



# Associations among psychopathology and eating disorder symptoms and behaviors in post-bariatric surgery patients

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## Abstract

**Purpose** A considerable number of post-bariatric surgery patients report problematic eating behaviors (PEBs) and/or eating disorders (EDs). Examining psychosocial variables associated with ED symptoms may identify targets for postoperative interventions to reduce these behaviors and improve surgical outcomes.

**Methods** A total of 161 participants completed the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) and the Eating Disorder Examination-Questionnaire (EDE-Q). Participants were classified into ED risk or no ED risk groups and subjective binge eating (SBE) or no SBE groups. Independent-sample t tests were computed to examine mean differences in total weight loss (%TWL) and MMPI-2-RF scale scores between the ED groups. Relative Risk Ratios (RRRs) were computed to determine which MMPI-2-RF scales were associated with increased risk of ED group membership.

**Results** The ED risk group lost significantly less weight (19.36% TWL) than the no ED risk group (25.18% TWL). The SBE group lost significantly less weight (17.98% TWL) than the no SBE group (25.57% TWL). Participants in the ED groups scored significantly higher on internalizing and externalizing MMPI-2-RF scales than the no ED groups. These scales were associated with increased risk (1.55–2.55 times the risk) of being classified into the ED groups.

**Conclusions** Patients who experienced postoperative ED symptoms lost significantly less weight than patients without ED symptoms. Postoperative ED symptoms are related to, and may be impacted by, higher levels of internalizing and externalizing dysfunction after surgery. Postoperative assessment of and interventions targeting psychosocial dysfunction could decrease ED symptoms.

**Level of evidence** III: Evidence obtained from well-designed cohort or case–control analytic studies.

**Keywords** Eating disorders · Bariatric surgery · Psychopathology · MMPI-2-RF · EDE-Q

## Introduction

Bariatric surgery leads to significant long-term weight loss and resolution of medical comorbidities [1–3]. Multidisciplinary teams assess and manage bariatric surgery patients to maximize surgical outcomes [4]. Within this team, mental

health professionals evaluate surgical candidates for possible surgical contraindications and implement pre-operative psychosocial interventions to optimize patients for surgery [5]. However, long-term postoperative management of patients is less common.

Problematic eating behaviors (PEBs) are frequently reported among people with obesity presenting for bariatric surgery, with some rising to the level of meeting criteria for an Eating Disorder (ED) [6–8]. While research has demonstrated that PEBs and EDs generally decrease pre- to post-operatively, a considerable number of patients still report PEBs (upwards of 47%) and/or meet criteria for an ED post-operatively (upwards of 10%) [6, 9–12]. PEBs and EDs have been found to be associated with worse weight loss trajectories [7, 9, 10, 13, 14]. Postoperative interventions targeting these maladaptive eating behaviors may improve surgical outcomes [15, 16]. Additionally, identifying psychosocial

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variables associated with ED symptoms and behaviors may help to identify targets for postoperative interventions to reduce these behaviors and further optimize surgery outcomes.

The current study examined whether postoperative Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) scale scores were associated with postoperative ED symptoms and behaviors. Additionally, MMPI-2-RF scale scores differences were examined between patients with or without ED symptoms. It was hypothesized that postoperative scores on MMPI-2-RF scales measuring emotional/internalizing dysfunction and behavioral/externalizing dysfunction would be associated with ED symptoms and behaviors. It was also hypothesized that patients with postoperative ED symptoms and behaviors would score significantly higher on postoperative MMPI-2-RF scales measuring emotional/internalizing dysfunction and behavioral/externalizing dysfunction than patients without ED symptoms and behaviors.

