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ORIGINAL ARTICLE

Behavioral and psychological factors associated with suboptimal weight loss in post-bariatric surgery patients

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Abstract

Purpose Bariatric surgery is the most effective long-term treatment for sustained weight loss in obesity. Studies have shown that not all patients lose the expected amount of weight. The aim of this study was to develop a better understanding of which behavioral and psychological factors are associated with suboptimal weight loss.

Methods The present paper describes a cross-sectional study that included 140 participants. The mean follow-up period after bariatric surgery was 3.16 years. Eating disorder pathology (Eating Disorder Examination-Questionnaire), impulsivity (Barratt Impulsiveness scale-II) and depressive symptoms (Beck Depression Inventory) were compared with successful and suboptimal participants. A weight loss of more than or equal to 50% of excess weight, was considered to be successful.

Results More than 81% of the participants met the criterion for successful weight loss. The suboptimal weight loss group reported more symptoms of eating disorder pathology ($p = .001$), more loss of control over eating ($p = .001$), and more avoidant behavior due to poor body image ($p < .001$). The suboptimal weight loss group scored higher on impulsivity ($p = .007$) and on depression ($p < .001$). More early weight loss was associated with better weight outcome later on ($r = .491$). Reporting more eating disorder pathology, a longer follow-up period and pre-operative super-obesity (body mass index ≥ 50 kg/m^2) at the time of surgery were associated with poorer weight loss ($p < .001$).

Conclusion Eating disorder pathology, loss of control over eating and avoidant behavior due to poor body image, as well as depressive symptoms and impulsivity, (as reported postoperatively) are associated with suboptimal weight loss.
Level III: Case–control analytic study.

Keywords Bariatric surgery · Weight loss · Obesity · Impulsivity · Eating disorder · Loss of control over eating

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Introduction

Obesity is a public health concern that has been increasing worldwide and is associated with reduced life expectancy, multiple medical conditions and psychopathology [1, 2]. Bariatric surgery (BS) is the most effective long-term way of losing weight [3–5]. However, studies have indicated that a that there is suboptimal weight loss or gradual weight regain in approximately 20–30% of patients, regardless of the malabsorptive or combined restrictive malabsorptive procedure used [6, 7].

Identifying variables associated with successful weight loss is of importance because suboptimal weight loss, considered a long-term complication, can lead to the re-emergence of obesity related health risks, and impaired quality of life [8]. The causes of suboptimal weight loss are thought to be multi-factorial and include—alongside technical, surgery-related factors—demographic, behavioral and psychological factors [9–16]. Being a male, age over 40 and a body mass index (BMI) over 50 kg/m^2 (super obesity) at time of surgery are found to be firmly associated with suboptimal weight loss [7, 10, 13, 17].

Previous studies of patient factors have focused on pre-operative factors, and little attention has been paid to the impact of psychological and behavioral factors during the period after surgery [9]. With regard to those post-operative factors, the literature is more inconclusive [18]. Dietary changes that patients must commit to after surgery may be associated with post-operative weight loss, but there is insufficient evidence for firm conclusions, and further research is needed [9]. The literature suggests that eating disorder pathology after surgery is more closely related to weight loss than pre-operative eating disorder pathology [19, 20]. Disordered eating behaviors after surgery such as loss of control over eating, grazing and stress eating are associated with poorer weight loss [16, 18, 21]. Most empirical support has been found for the association between loss of control over eating and poorer weight loss [18, 22]. Besides post-operative eating disorder pathology, more weight loss in the first 6 months has been identified as a positive predictor of later weight loss [9]. The association between post-operative weight loss and the presence of psychopathology, like depression, is still unclear [9]. Some studies have found no difference in weight loss between patients with and without the existence of post-operative a psychiatric disorder, while others have found a correlation between a post-operative depressive disorder and suboptimal weight loss [9, 23, 24].

Due to a limited amount of research, the literature is inconclusive about the association between weight loss after BS and a negative body image [25]. The study by Grilo and colleagues (2005) found that both checking and avoidance behaviors are significantly associated with the over-evaluation of weight and shape, a core feature of eating disorder pathology in general and in the bariatric population [26]. According to Ortega and colleagues (2012), a main predictor of psychopathology after BS is negative body image. A negative body image is associated with poorer mental health and higher symptoms of depression [27, 28]. The symptoms of depression may lead to disordered eating behaviour (e.g., LOC over eating and grazing), which may lead to weight regain.

