan om de operatie uit te stellen als een patiënt te weinig kennis heeft over gezond eten [5, 20]. Ze adviseren dan om eerst dieetbegeleiding te volgen, zodat de patiënt beter voorbereid is op de operatie. De richtlijnen maken echter niet duidelijk hoe bepaald moet worden of iemand onvoldoende kennis heeft over gezond eten of wat hiermee precies wordt bedoeld.

Klinische consequenties

Op dit moment worden voedsel- en gezondheidsvaardigheden niet officieel beoordeeld, ook al geven richtlijnen aan dat een gebrek aan kennis over gezond eten een reden kan zijn om de operatie uit te stellen. Het zou nuttig kunnen zijn om gevalideerde vragenlijsten, zoals die in **Hoofdstuk 6** zijn gebruikt, te integreren in de behandelprotocollen van klinieken. Hiermee kan op een gestandaardiseerde manier worden gekeken naar de vaardigheden van patiënten. Het is belangrijk te benadrukken dat dit niet als een nieuwe verplichte voorwaarde voor de operatie bedoeld is, maar als een hulpmiddel voor het screeningsteam. Het doel is om een advies te geven dat is afgestemd op de persoonlijke situatie en behoeften van elke patiënt.

Beperkingen en toekomstig onderzoek

Het is belangrijk om te benoemen dat deze vragenlijsten gebaseerd zijn op wat patiënten zelf invullen. Dit kan een vertekend beeld geven, omdat patiënten misschien te positieve antwoorden geven, vooral als ze denken dat dit hun kans op een operatie vergroot. Dit kan de betrouwbaarheid van de resultaten beïnvloeden. Om dit probleem te verminderen, kunnen de vragenlijsten worden gebruikt als hulpmiddel, vergelijkbaar met hoe klinieken vragenlijsten gebruiken voor psychologie en lichamelijke activiteit. Ze kunnen gesprekken met patiënten tijdens de screening ondersteunen en helpen om een nauwkeurigere inschatting te maken van hun voedsel- en gezondheidsvaardigheden. Dit zou nuttig zijn voor mensen die in aanmerking komen voor MBS.

In **Hoofdstuk 6** werden de vragenlijsten over voedsel- en gezondheidsvaardigheden afgenomen bij patiënten die al waren gescreend en geschikt bevonden voor MBS. Ze zaten al in hun preoperatieve traject, wat de druk om sociaal wenselijke antwoorden te geven mogelijk verminderde. Hun antwoorden op de vragenlijsten hadden namelijk geen invloed meer op hun geschiktheid voor de operatie. Toch kan niet volledig worden uitgesloten dat sommige patiënten nog steeds positieve antwoorden hebben gegeven om zichzelf in een beter daglicht te stellen, wat tot een vertekening (bias) kan leiden. Het is daarom belangrijk te onthouden dat deze vragenlijsten gebaseerd zijn op zelfrapportage. Ze geven weer hoe patiënten hun eigen vaardigheden en ervaringen inschatten.

De studie beschreven in **Hoofdstuk 6** is nog bezig en zal ook de relatie tussen voedsel- en gezondheidsvaardigheden en gewichtsverlies na MBS onderzoeken. Als blijkt dat preoperatieve vaardigheden of veranderingen in deze vaardigheden

tijdens de begeleiding verband houden met gewichtsverlies, kan het nuttig zijn om te onderzoeken of het verbeteren van deze vaardigheden ook de resultaten van de operatie verbetert. Toekomstig onderzoek zou meer patiënten met een lager vaardigheidsniveau moeten betrekken, omdat in **Hoofdstuk 6** maar weinig mensen uit deze groep zijn meegenomen. Hierdoor is het lastig om duidelijke conclusies te trekken. Daarnaast zou het gebruik van papieren of mondelinge vragenlijsten, naast digitale versies, kunnen helpen om selectiebias te verminderen. Dit kan een completer beeld geven van patiënten met verschillende vaardigheidsniveaus.