## Methods

### Participants

Patients who had bariatric surgery and were approaching 5 postoperative years were contacted to participate in a larger outcome study via a mailed recruitment letter ( $N = 1382$ ). From this, 168 participants came in-person and consented to participate in the study. Of those, 7 participants were excluded from the current study due to producing an invalid MMPI-2-RF protocol as recommended in the MMPI-2-RF Technical Manual [17], leaving a final sample of 161 participants. The majority of the final sample were women (69.6%), the mean pre-operative age was 51.32 years ( $SD = 10.35$ ), and the mean age at the time of the outcome study was 57.29 years ( $SD = 10.46$ ). The mean time between surgery and the outcome study was 6.03 years ( $SD = 0.69$ ). The average pre-operative BMI was 46.37  $\text{kg/m}^2$  ( $SD = 8.18 \text{ kg/m}^2$ ). Reported races were 69.6% Caucasian, 28.6% Black, and 1.9% Latino. Surgery type breakdown was 74.5% Roux-en-Y Gastric Bypass, 22.4% Sleeve Gastrectomy, and 5% other surgery type (e.g., duodenal switch). Lastly, the average percent total weight loss (%TWL) at the time of outcome was 22.98% ( $SD = 11.71$ ). Chi-square and t-test analyses revealed no significant demographic differences between participants who produced a valid MMPI-2-RF protocol and those who produced an invalid MMPI-2-RF protocol. Compared to other bariatric surgery study samples utilizing this center's pre-operative population, the current sample was similar in gender and racial composition and presurgical BMIs, but older [17].

### Measures

*Preoperative information.* Demographic and biological information (i.e., age, ethnicity, gender, and pre-operative BMI), psychiatric diagnoses, and Binge Eating Scale (BES) scores were obtained and coded through a retrospective chart review of patients' electronic medical records (EMRs) by trained research assistants.

*Minnesota multiphasic personality inventory-2-restructured form (MMPI-2-RF);* [18]. The MMPI-2-RF is a self-report, broadband measure of personality and psychopathology comprised of 338 true–false items. Items are scored on 9 Validity and 42 Substantive Scales. The Substantive Scales are organized into a hierarchical and dimensional framework, consistent with contemporary theories of personality and psychopathology. The emotional/internalizing dysfunction and behavioral/externalizing dysfunction scales were used in the current study. MMPI-2-RF scales scores have demonstrated good reliability and validity in bariatric surgery samples and have published comparison group data [19, 20–24].

*Eating Disorder Examination-Questionnaire (EDE-Q);* [25]. The EDE-Q is a 28-item self-report measure assessing feelings, attitudes, and behaviors associated with eating pathology. Items are scored onto four subscales: Restraint, Eating Concern, Shape Concern, and Weight Concern. Behavioral frequency items assess the number of times or days a person has engaged in binge eating-related or compensatory behaviors. Adequate reliability and validity has been demonstrated among bariatric surgery samples [26–28]. In the current study, internal consistency coefficients were: Restraint ( $\alpha = 0.72$ ), Eating Concern ( $\alpha = 0.73$ ), Shape Concern ( $\alpha = 0.88$ ), and Weight Concern ( $\alpha = 0.78$ ).

### Procedures

All patients consented to participate in the study and received a \$110 gift card as compensation for travel, parking, and time of participating. A trained research/clinical staff first measured the participant's weight. The participant then completed the MMPI-2-RF on a designated testing computer and completed a battery of questionnaires via paper–pencil format as part of a larger outcome study. Lastly, the clinical/research staff gave the participant a brief report documenting their current weight and feedback based on the results of the psychological assessment.

### Statistical analyses

ED risk was determined from participants' scores on the EDE-Q subscales. For each subscale, a score at or above

a 4 was considered clinically elevated and coded as 1 [29, 30]. A subscale score below 4 was coded as 0. An overall ED risk variable was created by summing the dichotomized EDE-Q subscale variables (maximum score of 4). This score was then dichotomized, with participants with a total score at or above 1 being put in the ED risk group ( $n=61$ ) and participants with a total score of 0 put in the no ED risk group ( $n=100$ ). Subjective binge eating (SBE) episodes were captured by an EDE-Q frequency item asking how many times in the past 28 days a participant had eaten an unusually large amount of food and experienced a sense of loss of control over eating. Responses to this item were dichotomized, with all responses at or above a 1 being coded as a 1. This was used to create a dichotomized SBE group, with patients coded as a 1 being placed into the SBE group ( $n=55$ ) and patients coded as a 0 placed into the no SBE group ( $n=106$ ). A summary of the demographic, biological, and psychosocial information for each group is presented in Table 1.