Impulsivity is another psychological factor associated with suboptimal weight loss after BS [15]. Impulsivity is a multi-faceted construct, and in our study, we focused on impulsivity as a personality trait. Impulsivity, measured using self-report questionnaires, is considered to be a stable personality trait considers the tendency for disinhibited or spontaneous behavior without adequate forethought or consideration of the consequences [29]. Several facets of impulsivity, such as heightened reward sensitivity and insufficient response inhibition, have been linked to obesity [30]. On a behavioral level, people with a higher level of impulsivity tend to eat more unhealthy foods [31]. The review by Schag and colleagues (2013) showed that impulsivity in obese patients mainly expresses itself in disordered eating behaviors by loss of control over eating [32]. It has also been suggested that impulsivity has an indirect negative impact on weight loss after BS that is mediated by depression for instance when being in a negative mood enhances impulsivity and thus leads to impulsive overeating [15]. Obese people showed more disordered eating behaviors especially when they experience a negative mood [33]. The study by Schag and colleagues (2016) showed that impulsivity and depressive symptoms both are associated with disordered eating behaviors [15].

According to previous research the prevalence of psychopathology in bariatric patients is approximately 50% [7, 34–36]. Psychopathology seems to be related with post-operative weight loss [37]. Successful or suboptimal post-operative weight loss is associated with the degree to which patients benefited from previous psychological treatment.

The aim of this study was to develop a better understanding of which post-operative behavioral and psychological factors are associated with suboptimal weight loss after BS.

In addition, we examined whether better weight loss in the first 6 months was associated with better weight outcome on longterm. We also explored the factors; pre-operative super-obesity, age and gender were associated to suboptimal weight loss. We hypothesized that post-operative eating disorder pathology, depression and impulsivity were associated with suboptimal weight loss after BS.

Methods

Participants

Participants were recruited through advertising on online Dutch platforms developed for bariatric peer support. In addition, recruitment by advertising took place through Dutch general hospitals where BS is performed. Finally, eligible patients of an eating disorder treatment center were invited by health professionals to participate. In total, 129 of the 140 (92%) participants were recruited through online platforms and general hospitals and 11 of the 140 (8%) participants were recruited through an eating disorder treatment center.

Participants were included if the follow-up period after BS was at least 9 months, if they were older than 18 and if the bariatric surgical procedure was a malabsorptive procedure or combined restrictive malabsorptive procedure. A 9-month follow-up period was chosen as a cut-off point given that surgical impact usually begins to decrease around one year post-operatively, and the influence of psychological factors may, therefore, become more evident [16]. Since post-operative weight loss varies between restrictive procedures (e.g., gastric banding) and malabsorptive or combined malabsorptive procedures (e.g., gastric bypass), with greater weight loss occurring in patients undergoing malabsorptive or combined malabsorptive procedures, in this study, participants who had undergone a restrictive procedure ($N = 13$) were excluded [16]. Self-report questionnaires were used to assess all participants. The self-report questionnaires were completed by 153 of the 186 participants. Participants who did not completed the self-report questionnaires were excluded from the final analysis. This study finally included 140 participants and it was conducted between June 2014 and June 2016.

The participants were assigned to a successful or a suboptimal weight loss group. The definition used for success was: percentage of excess weight loss (% EWL) of 50% or more at the time of completing the questionnaire. Percentage of EWL was calculated as ((Δ pre-surgery weight and post-operative weight)/(initial weight − ideal weight)) × 100% [5, 7]. A Body Mass Index (BMI) of 25 kg/m^2 was used as the criterion for ideal weight.

To define successful weight loss, some studies recommend using a weight outcome measure that reduces the influence of initial BMI when comparing the results for patients with a lower and higher BMI; total body weight loss (TBWL) outcome measure [9]. Due to the fact that % EWL is the most commonly used metric, % EWL definition was used throughout this study [3, 6, 13, 21, 24, 38].