De toekomst van obesitaszorg

Dit proefschrift laat zien dat het op basis van factoren vóór de operatie heel lastig is om te voorspellen hoeveel gewicht iemand zal verliezen na MBS. Dit roept de vraag op of de huidige manier van screenen wel de beste manier is om te bepalen wie de operatie mag ondergaan. Misschien is een bredere aanpak, waarbij wordt gekeken naar alle factoren die bijdragen aan obesitas én gewichtsverlies na MBS, effectiever. Beslissingen zouden gebaseerd moeten zijn op zorg op maat, in plaats van strikte screeningscriteria.

Daarnaast is het belangrijk om verder te kijken dan alleen gewichtsverlies als belangrijkste resultaat van MBS. Het verbeteren van medische problemen die samenhangen met obesitas, een betere kwaliteit van leven en het algehele welzijn zijn minstens net zo belangrijk om het succes van een operatie te beoordelen. Bijvoorbeeld: is het eerlijk om iemand met psychische klachten een operatie te weigeren alleen omdat diegene mogelijk iets minder gewicht zal verliezen (bijvoorbeeld 20-25%)? Alleen als de risico's, zoals een verergering van psychische klachten, groter zijn dan de voordelen van de operatie, zou je dit kunnen overwegen. Dit laat zien hoe belangrijk het is om de behandeling af te stemmen op de persoonlijke situatie van de patiënt.

We leren steeds meer over de oorzaken van obesitas, zoals de invloed van genetica en darmhormonen. Daardoor zullen behandelingen in de toekomst beter afgestemd kunnen worden op de behoeften van iedere persoon. Ook de ontwikkeling van nieuwe medicijnen tegen obesitas —hoewel dit buiten de scope van deze studie valt— zal een belangrijke rol spelen in de toekomstige behandeling van obesitas en de plaats die MBS daarin heeft.

Referenties

1. Sjöström L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. J Intern Med. 2013;273(3):219-34.
2. Glazer S, Biertho L. Canadian Adult Obesity Clinical Practice Guidelines: Bariatric Surgery: Selection & Pre-Operative Workup. 2020 [Accessed February 16th 2024]. Available from: https://obesitycanada.ca/guidelines/preop.
3. Biertho L, Hong D, Gagner M. Adult Obesity Clinical Practice Guidelines: Bariatric Surgery: Surgical Options and Outcomes. 2020 [Accessed February 16th 2024]. Available from: https://obesitycanada.ca/guidelines/surgeryoptions/.
4. Di Lorenzo N, Antoniou SA, Batterham RL, et al. Clinical practice guidelines of the European Association for Endoscopic Surgery (EAES) on bariatric surgery: update 2020 endorsed by IFSO-EC, EASO and ESPCOP. Surg Endosc. 2020;34(6):2332-58.
5. Chirurgische behandeling van Obesitas - Richtlijn - Richtlijnendatabase [Internet] 2020 [Accessed 16th February 2024]. Available from: https://richtlijnendatabase.nl/richtlijn/chirurgische_behandeling_van_obesitas/startpagina_-_chirurgische_behandeling_van_obesitas.html.
6. Shiau J, Biertho L. Canadian Adult Obesity Clinical Practice Guidelines: Bariatric Surgery: Postoperative Management. 2020 [Accessed February 16th 2024]. Available from: https://obesitycanada.ca/guidelines/postop/.
7. Vermeer KJ, Monpellier VM, Cahn W, Janssen IMC. Bariatric surgery in patients with psychiatric comorbidity: Significant weight loss and improvement of physical quality of life. Clin Obes. 2020;10(4):e12373.
8. 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 & BARIATRIC SURGERY, OBESITY MEDICINE ASSOCIATION, AND AMERICAN SOCIETY OF ANESTHESIOLOGISTS - EXECUTIVE SUMMARY. Endocr Pract. 2019;25(12):1346-59.
9. Jacobs A, Liem RSL, Janssen IMC, Tollenaar R, Monpellier VM. Weight loss after bariatric surgery: a comparison between delayed and immediate qualification according to the last resort criterion. Surg Obes Relat Dis. 2021;17(4):718-25.
10. Tewksbury C, Williams NN, Dumon KR, Sarwer DB. Preoperative Medical Weight Management in Bariatric Surgery: a Review and Reconsideration. Obes Surg. 2017;27(1):208-14.
11. Kim JJ, Rogers AM, Ballem N, Schirmer B. ASMBS updated position statement on insurance mandated preoperative weight loss requirements. Surg Obes Relat Dis. 2016;12(5):955-9.
12. Heelkunde NVv. Richtlijn Morbide Obesitas. 2011.
13. Livhits M, Mercado C, Yermilov I, et al. Does weight loss immediately before bariatric surgery improve outcomes: a systematic review. Surg Obes Relat Dis. 2009;5(6):713-21.
14. Leeuwarden MC. Kom ik in aanmerking? 2024 [Available from: https://www.mcl.nl/afdelingen/centrum-obesitas-noord-nederland/kom-ik-in-aanmerking.
15. Zorgverzekeraar SH. Bariatrische chirurgie 2024 [Available from: https://www.stadholland.nl/consumenten/vergoedingen/bariatrische-chirurgie.
16. Vidgen HA, Gallegos D. Defining food literacy and its components. Appetite. 2014;76:50-9.