Independent-sample *t* tests were first calculated to examine differences in mean MMPI-2-RF scores and %TWL between participants in the ED risk versus no ED risk group and participants in the SBE versus no SBE group. Effect sizes (i.e., Cohen's *d*) were calculated to identify small (0.20), medium (0.50), and large (0.80) mean differences between the groups.

Relative Risk Ratios (RRRs) were then calculated for multiple MMPI-2-RF Substantive Scale score cut-offs (i.e., 55T, 60T, and 65T) to determine which MMPI-2-RF scales were associated with an increased risk for ED symptoms. RRRs were calculated by dividing the risk of being classified into the ED group for participants who scored at or above the MMPI-2-RF scale score cut-off by the risk of participants who scored below the cut-off. RRRs were considered statistically significant if the 95% Confidence Interval (CI) did not include 1.

## Results

Results of the independent-samples *t*-tests indicated significant mean differences in %TWL between the groups. The ED risk group lost significantly less ( $p=0.002$ ,  $d=0.50$ ) weight (19.36% TWL) than the no ED risk group (25.18% TWL). The SBE group lost significantly less ( $p<0.001$ ,  $d=0.69$ ) weight (17.98% TWL) than the no SBE group (25.57% TWL).

As hypothesized, the ED risk and no ED risk groups had significant mean differences on MMPI-2-RF scales measuring internalizing and externalizing dysfunction, with the ED risk group scoring significantly higher (Table 2). The groups exhibited small to medium differences (i.e., Cohen's  $d<0.50$ ) on the following MMPI-2-RF scales: Behavioral/

**Table 1** Summary of sample characteristics

	Eating disorder (ED) risk groups		Subjective binge eating (SBE) groups	
	No ED risk ( $n=100$ )	ED risk ( $n=61$ )	No SBE ( $n=106$ )	SBE ( $n=55$ )
Age	56.69 (10.43)	57.92 (10.56)	56.73 (10.29)	58.42 (10.80)
Gender	35% men, 65% women	23% men, 77% women	31% men, 69% women	29% men, 71% women
Race	71% White, 27% Black, 2% Latino	67% White, 31% Black, 2% Latino	70% White, 28% Black, 2% Latino	69% White, 29% Black, 2% Latino
Surgery type	76% RYGB, 21% SG, 3% other procedure	72% RYGB, 25% SG, 3% other procedure	75% RYGB, 24% SG, 1% other procedure	75% RYGB, 20% SG, 5% other procedure
Preop BMI	45.77 (7.88)	47.36 (8.63)	47.08 (8.70)	45.00 (6.96)
BES score	11.38 (7.33)	14.19 (8.55)	11.48 (7.97)	14.38 (7.50)
BED	14%	20%	13.3%	21.8%
MDD	7%	11.5%	9.4%	7.3%
GAD	3%	3.3%	3.8%	1.8%
PTSD	1%	4.9%	2.8%	1.8%
BD	0%	3.3%	0%	3.6%
PD	0%	0%	0%	0%
AUD	1%	0%	0.9%	0%
SUD	0%	0%	0%	0%
Postop BMI	34.25 (7.42)	38.28 (9.17)	35.10 (8.57)	37.10 (7.79)
%TWL	25.18 (10.76)	19.36 (12.37)	25.57 (11.67)	17.98 (10.15)

*Preop BMI* pre-operative body mass index, *BES* Binge Eating Scale, *BED* binge eating disorder, *MDD* major depressive disorder, *GAD* generalized anxiety disorder, *PTSD* post-traumatic stress disorder, *BD* bipolar disorder, *PD* personality disorder, *AUD* alcohol use disorder, *SUD* substance use disorder, *Postop BMI* postoperative body mass index, *%TWL* percent total weight loss