Central Committee on Human Research (CCMO) has waived the requirement of ethical approval. The CCMO has ruled that Dutch law on research with humans does not apply to the collection of anonymized retrospective information for routine procedures. All participants gave informed written consent before enrolment. The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Assessments

Online self-report questionnaires were used to assess all participants. The socio-demographic variables used were gender and age. Other variables used were type of surgery, pre-operative weight in kilograms (kg), weight at 6 months follow-up after BS (kg), current weight (kg) and date of surgery.

Eating disorder pathology was evaluated using the Dutch version of the Eating Disorder Examination Questionnaire (EDE-Q), which is designed to assess eating disorder pathology [39, 40]. The EDE-Q consists of 36 items and 4 subscales (eating restraint, eating concerns, weight concerns and shape concerns) and yields a global score. Scores per subscale are the average score of all items in the scale. The global scale is the mean score of the four subscale means. The frequency of various forms of overeating, including binge eating, was also assessed by the EDE-Q. Loss of control (LOC) over eating was defined as the presence of any LOC episodes in the previous 28 days. This method of LOC over eating was previously used in other studies [22, 41, 42]. Items are rated on a 7-point Liker scale (0–6), with higher scores reflecting greater severity or frequency. The internal consistency of the EDE-Q is high (Cronbach's $\alpha = 0.95$) [43].

Body image was assessed using the Dutch version of the Body Image Avoidance Questionnaire (BIAQ), which consists of 19 items [44, 45; Dutch version not published]. This is a self-report questionnaire which measures behavioral avoidance, which is related to body image distress or dissatisfaction. The questionnaire has four subscales (clothing avoidance, avoiding social activities, eating restraint and grooming and weighing) and yields a global score. The subscale clothing avoidance measures disgust or covering up the body through clothing choices; the subscale avoiding social activities measures avoidance of social situations involving eating or focus on appearance; the subscale restraint measures dietary restrictions and the subscale grooming/weighing measures checking behavior such as scrutinizing oneself in the mirror and weighing. All items are scored on a 6-point scale according to the frequency of engagement in the behavior, from never (0) to always (5). The original BIAQ has a high internal consistency (Cronbach' s $\alpha = 0.89$) [44].

Impulsivity was measured using the Dutch version of the Barratt Impulsiveness Scale-II (BIS-II), which consists of

30 items with a 4-point Likert scale [46, 47; Dutch version not published]. The BIS-II consists of three subscales of impulsivity (attention, motor and non-planning impulsivity) and yields a global score. The attention subscale measures poor concentration and thought intrusions; the motor subscale measures acting without thinking and the non-planning subscale measures the lack of future planning. The global score can range from 30 to 120, with a higher score indicating more impulsivity. Internal consistency (Cronbach's $\alpha = 0.83$) and test–retest reliability (Spearman's rho = 0.83) are high [48].

Depressive symptoms were assessed with the Dutch version of the Beck Depression Inventory (BDI), a self-report questionnaire consisting of 21 items, with a higher score indicating a higher level of depressive symptoms. Internal consistency (Cronbach's $\alpha = 0.88$) is high [49–51].

Data analysis

Statistical analyses were performed using the IBM SPSS statistics program, version 19. Analysis of variance (ANOVA) was used for all variables except the nominal variables, to compare the differences between < 50% EWL and ≥ 50% EWL. For analyses comparing two nominal variables, a chi-square test was used (type of surgery, loss of control (LOC) over eating, previous psychological treatment, pre-operative super-obesity, gender and age at time of surgery). There were statistically significant differences in the follow-up time after surgery between the groups, and the group means were therefore adjusted for confounders by entering follow-up time after surgery as a covariate. ANOVA assumptions were tested. In case of non-normal distribution, data were transformed through ANCOVA before statistical testing; this is indicated in the Results section. A Pearson's *R* analysis was conducted to measure the strength of the association between weight loss in the first 6 months and total weight loss after surgery. Multiple logistic regression analyses were conducted to identify variables that predicted less weight loss. The cutoff for significant mean differences between the groups was set at $p < 0.05$.