17. Health.gov. Health Literacy in Healthy People 2030 2021 [updated August 24th 2021. Available from: https://health.gov/our-work/national-health-initiatives/healthy-people/healthy-people-2030/health-literacy-healthy-people-2030.

18. Albarracín D, Fayaz-Farkhad B, Granados Samayoa JA. Determinants of behaviour and their efficacy as targets of behavioural change interventions. Nature Reviews Psychology. 2024;3(6):377-92.

19. Holloway A, Watson HE. Role of self-efficacy and behaviour change. Int J Nurs Pract. 2002;8(2):106-15.

20. Vitalys. Wanneer komt uw patiënt in aanmerking voor een bariatrische operatie 2024 [3-7-2024]. Available from: https://www.vitalys.nl/voor-verwijzers/criteria-en-aanmelden/criteria-voor-bariatrische-chirurgie/.

Addendum

List of abbreviations

ASMBS	American Society for Metabolic and Bariatric Surgery
BMI	body mass index
BMS	bariatric-metabolic surgery
CCBRS	Cleveland Clinic Behavioral Rating System
CEFR	Common European Framework of Reference
CI	confidence interval
CLI	combined lifestyle intervention
DATO	Dutch Audit of Treatment of Obesity
DSM	diagnostic and statistical manual of mental disorders
EDE-Q	eating disorder examination-questionnaire
EWL	excess weight loss
HLS-EU-Q16	European Health Literacy Survey Questionnaire
IFSO	International Federation for the Surgery of Obesity
MBS	metabolic and bariatric surgery
METC	medisch-ethische toetsingscommissie
MWP	mandatory weight loss program
NOK	Nederlandse Obesitas Kliniek (Dutch Obesity Clinic)
OR	odds ratio
PA	physical activity
QoL	quality of life
RCT	randomized controlled trial
RYGB	Roux-en-Y gastric bypass
SD	standard deviation
SF-36	short form health survey (36 items)
SG	sleeve gastrectomy
SPFL	self-perceived food literacy
TWL	total weight loss

List of publications

1. **Jacobs A**, Vermeer K, Slok AN, Janssen IMC, Tollenaar R, Monpellier VM. Long-Term Weight Loss and Attendance Outcomes Following Metabolic and Bariatric Surgery: An Evaluation of The Cleveland Clinic Behavioral Rating System. Obes Surg. 2024;34(11):4166-78.

2. **Jacobs A**, Nijland LMG, Steenhuis IHM, van Veen RN, Liem RSL, Pijl H, Ter Beek L, Tollenaar R, Monpellier VM. Food and Health Literacy in Patients Awaiting Metabolic-Bariatric Surgery. Obes Facts. 2024:1-9.

3. **Jacobs A**, Monpellier VM, Torensma B, Antoniou EE, Janssen IMC, Tollenaar R, Jansen ATM. Influence of mental and behavioral factors on weight loss after bariatric surgery: A systematic review and meta-analysis. Obes Rev. 2024;25(6):e13729.

