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ORIGINAL CONTRIBUTIONS

Predictors of Preoperative Weight Loss in Morbidly Obese Adults Waiting for Bariatric Surgery: A Prospective Cohort Study

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Abstract
Background Preoperative weight loss is encouraged before bariatric surgery, as it is associated with improved surgical conditions. It has also been related to better postoperative outcomes, but this relationship is less clear. However, little is known about what predicts weight loss preoperatively, so the aim was to identify psychosocial and clinical predictors of preoperative weight loss.
Methods Weight was measured at the first visit, the time of surgery approval, and on the day of surgery in 286 bariatric surgery patients (227 women). A questionnaire consisting of multiple psychosocial measures was completed before surgery.
Results Preoperatively, patients experienced a mean weight loss of 3.8 %. Men lost significantly more weight than women (mean=5.4, SD=6.0 vs. mean=3.4, SD=5.8, $t=-2.3$, $p<0.05$), and 43.2 % of the patients lost ≥5% of their body weight. A high weight loss goal ($\beta=0.20$, $p<0.001$), frequent self-weighing ($\beta=0.18$, $p<0.002$), and being close to or at highest lifetime weight when applying for surgery ($\beta=-0.30$, $p<0.0001$) were identified as predictors of weight loss, after controlling for body mass index (BMI), gender, and length of preoperative time period.
Conclusions A relatively low proportion of patients lost the recommended weight preoperatively. Our results indicate that patients benefit from monitoring weight preoperatively and that allowing patients to keep their high weight loss goals may contribute to higher weight loss. Further investigation of these predictors could provide valuable knowledge regarding how to support and motivate patients to lose weight preoperatively.

Keywords Bariatric surgery · Preoperative weight loss · Morbidly obese · Psychosocial

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Introduction

Bariatric surgery is an effective weight loss treatment option for obese individuals [1, 2]. Many programs require patients to lose weight before surgery [1]. Preoperative weight loss has been associated with improved surgical outcomes [3, 4] and greater postoperative weight loss [5–7], and may indicate the degree of patient motivation and likelihood of better compliance with postoperative recommendations [8–10]. Weight reduction can reduce liver volume and visceral fat as well as improve the metabolic status of the patient [4, 11], which is the rationale stated in the American clinical guidelines [12] for encouraging preoperative weight loss. However, the relationship between preoperative weight loss and postoperative outcomes is less clear [7, 13]. There exists no consensus

regarding the best preoperative practices and optimal weight loss, but a 5–10 % weight loss is generally recommended [3, 5, 7] and a preoperative specific diet is often suggested [7]. Patients admitted to bariatric surgery often report previous successful weight loss attempts, but they have difficulty maintaining the weight loss [14]. Thus, many bariatric surgery patients have the ability to lose weight over a limited period preoperatively. However, studies have shown that a substantial proportion of patients fail to do so, with some even gaining weight [15, 16]. Research has mainly focused on preoperative weight loss as a predictor of surgical and postoperative outcomes, whereas factors related to preoperative weight loss have been overlooked. To our knowledge, this is the first study to examine the psychosocial and clinical predictors of preoperative weight loss.

Self-regulation refers to the process of controlling or altering learned and automated responses such as unhealthy eating or sedentary habits, which can be difficult for most people [17]. Achieving behavior change requires *motivation* to change, a clear *goal* to pursue, continual *monitoring* of one's behavior and progress towards the goal, and *self-control* to resist urges and temptation [17]. Different psychosocial factors can facilitate this process or function as potential barriers. Within a self-regulation framework, past behavior is generally a strong predictor of future behavior [18, 19], and factors that influenced previous weight loss attempts are likely to continue to play a role preoperatively. Previous successful weight loss attempts followed by weight gain may affect patients' motivation, self-esteem, and belief in their ability to lose weight in the future (self-efficacy). Monitoring weight and using feedback to regulate one's behavior requires a high degree of self-control, which is a limited energy resource [20]. Mental health problems, alcohol consumption, dysfunctional emotional regulation, and demanding social relations can all deplete this self-regulatory resource [21] and leave patients with limited capacity to focus on eating more healthily or being physically active.

The aim of the present study was to examine clinical, demographic, and self-regulation factors as predictors of preoperative weight loss in a sample of bariatric surgery patients.