Results

The mean age of all the participants was 47.52 (SD 9.79) and the mean pre-operative BMI was 46.76 kg/m^2 (SD 8.00). The average follow-up time post-operative was 3.16 years (SD 2.83). Eighty-one percent of the participants ($n = 105$) met the criterion for successful weight loss; 19% ($n = 27$) met the criterion for suboptimal weight loss. The mean follow-up time after bariatric surgery was significantly longer in the suboptimal group ($p = 0.003$), with an average of 4.99 years (SD 4.45; range 0.95–24.48 years), compared to the successful group, which was 2.72 years (SD 2.09; range 0.76–15.54 years). A significant difference in distribution between < 50% EWL and ≥ 50% EWL in the participants recruited through the Dutch eating disorder treatment center was found $\chi^2(1) = 15.085$, $p < 0.001$. In the total cohort of < 50% EWL, 26% (7/27) was recruited through the treatment center.

In total, 83% of the participants had a gastric bypass ($N = 117$). There was no significant difference between type of surgery (gastric bypass and other type of surgery or gastric banding) with regard to weight loss $\chi^2(1) = 0.588$, $p = 0.443$ (Table 1).

Data of the EDE-Q (eating restraint, eating concerns, weight concerns, shape concerns and EDE-Q global score), BIAQ (avoiding social activities and eating restraint) and the BDI global score were not normally distributed, therefore an ANCOVA transformation was performed. By comparison with the successful group, participants in the suboptimal group scored higher on eating concerns ($p = 0.003$), weight concerns ($p = 0.001$), shape concerns ($p = 0.001$) and EDE-Q global score ($p = 0.001$). Participants from the suboptimal group scored higher on clothing avoidance ($p < 0.001$), avoiding social activities ($p < 0.001$) and BIAQ global score ($p < 0.001$), whereas the successful weight loss group scored higher on grooming and weighing ($p = 0.002$).

Analysis of variance identified significant differences in the BIS-II subscales for attention ($p = .019$), non-planning ($p = 0.022$) and in the BIS-II global score ($p = 0.007$); the scores in the suboptimal group were higher than those in the successful group. With regard to the BDI global score,

Table 1 Descriptive statistics of the study sample ($N = 140$)

	Successful		Suboptimal		*N*
	≥ 50% excess weight loss		< 50% excess weight loss		
	n	%	*N*	%	
Gender					
Male	11	10	3	11	14
Female	102	90	24	89	126
	M	SD	*M*	SD	*N*
Age	47.36	9.82	46.28	10.64	139
	n	%	*N*	%	*N*
Type of surgery					
Gastric bypass	98	87	19	70	117
Gastric bypass after binding	4	3	4	15	8
Other type of surgery	11	10	4	15	15
	M	*SD*	*M*	*SD*	*N*
Body mass index					
Pre-surgery	45.96	7.29	51.71	9.61	140
6 months post-operative	34.17	6.92	41.69	8.15	140
Current	29.04	4.69	44.09	7.08	140

the suboptimal group scored significantly higher than the successful group ($p < 0.001$) (Table 2).

Overall, there were significant differences between the groups in terms of loss of control (LOC) over eating based on the EDE-Q ($p = 0.001$), previous psychological treatment ($p = 0.014$) and pre-operative super-obesity ($p = 0.032$). In the suboptimal group, 44% had pre-operative super-obesity, while 24% of the successful group had pre-operative super-obesity (Table 3).

A Pearson's *R* analysis revealed a moderate positive correlation ($r = 0.491$). More weight loss in the first 6 months after BS seems to be associated with more weight loss at time of measurement.

Several multiple regression analyses were performed and a significant difference was found only with backward multiple linear regression, which indicated that pre-operative super-obesity, longer follow-up time after surgery and a higher score on the EDE-Q global score were related to less weight loss (Table 4).

Discussion

The aim of this study was to identify the behavioral and psychological factors that are associated with suboptimal weight loss in post-bariatric surgery patients. This study, through bivariate analyses, found an association between suboptimal weight loss and the following behavioral factors: disordered eating behaviors, negative body-image avoidant behavior and less weight loss in the first 6 months. Besides, this study suggests that suboptimal weight loss is associated with two psychological factors, namely impulsivity and depressive symptoms. In addition, with regard to behavioral and psychological factors, an association between suboptimal weight loss and previous psychological treatment was found. Finally, in our multiple backward regression analysis, we found that pre-operative super-obesity, eating disorder pathology and a longer follow-up period seems to be associated with suboptimal weight loss.