4. Saux P, Bauvin P, Raverdy V, Teigny J, Verkindt H, Soumphonphakdy T, Debert M, **Jacobs A**, Jacobs D, Monpellier V, Lee PC, Lim CH, Andersson-Assarsson JC, Carlsson L, Svensson P-A, Galtier F, Dezfoulian G, Moldovanu M, Andrieux S, Couster J, Lepage M, Lembo E, Verrastro O, Robert M, Salminen P, Mingrone G, Peterli R, Cohen RV, Zerrweck C, Nocca D, Le Roux CW, Caiazzo R, Preux P, Pattou F. Development and validation of an interpretable machine learning-based calculator for predicting 5-year weight trajectories after bariatric surgery: a multinational retrospective cohort SOPHIA study. The Lancet Digital Health. 2023;5(10):e692-e702.

5. **Jacobs A**, Al Nawas M, Deden LN, Dijksman LM, Boerma E-JG, Demirkiran A, Hazebroek EJ, Wiezer MJ, Derksen WJM, Monpellier VM. Preoperative Weight Gain Is Not Related to Lower Postoperative Weight Loss, But to Lower Total Weight Loss up to 3 Years After Bariatric-Metabolic Surgery. Obesity Surgery. 2023;33(12):3746-54.

6. Nijland LMG, Reiber BMM, Monpellier VM, **Jacobs A**, Hazebroek EJ, van Veen RN, Demirkiran A, de Castro SMM. The association between patient attendance to a perioperative group-based lifestyle program and weight loss after bariatric surgery. Surgery for Obesity and Related Diseases. 2022;18(6):747-54.

7. **Jacobs A**, Liem RSL, Janssen IMC, Tollenaar RAEM, Monpellier VM, Demirkiran A, van Veen R, Hazebroek E, Greve JW, Wiezer RM, Swank D, Knook M, Faraj D, Tseng L, de Castro S, Marsman H, van Tets W, Cense H, Tenhagen M, Boerma EJ, Fransen S, Meesters B, Wijffels N, te Riele W, Derksen W, Takkenberg M, Aufenacker T, Vening W, Witteman B, den Hengst W. Weight loss after bariatric surgery: a comparison between delayed and immediate qualification according to the last resort criterion. Surgery for Obesity and Related Diseases. 2021;17(4):718-25.

Dankwoord

Tijdens de totstandkoming van dit proefschrift heb ik door de jaren heen van velen hulp en steun mogen ontvangen. Helaas kan ik niet iedereen persoonlijk noemen, maar ik wil iedereen die op welke manier dan ook betrokken is geweest, mijn oprechte dank betuigen. Een aantal mensen wil ik graag in het bijzonder benoemen.

Allereerst mijn promotor prof. dr. R.A.E.M Tollenaar. Beste Rob, bedankt voor je vertrouwen in mij als buitenpromovendus en je waardevolle steun, zelfs in uitdagende tijden. Jouw typering van mij als "zelfrijzend bakmeel+++" zal me altijd bijblijven, net als ons open en laagdrempelige contact, dat ik enorm heb gewaardeerd.

Mijn andere promotor, prof. dr. H. Pijl. Beste Hanno, jouw kritische blik, snelle reacties en waardevolle feedback hebben mijn proefschrift enorm verrijkt, en jouw betrokkenheid was voelbaar, ondanks dat we elkaar slechts twee keer in persoon hebben ontmoet. Dank voor je steun en vertrouwen de afgelopen vier jaar.

Mijn co-promotor dr. V.M. Monpellier. Beste Valerie, jouw begeleiding, van het brainstormen over onderwerpen tot de afronding van dit proefschrift, speelde een grote rol in mijn promotietraject. Ik heb veel geleerd van jouw kennis over onderzoek, epidemiologie en schrijven, en ondanks ons verschil in "interne thermostaten" heb ik onze samenwerking altijd als prettig ervaren – dank voor alles!

Drs. R.S.L. Liem. Beste Ronald, zonder jou was dit promotietraject er niet geweest. Jij bracht mij na mijn coschap chirurgie in contact met de Nederlandse Obesitas Kliniek (NOK), waar ik startte met onderzoek. Dit heeft geleid tot een wetenschapsstage en uiteindelijk deze promotie. Dank voor al je vakinhoudelijke kennis en steun gedurende dit proces.