Methods

Participants and procedures

All participants were recruited for the Oslo Bariatric Surgery Study (OBSS) at the Centre for Morbid Obesity and Bariatric Surgery (CMOBS) at Oslo University Hospital, Norway between February 2011 and September 2013. The recruitment process is described in Fig. 1. Out of 506 eligible patients, 302 patients answered the questionnaire (response rate=59.7 %). Patients were eligible for surgery if they had a body mass index (BMI) ≥40 kg/m^2 or BMI ≥35 kg/m^2 with obesity-related comorbidities, and had failed at previous attempts of maintaining weight loss [22]. After surgery approval, the surgeons asked the patients to participate in the study and those who gave informed consent completed an extensive postal questionnaire with multiple measures.

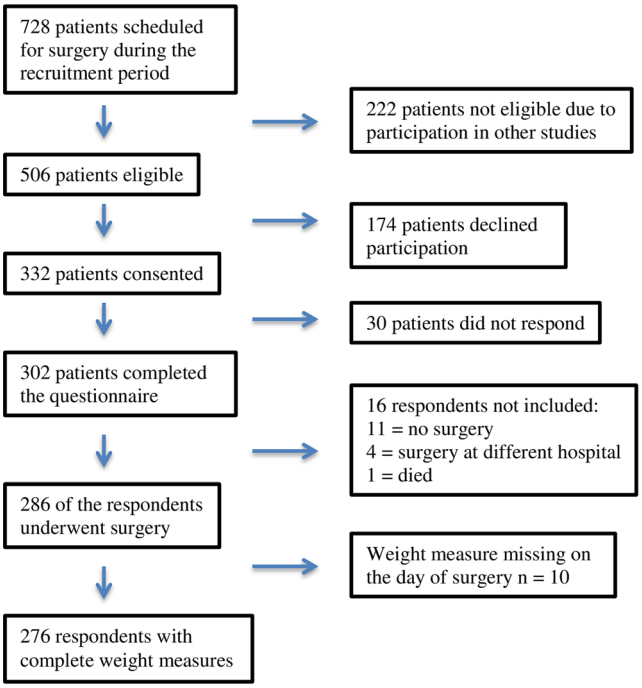

Fig. 1 Flow diagram of the recruitment process

At the CMOBS, patients are required to participate in a preoperative, 40-h educational course on the surgical, psychological, and nutritional aspects of gastric bypass. A 5–10 % weight loss and adherence to a 3-week preoperative 1000-caloric diet were strongly advised.

Measures

Weight was measured using a platform scale, Seca 635, III, at the first preoperative visit (T1), the day surgery was approved (T2), and the day of surgery (T3). The length of waiting period varied from 58 to 731 (mean=448, SD=174) days. Percent total weight loss was used as outcome measure.

Socio-demographic variables included gender, age, educational background, and marital status.

Weight loss goal was assessed by a single question from the Goals and Relative Weight Questionnaire [23]: "Please indicate the weight you would be happy to achieve as the final result of the surgery." The relative difference in percentage between the weight patients indicated as "happy weight" and their weight at first preoperative visit was calculated. A higher percentage indicates higher expectations of weight loss after surgery.

Diet and weight loss history were mapped by different single questions extracted from the Survey for Eating Disorders [24]

and Weight and Lifestyle Inventory [25]. The questions addressed the presence of binge eating (1=never, 2=previously, 3=now), frequency of previous successful weight loss attempts, different diet strategies used (11 strategies listed), number of times participated in organized weight loss programs, and currently dieting (1=no, 2=yes). Weight history was assessed by questions about obesity in childhood (1=no, 2=yes), family obesity, highest lifetime weight, and how often participants monitored their weight (1=almost never to 7=more than once a day). *Previous weight loss* (%) was calculated as the percentage difference between weight at first preoperative visit (weight T1) and "highest lifetime weight". A lower percentage indicates being at their highest lifetime weight when applying for surgery.

Alcohol use was assessed by asking "How often have you consumed one or more than one unit of alcohol in the space of the last year? (One unit=one glass of beer, wine, or one drink, 1=never consumed alcohol to 9=daily/almost daily).

Frequency of snacking was measured by using the mean sum score of four questions pertaining to the frequency of eating sweets, caloric food, night eating, and consumption of fizzy drinks. Responses ranged from 1 (never) to 5 (always), with higher scores indicating higher frequency.