In this study, weight loss was suboptimal in 19% of the participants. This finding is consistent with previous research [6, 7, 24]. Our results support findings from previous research that post-operative eating disorder pathology (such as concerns about weight, body image, eating pattern and loss of control over eating) are associated with suboptimal weight loss after bariatric surgery (BS) [15, 18, 20, 52]. Weight loss after BS depends on the adoption of a personalized healthy eating pattern that takes into account both individual and psychological factors influencing dietary adherence [53]. Most empirical support can be found for the specific association between post-operative, self-reported, loss of control (LOC) over eating

Table 2 Outcome measures of self-report questionnaires among participants with successful and suboptimal weight loss

	Successful		Suboptimal		*n*	*F*	*df*	*p*
	≥ 50% excess weight loss		< 50% excess weight loss					
	M	*SD*	*M*	*SD*				
EDE-Q								
Eating restraint	1.58	1.45	1.79	1.28	138	0.455	137	.501
Eating concerns	1.19	1.38	2.21	1.72	136	9.359	134	**.003**
Weight concerns	2.12	1.60	3.57	1.78	136	11.480	134	**0.001**
Shape concerns	2.43	1.72	3.93	1.63	135	11.891	133	**.001**
EDE-Q global score	1.79	1.33	2.86	1.33	133	11.250	131	**.001**
BIAQ								
Clothing avoidance	11.77	7.12	21.59	11.59	135	23.514	133	**< .001**
Avoiding social activities	2.42	3.62	6.10	6.21	135	14.533	133	**< .001**
Eating restraint	3.21	2.54	3.30	2.33	135	.002	133	.962
Grooming and weighing	9.09	3.08	6.93	3.06	135	10.165	133	**.002**
BIAQ global score	27.51	11.82	39.68	17.15	135	13.973	135	**< .001**
BIS-II								
Attention	15.85	3.84	17.94	5.32	132	5.637	130	**.019**
Motor	20.96	3.32	22.57	4.17	131	3.722	129	.056*
Non–planning	24.26	4.16	26.26	4.42	132	5.402	130	**.022**
BIS-II global score	61.11	9.05	66.70	11.21	132	7.424	130	**.007**
BDI								
BDI global score	8.49	7.66	18.15	11.46	127	18.694	125	**< .001**

Bold *p* values represent significant discrepancies between the groups, * trend

Table 3 Outcome measures of variables among participants with successful and suboptimal weight loss

	Successful		Suboptimal		*n*	χ^2	*df*	*p*
	≥ 50% excess weight loss		< 50% excess weight loss					
	n	%	*n*	%				
Loss of control								
Yes	14	13	11	41	137	11.404	1	**.001**
No	96	87	16	59				
Previous treatment for eating disorder								
Yes	27	24	8	30	140	.382	1	.536
No	86	76	19	70				
Previous psychological treatment								
Yes	63	56	22	81	140	6.048	1	**.014**
No	50	44	5	19				
Pre-operative super-obesity								
Morbid obesity	86	76	15	56	140	4.580	1	**.032**
Super-obesity	27	24	12	44				
Gender								
Male	11	10	3	42	140	.046	1	.830
Female	102	90	15	58				
Age at time of surgery								
< 40 years	33	29	11	31	139	1.678	1	.195
≥ 40 years	80	70.8	18	69				

Bold *p* values represent significant discrepancies between the groups

Table 4 Multiple backward regression to predict weight loss

	B	SE	*β*	*p*	Adjusted R^2	*n*	*F*(3, 129)	*p*
EDE-Q global score	− 3.565	1.138	− .239	.002	.245	132	15.306	**< .001**
Follow-up time after surgery	− 1.210	.562	− .167	.033				
Pre-operative super-obesity	21.130	3.621	.450	< .001				

Variables entered in the multiple backward regression were: EDE-Q global score, follow-up time after surgery and pre-operative super-obesity

and suboptimal weight loss [22, 54]. The subjective sense of LOC over eating has significant impact on weight. The possible explanation can be that global caloric intake is probably higher when there is a LOC over eating and less weight loss can therefore be expected [22]. Post-operative disordered eating behaviors are also likely to compromise the adherence to dietary plans [53, 55].