Dr. B. Torensma. Beste Bart, vanaf onze eerste ontmoeting bij IFSO Madrid was er een goede klik. De jaren daarna ben je mijn rots in de branding geweest op momenten dat ik het het hardst nodig had. Ik kon altijd bij je terecht voor onderzoeks- en epidemiologische vragen of om gewoon even mijn hart te luchten. Ik ben je daar ontzettend dankbaar voor.

Mijn dank gaat ook uit naar de Nederlandse Obesitas Kliniek, waaronder (oud-) directeuren Kobus Dijkhorst, Jean Pierre van Erve, Gijs van Acker en Ignace Janssen, voor het mogelijk maken van de onderzoeken die de basis vormden voor dit

proefschrift. Ook wil ik de zorgcoördinatoren bedanken die hebben geholpen bij het includeren van patiënten voor de NUTRI-studie, evenals alle andere collega's met wie ik tijdens mijn tijd bij de NOK heb mogen samenwerken.

Lieve Lynn, mijn beste vriendin en paranimf. Je hebt me onvoorwaardelijk gesteund en altijd in me geloofd. Ik geniet van onze vriendinnendagjes, feestjes, spelletjesavonden en gezamenlijke liefde voor ABBA. Ik kijk ernaar uit om nog veel meer mooie herinneringen samen te maken. Ik ben onze vriendschap zeer dankbaar.

Lieve Anouschka, mijn andere beste vriendin en tevens paranimf. We vonden elkaar tijdens de EL CID en hebben elkaars zijde niet meer verlaten. Onze jaarlijkse weekendjes weg naar ongebruikelijke bestemmingen, het wintersporten en gewoon lekker kletsen met een kopje thee zijn momenten die ik koester. Dank je wel voor je steun, vertrouwen en onze waardevolle vriendschap.

Lieve Esther en Erica, jullie zijn door de jaren heen uitgegroeid van jaargenootjes tot dierbare vriendinnen. Jullie weten als geen ander mij een spiegel voor te houden wanneer dat nodig is, zowel voor werk als privé. Bedankt voor alle fijne gesprekken, bemoedigende woorden en momenten waarop jullie er voor mij waren.

Veel dank aan mijn CrossFit-maatjes, want wat is nou een betere uitlaatklep dan elke avond samen een WOD doen en afsluiten met een gezellig kopje thee?

Mijn mede-promovendi, onder wie Phillip, Marijn en May, wil ik bedanken voor de onvergetelijke congressen die we samen over de hele wereld hebben mogen beleven.

Lieve papa, mama en broertje Martijn. Dank jullie wel voor jullie onvoorwaardelijke steun en het geloof in mij om dit proefschrift tot een goed einde te brengen. Jullie staan altijd voor mij klaar, en dankzij jullie ben ik de persoon geworden die ik vandaag de dag ben. Ik ben jullie ontzettend dankbaar.

Curriculum vitae

Anne Jacobs was born on May 22, 1996, in Den Helder. In 2014, she graduated Cum Laude from the Lyceum Aan Zee in Den Helder, completing the VWO program. She then pursued a medical degree at Leiden University Medical Center in Leiden. During her Bachelor's degree, Anne took on various medical and non-medical side jobs to broaden her skills and personal development.

During her medical rotations, she began working as a researcher in metabolic and bariatric surgery to further pursue her academic ambitions. This experience evolved into a scientific internship, leading to her first publication. During her Master's degree, she also participated in a Honours Programme, the Leiden Leadership Programme, to enhance her leadership capabilities.

Anne graduated Cum Laude from medical school in 2021, earning the title of Doctorandus. In the same year, she started a PhD in metabolic and bariatric surgery at the Leiden University Medical Center while simultaneously working three days a week as a medical doctor at the Dutch Obesity Clinic. After 2.5 years, she decided to pursue her passion for orthopaedic surgery and transitioned to a full-time role as a medical doctor in orthopaedics at Bergman Clinics in Rijswijk. Additionally, she started working as a freelance CrossFit coach to incorporate her love for sports. During her time at the Bergman Clinics, Anne successfully completed her articles and PhD-thesis. She is set to defend her thesis while working in the orthopaedic surgery department at Noordwest Ziekenhuisgroep in Alkmaar.