Physical activity was assessed with the International Physical Activity Questionnaire (IPAQ) short-form [26]. This is a validated measure of frequency of weighted activity levels during the last week. Mean scores are reported as metabolic equivalent (MET) minutes values.

Outcome expectations were operationalized by asking the respondents to indicate how likely it is that they will feel this way 3 years after the operation (1=definitely not, 10=most definitely) considering nine different aspects. The scale was developed for OBSS and two subscales, *well-being expectancies* and *social competence expectancies* were computed.

Self-efficacy was measured by the General Perceived Self-efficacy Scale, a 10-item measure of a person's beliefs in mastering new behaviors or situations [27, 28]. Higher mean score indicates higher degrees of self-efficacy.

Self-esteem was assessed using the short-form of the Rosenberg's Self-Esteem Scale [29]. This four-item version correlates well with the original ten-item scale [30]. Higher mean scores reflect higher self-esteem.

Emotion regulation strategies were measured using the Emotion Regulation Questionnaire [31]. The response categories ranged from 1 (strongly disagree) to 7 (strongly agree), with a higher mean score indicating higher degrees of emotion reappraisal and/or suppression.

Anxiety and depression were assessed using the Hospital Anxiety & Depression Scale [32]. Higher scores reflect more symptoms.

Satisfaction with current partner relationship was assessed using the Relationship Assessment Scale [33]. It is a five-item scale with response options ranging from 1 (little) to 4 (much).

Social support was measured with the family cohesion and social competence subscales of the Resilience Scale for Adults [34], assessing protective factors important for preventing maladjustment and psychological problems.

Ethical considerations

All participants received oral and written information about the study before giving written consent. The study was approved by the Data Protection Supervisor, the Regional Committee for Medical and Health Research Ethics (2012/17028), South-Eastern Norway, and the Privacy Ombudsman for Research at Oslo University Hospital.

Statistical analysis

An independent sample *t* test was conducted to test gender differences in weight, weight loss measures, and diet history. To determine which variables to include in the regression analysis, Pearson correlation coefficients between the study variables and percent preoperative weight loss were calculated. The length of preoperative waiting period could influence weight loss; therefore, partial correlations were used with time as a covariate. Variables significantly correlated with the outcome measure ($p<0.05$) were included in the multiple regression analysis, which was used to circumvent problems of multicollinearity due to multiple intercorrelated predictors. Preoperative period, gender, and BMI (kg/m^2) were entered

Table 1 Demographic characteristics of participants (n=286)

	n	Percent
Gender		
Women	227	79.4
Men	59	20.6
Age		
<40 years	87	30.4
40–49 years	114	39.9
≥50 years	85	29.7
Education		
<9 years	57	20.4
10–12 years	138	49.3
>12 years	85	30.4
Professional status		
Employed	193	69.9
On welfare	28	9.8
Unemployed	55	19.2
Marital status		
Married/partner	185	66.1
Single	95	33.9
Children (yes)	226	79

Table 2 Descriptive statistics and gender differences in patients' weight, preoperative weight loss, time difference between clinic visits, and diet and weight loss history

	Total n=286				Women n=227	Men n=59	t value
	Mean	SD	Min	Max	Mean (SD)	Mean (SD)	
BMI (T1)	44.9	6.1	34	67	44.9 (5.9)	45.5 (6.6)	−0.66
Weight T1 (kg)	130.3	22.4	87	222	125.4 (18.8)	149.1 (25.2)	−6.76***
Weight T2 (kg)	130.7	22.1	78	219	126.1 (18.8)	148.2 (24.9)	−6.35
Weight T3 (kg)	125.0	20.8	78	200	121.2 (18.7)	140.2 (21.9)	−6.53***
Weight loss T1–T2 (%)[a]	−0.5	4.8	−19	18	−0.7 (5.0)	0.5 (3.8)	−1.74
Weight loss T2–T3 (%)[a]	4.2	4.2	−8	18	4.0 (4.0)	4.9 (4.8)	−1.41
Weight loss T1–T3 (%)[a]	3.8	5.9	−14	22	3.4 (5.8)	5.4 (6.0)	−2.31*
First time period (days)	300	170	0	731	304.5 (162.8)	285.5 (191.3)	0.77
Second time period (days)	160	92	15	423	159.6 (91.1)	162.2 (92.6)	−0.20
Total time period (days)	448	174	58	731	451.3 (172.8)	437.3 (181.1)	0.55
Number of weight loss >10 kg	4.2	3.4	0	12	4.4 (3.4)	3.6 (3.2)	1.57
Number of times participated in an organized diet program	3.2	2.7	0	10	3.6 (2.8)	1.7 (1.8)	6.06***
Number of years dieted during lifetime (%)	53.9	17.4	4.4	88.5	56.5 (15.9)	43.7 (19.3)	4.52***
Number of diet strategies used[b]	4.9	2.3	1	11	5.2 (2.3)	3.8 (1.8)	4.44***