In the present study, we found that successful weight loss in the first 6 months is associated to successful weight loss during the follow-up period; this is in accordance with the literature [9]. A possible explanation could be that the ability to adjust to the required BS recommendations directly after surgery is linked to the ability to maintain the required behavioral adjustments. However, the evidence is insufficient as a basis for firm conclusions. We are not aware of any research whether early adherence to post-operative conditions predicts later outcome.

We found that body-image avoidant behavior is associated with suboptimal weight loss after BS. The core feature of eating disorder pathology in the bariatric population, is over-evaluation of weight and shape [26]. The study by Grilo and colleagues (2005) found that body image avoidant behavior is significantly associated with over-evaluation of weight and shape. The higher presence of avoidant behavior in the suboptimal weight loss group compared to the successful group in our study could be a result of possible disappointment with the amount of weight lost, leading to body avoidance. The direction of this relationship remains unclear due to the lack of pre-operative data in our study. There is no consensus in the literature about what relationships exist between weight loss after BS and body image [25]. In the review by Bertoletti and colleagues (2019) concerns about body image were related to depressive symptoms, loss of control over

eating and experiences of social discrimination and bullying. Further, this review reports that improvement in body image was associated with a decrease in compulsive eating symptoms, reduction of BMI and increase in percentage excess weight loss in some studies, but that other studies did not find an association between body image and weight loss after BS. However, the assessment of weight and shape concerns is complicated in post-operative bariatric patients, since shape concerns in the population of bariatric patients are different than in other populations [55]. Weight loss is frequently accompanied with loose skin which is associated with higher body dissatisfaction and depressive symptoms [56].

Impulsivity is a central factor in disordered eating behaviors and obesity and can contribute to the experience of suboptimal outcomes after BS [57]. In our study, we found that impulsivity (i.e., poorer concentration and thought intrusions) is associated with poorer weight loss after BS. The research by Schag and colleagues [15] suggests that impulsivity has an indirect impact on weight loss after BS that is mediated by depression and transferred through disordered eating behaviors. The disinhibition observed in people with obesity and loss of control over eating, and the emotional dysregulation associated with mood disorders, all likely share commonalities that may be associated with suboptimal weight loss after BS. Another possible explanation could be that higher levels of impulsivity make it difficult to comply with the recommendations after BS. Facets of impulsivity may represent a transdiagnostic process that underlies multiple health-related behaviors, including physical activity, diet and adherence to treatment regiments [58].

In the review of Herpertz and colleagues (2004) was found that earlier studies have generated conflicting results about the post-operative presence of depressive symptoms and weight loss [18]. The difference in level of depression in our study must be interpreted with caution. The direction of this relationship is unclear due to the lack of pre-operative data. A different study design would be needed to clarify the direction of the relationship. The finding of mild depressive symptoms in participants with suboptimal weight loss may be related to disappointment that weight loss has been less than expected.

In addition, we found in our study that previous psychological treatment is associated with suboptimal weight loss. A history of psychopathology seems to be associated with weight loss [37]. Positive or negative post-operative weight loss is associated with the degree to which patients benefited from psychological treatment in the past. Our findings were not supported by previous studies, in which was found that patients who had received previous psychological treatment had improved weight loss compared with individuals without pervious psychological treatment [37, 59]. Due to the lack of additional information with regard to the nature of these psychological treatments in this study further interpretations cannot be made.

We found an association between higher baseline BMI at time of surgery, particularly pre-operative super-obesity, and suboptimal weight loss. This is in line with the literature [13]. The predictor found in other studies for suboptimal weight loss when being over 40 years at the time of surgery was not found in this study, probably due to the small number of participants below the age of 40.

Our finding that the duration of the follow-up period was associated to suboptimal weight loss needs additional research in the form of a longitudinal study. It is advisable to have a measurement at a predefined time after BS. A possible explanation could be that a higher impulsivity leads to difficulties maintaining the required behavioral adjustments. Bariatric surgery patients in need of support due to suboptimal weight loss, may feel at loss for help and guidance with regard to the required behavioral adjustment [60]. Among BS patients there is a demand for improved information pre-operatively, to prepare for post-operative issues.