BMI=body mass index (kg/m^2)

* p<0.05; ** p<0.01; *** p<0.001

[a] Negative value=weight gain; T1=first visit, T2=surgery approved, T3=day of surgery

[b] Diet strategies used: skipped a meal, eaten less at every meal, eaten less carbohydrates, taken laxatives, used diet drugs, vigorous physical exercise, eaten less sweets, fasted, eaten less fat, vomited, and other

as control variables in the regression model. Due to the small number of male respondents, separate analyses by gender were not conducted.

Results

Of the 302 respondents, 286 patients (227 women) underwent surgery. The majority of patients (270 patients) underwent Roux-en-Y gastric bypass, 16 patients underwent sleeve gastrectomy, and 16 did not undergo surgery. To evaluate the representativeness of the study sample with the clinical population at the CMOBS, BMI, gender, and age of the patients who underwent surgery during the recruitment period (n=728) were compared with those of the study sample. The study sample had a significantly higher proportion of women (79.4 vs. 67.7 %, p<0.001), but there were no differences in age or BMI between the groups. Patient characteristics are described in Table 1.

Table 2 presents the weight measures together with variables describing previous diet and weight loss history (276

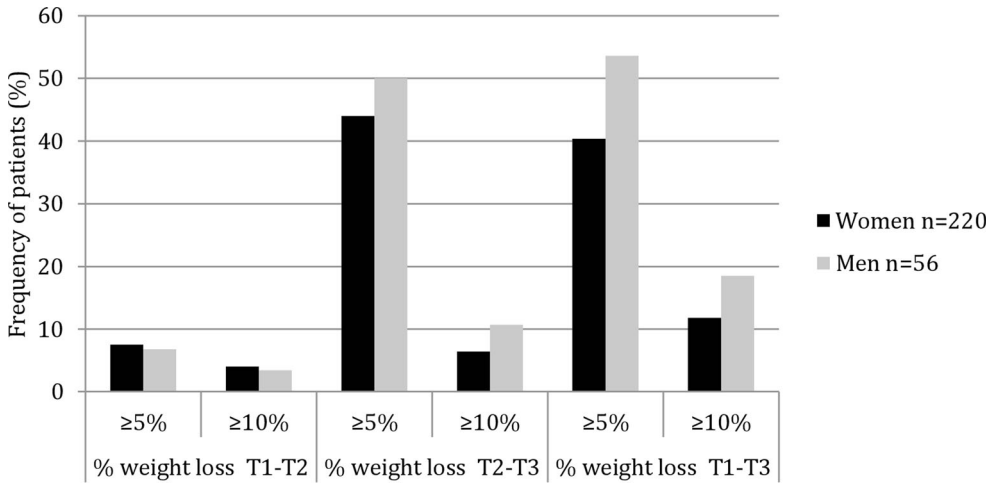

Fig. 2 Frequency of patients achieving 5–10 % preoperative weight loss

patients had complete weight measures). Women had spent more time dieting, used more diet strategies, and participated more frequently in weight loss programs than men.

Patients gained weight on average during the first preoperative period. After approval for surgery, the mean weight loss was 4.2 %. The total mean weight loss was 3.8 %, with men losing significantly more weight than women (mean=5.4, SD=6.0 vs. mean=3.4, SD=5.8, $t=-2.3$, $p<0.05$). Figure 2 shows that 13.1 % of the participants reached the goal of 10 % weight loss, whereas 43.2 % lost ≥5 % of their weight while waiting for surgery.

Partial correlation was used to explore the relationship between the study variables and preoperative weight loss, controlling for time differences (Table 3). Male sex, BMI, weight loss goal, weight monitoring, and initiation of diet at the time of surgery approval were all positively correlated with preoperative weight loss. Weight loss before applying for surgery was negatively correlated with the outcome measure. To analyze the relative contribution of potential predictors of preoperative weight loss, only the variables that were significantly correlated with the outcome variable were included in a hierarchical multiple linear regression analysis (Table 4). All

Table 3 Partial correlations between independent variables and preoperative weight loss, controlling for time between visits

	Weight loss % T1–T2	Weight loss % T2–T3	Total weight loss %	Mean	SD	α
Age	0.09	−0.03	0.05	43.9	9.6	
Gender (women=1, men=2)	0.10	0.09	0.14*	1.2	0.4	
BMI (kg/m^2)	0.24**	0.06	0.24***	45.0	6.1	
Weight loss/diet history						
5. Overweight as a child[a]	0.03	0.07	0.07	1.6	0.5	
6. Overweight spouse/partner[a]	0.01	0.09	0.07	1.9	0.9	
7. Self-monitoring weight	0.13*	0.01	0.12*	2.7	1.5	
8. Currently dieting[a]	0.08	0.13*	0.15*	1.6	0.5	
9. Number of weight loss >10 kg	0.05	−0.01	0.05	4.2	3.4	
10. Number of times participated in organized diet programs	−0.06	−0.09	−0.10	3.2	2.7	
11. Number of years dieted during life (%)	0.05	−0.01	0.04	53.9	17.4	
12. Previous weight loss (%)[b]	−0.36***	−0.04	−0.31***	5.7	5.3	
13. Number of diet strategies used	−0.10	−0.01	−0.09	4.9	2.3	
Behavior						
24. Alcohol use	−0.01	−0.02	0.03	4.0	1.7	
25. Snacking	−0.08	0.02	−0.05	2.5	0.7	
26. Physical activity (MET-min/week)	0.04	0.00	0.03	1838.1	2238.1	
Motivation/expectations						
1. Well-being expectations	0.04	0.02	0.04	8.4	1.4	.85
2. Social competence expectations	−0.04	−0.09	−0.11	7.5	1.7	.76
3. Weight loss goal	0.26***	0.05	0.24***	37.8	8.0	
4. Worries for surgical complications	−0.14*	0.03	−0.09	2.3	1.0	
Psychosocial and clinical measures						
14. Self-efficacy	0.03	0.02	0.04	3.1	0.4	.87
15. Self-esteem	0.03	−0.07	−0.04	2.7	0.7	.80
16. Emotional regulation—reappraisal	0.04	0.02	0.05	4.0	0.9	.80
17. Emotional regulation—suppression	−0.00	0.06	0.05	3.8	1.1	.79
18. Anxiety	−0.03	0.03	0.00	7.0	4.3	
19. Depression	−0.08	0.05	−0.03	5.4	3.8	
20. Binge eating	−0.13*	0.03	−0.08	1.7	0.8	
21. Satisfaction with relationship	0.05	−0.13	−0.04	5.6	1.1	.86
22. Resilience—family cohesion	0.04	−0.03	0.00	3.6	0.6	.86
23. Resilience—social competence	0.01	−0.16**	−0.12	3.7	0.8	.83

*$p<0.05$; **$p<0.01$; ***$p<0.001$

[a] Overweight as a child, overweight spouse/partner, and currently dieting are dichotomous variables: No=1, Yes=2

[b] Percent weight difference between highest lifetime weight and weight at first visit; T1=first visit, T2=surgery approved, and T3=day of surgery

Table 4 Results of hierarchical linear multiple regression with total preoperative weight loss (%) as criterion (n=262)

						95 % CI B coefficient	
	R^2	ΔR^2	B	β	p value	Lower	Upper
Block 1	0.093***						
Total time period			−0.00	−0.11	0.071	−0.01	0.00
Gender			2.08	0.14	0.018	0.36	3.81
BMI			0.23	0.24	0.000	0.12	0.35
Block 2	0.228***	0.135***					
Total time period			−0.00	−0.12	0.031	−0.01	0.00
Gender			2.57	0.17	0.003	0.90	4.24
BMI			0.01	0.01	0.913	−0.14	0.16
Self-monitoring weight			0.71	0.18	0.002	0.27	1.15
Currently dieting			1.30	0.11	0.062	−0.07	2.65
Previous weight loss (%)			−0.33	−0.30	0.000	−0.46	−0.20
Weight loss goal (%)			0.15	0.20	0.009	0.04	0.25