The strength of our study is that we studied the impact of post-operative behavioral as well as the psychological factors on suboptimal weight loss. Since there is only a limited body of research addressing the impact of post-operative psychological and behavioral factors on suboptimal weight loss, this study is an extension of the existing body of literature. Identifying variables associated with successful weight loss is of importance because suboptimal weight loss, considered a long-term complication, can lead to the re-emergence of obesity related comorbidities and an impaired quality of life. Another strength of our study is the average duration of the follow-up post-operative, since this is associated with suboptimal weight loss. A long follow-up duration is essential to observe the impact of behavioral and psychological factors on weight loss post-operative. Our findings that increased impulsivity post-operative and eating disorder pathology post-operative are associated with suboptimal weight loss are of importance for clinical implications.

This study has some potential limitations that should be taken in consideration when interpreting the findings. There was a recruitment bias: the participants recruited through a Dutch treatment facility and the participants recruited through Dutch online platforms and Dutch general hospitals were heterogeneous. The study by Fitzgibbon and colleagues (1993) indicates that obese individuals seeking treatment reported greater psychopathology and more loss of control over eating than those who did not seek treatment [61]. In addition, people who are disappointed after BS could be more inclined to participate in an online survey of weight loss after BS than participants who lost more weight after surgery. Only post-operative data were obtained. Due to the lack of pre-operative data, it remains unclear whether the observed differences were already present before surgery or

whether they developed after surgery. Therefore, a causal relationship cannot be claimed. A limitation of this study is the lack of information about the weight trajectory after BS; due to this lack of information, it is unknown whether participants in the suboptimal weight group initially lost weight and may have regained weight over time. Another limitation to consider is that different types of malabsorptive procedures and combined restrictive malabsorptive procedures were included. These procedures can differ in efficacy [4]. However, the majority of the participants had a gastric bypass. Furthermore, all data were collected through self-report measures. Self-report questionnaires can be inaccurate because of response distortions and retrospective recall [39]. In particular self-report on pre-operative weight, 6 months post-operative weight and current weight is prone for inaccuracy. In addition, not all the measurements used were validated for this specific population. Despite these limitations, the current findings show that psychological and behavioral factors are associated with suboptimal weight loss, which is of importance to optimize the effect of BS.

Conclusion

In this study several post-operative psychological and behavioral factors of eating disorder pathology, impulsivity and depressive symptoms were associated with suboptimal weight loss.

The early identification of postoperative factors, such as loss of control over eating or depression, that negatively impact successful weight loss and for which there are evidence-based treatments, will probably improve the overall efficacy of bariatric surgery [21]. Pre-operative and frequent post-operative monitoring of these psychological and behavioral factors are therefore needed.

Because gradual weight regain and suboptimal weight loss are associated with the number of years since surgery, it is important to have a long follow-up period during which patients are monitored. During follow-up, it can be useful to help patients to achieve early weight loss by helping them to adjust to postoperative recommendations relating to diet, physical activity, medical care and support group attendance.

What is already known on this subject?

Bariatric surgery is the most effective long-term way of losing weight [3–5]. However, studies have indicated that a substantial proportion of patients regain lost weight over time and that there is suboptimal weight loss or gradual weight regain in approximately 20–30% of patients. Being a male, age over 40 and a BMI over 50 kg/m^2 (super obesity) at time of surgery are found to be firmly associated with suboptimal weight loss. Previous studies of patient factors have focused on pre-operative factors, and little attention has been paid to the impact of psychological and behavioral factors during the period after surgery [9]. With regard to these post-operative factors, the literature is more inconclusive [18].

What your study adds?

The association between post-operative weight loss and the presence of psychological and psychiatric factors is still unclear [9]. Another strength of our study is the average duration of the follow-up post-operative, since this is associated with suboptimal weight loss. A long follow-up duration is essential to observe the impact of behavioral and psychological factors on weight loss post-operative. Our findings that increased impulsivity post-operative and eating disorder pathology post-operative are associated with suboptimal weight loss are of importance for clinical implications. Identifying variables associated with successful weight loss is of importance because suboptimal weight loss, considered a long-term complication, can lead to the re-emergence of obesity related comorbidities and impaired quality of life.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in this study.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki.

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