Total time period = time from first visit until surgery; gender and currently dieting are dichotomous variables, Gender: Women=0, Men=1; Currently dieting: No=0, Yes=1

BMI=body mass index (kg/m^2)

*p<0.05; **p<0.01; ***p<0.001

correlations within the included independent variables were in the small to medium range. Length of preoperative period, gender, and BMI were entered at first as control variables, explaining 9.3 % of the variance in preoperative weight loss. Including the independent variables increased the explained variance to 22.8 % (effect size: medium to large, Cohens f^2= 0.30) [35]. A high weight loss goal, regular weight monitoring, and less weight loss before applying for surgery all uniquely contributed to preoperative weight loss, controlling for BMI, gender, and duration of waiting period.

Discussion

The present study is, to our knowledge, the first to identify psychosocial predictors of preoperative weight loss in bariatric surgery patients. Two of the significant predictors—weight loss goal and self-weighing—are central to self-regulation of behavior change. Being closer to or at the highest lifetime weight when applying for surgery also predicted weight loss. Current diet did not predict weight loss, which may be because the questionnaire was completed before the recommended final 3-week diet had started.

Less than half of the patients lost ≥5 % of their weight, which coincides with other findings [7, 36]. Higher BMI was related to preoperative weight loss, and women had a more frequent and successful diet history than men. More experience using diets did not result in better outcome, as men lost relatively more weight than women. Gender differences in weight loss reported in the literature has varied from no differences to men losing more weight than women [37], coinciding with our results. Furthermore, a shorter waiting period before surgery was associated with weight loss. This might be explained by a tendency to increase food consumption before going on a diet, termed as “the last supper effect” [38, 39]. This finding indicates that a shorter preoperative period might support higher weight loss.

Our result showing that high weight loss goals predicted preoperative weight loss contradicts the common perception that unrealistic goals lead to less motivation and poor outcomes [40, 41]. Bariatric surgery patients are often encouraged to set realistic weight loss goals [40, 41], and unrealistic goals have been considered potential contraindications to surgery [42, 43]. Based on recent findings showing that unrealistic goals may not have detrimental effects on weight loss outcomes, it has been proposed that clinicians should be careful in trying to reduce patients’ high weight loss goals [40, 44]. Our results support this proposal and indicate a need for more research regarding how to deal with patients’ weight loss goals preoperatively.

Another key component in the self-regulation process of weight control is to monitor behavior change in relation to a set weight loss goal [45]. The positive relationship between frequent self-weighing and higher weight loss that we found is in line with previous research [46, 47]. Self-weighing increases awareness of desired behavior change, and this feedback can be used to control weight gain [48]. Based on our findings, encouraging the patients to self-monitor weight might contribute to higher preoperative weight loss.

Finally, a smaller difference between patients’ highest lifetime weight and weight at first visit (T1) predicted higher weight loss. It could be that the patients at their highest lifetime weight when applying for surgery were the most inexperienced dieters,

and thereby may have benefited the most from attending the educational course at the CMOBS and dieting preoperatively.

Knowing that past behavior is a predictor of future behavior [19], we would expect previous weight loss to predict weight loss, but it did not. Being physically active and eating less unhealthy food was also not related to higher weight loss. These findings may be explained by biological mechanisms, as energy expenditure is normally reduced after losing weight, especially after weight loss due to dietary restrictions [49, 50]. It is well known that weight loss levels off at approximately 6 months after most weight loss attempts or interventions [51]. Patients who lost weight before applying for surgery may have experienced a reduction in resting metabolic rate and a plateau in weight loss, resulting in lower weight loss. Alternatively, they might have simply decided to wait for the effects of the surgery.

Although the study response rate was relative low (59.7 %), the only difference found between the study participants and total population was an overrepresentation of women (80 %) in the study sample, reflecting a common discrepancy in bariatric surgery. The small sample size of men prevented analyzing gender differences in depth. Another limitation was a lack of information regarding adherence to the prescribed diet.

Conclusions

A relatively low proportion of patients lost the recommended weight preoperatively despite the risk of surgery being postponed or canceled. High weight loss goal, frequent self-weighing, and low previous weight loss were identified as predictors of preoperative weight loss. Based on our results, recommending self-weighing preoperatively seems to be beneficial. Moreover, the value of adjusting weight loss goals before surgery requires further exploration. Future investigation of these factors could contribute to improve preoperative practice.

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

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