**Table 2** MMPI-2-RF scale score differences between the ED risk groups

Scale	No ED risk ( <i>n</i> = 100)		ED risk ( <i>n</i> = 61)		<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
EID	45	9.81	54	12.01	< .001	.83
BXD	45	7.77	48	8.34	.02	.37
RCd	47	9.13	55	11.55	< .001	.77
RC2	46	10.25	53	12.51	< .001	.64
RC4	47	7.86	50	9.02	.04	.34
RC7	44	8.29	52	10.61	< .001	.81
RC9	43	7.99	48	8.24	.002	.51
SUI	48	7.16	53	12.85	.01	.50
HLP	47	8.49	54	11.76	< .001	.67
SFD	47	8.30	53	12.71	.001	.60
NFC	47	9.40	54	10.68	< .001	.65
STW	47	8.99	55	10.40	< .001	.75
AXY	48	7.10	53	13.37	.003	.53
ANP	47	8.76	51	11.66	.01	.41
BRF	46	6.50	49	8.94	.03	.38
MSF	50	9.07	53	9.03	.06	
JCP	49	9.12	50	10.42	.57	
SUB	45	5.38	47	8.28	.17	
AGG	44	7.85	47	8.37	.02	.38
ACT	44	9.35	46	8.43	.08	
AGGR-r	52	9.93	52	9.32	.81	
DISC-r	45	7.21	47	6.86	.05	.32
NEGE-r	46	8.99	54	11.14	< .001	.83
INTR-r	51	9.41	55	11.24	.04	.33

*M* mean, *SD* standard deviation, *d* Cohen's *d*, *EID* emotional/internalizing dysfunction, *RCd* demoralization, *RC2* low positive emotions, *RC4* antisocial behaviors, *RC7* dysfunctional negative emotions, *RC9* hypomanic activation, *SUI* suicidal/death ideation, *HLP* helplessness/hopelessness, *SFD* self-doubt, *NFC* inefficacy, *STW* stress/worry, *AXY* anxiety, *ANP* anger proneness, *BRF* behavior-restricting fears, *MSF* multiple specific fears, *JCP* Juvenile conduct problems, *SUB* substance abuse, *AGG* aggression, *ACT* activation, *AGGR-r* aggressiveness-revised, *DISC-r* disconstraint-revised, *NEGE-r* negative emotionality/neuroticism-revised, and *INTR-r* introversion/low positive emotionality-revised

Externalizing Dysfunction (BXD), Antisocial Behaviors (RC4), Anger Proneness (ANP), Behavior Restricting Fears (BRF), Aggression (AGG), Disconstraint-revised (DISC-r), and Introversion/Low Positive Emotions-revised (INTR-r). The groups exhibited medium to large differences (i.e., Cohen's  $d=0.50-0.79$ ) on the following MMPI-2-RF scales: Demoralization (RCd), Low Positive Emotions (RC2), Hypomanic Activation (RC9), Suicide/Death Ideation (SUI), Helplessness/Hopelessness (HLP), Self-Doubt (SFD), Inefficacy (NFC), Stress/Worry (STW), and Anxiety (AXY). Lastly, the groups exhibited large differences (i.e., Cohen's  $d\geq 0.80$ ) on the following MMPI-2-RF scales: Emotional/Internalizing Dysfunction (EID), Dysfunctional Negative Emotions (RC7), and Negative Emotionality/Neuroticism-revised (NEGE-r). Results of the independent-samples *t* tests indicated significant mean differences on MMPI-2-RF scales measuring internalizing and externalizing dysfunction between the SBE and no SBE groups, with the SBE group

scoring significantly higher (Table 3). The groups exhibited small to medium differences (i.e., Cohen's  $d\leq 0.50$ ) on the following MMPI-2-RF scales: EID, RCd, RC7, SUI, HLP, NFC, STW, Activation (ACT), and NEGE-r.

The RRR analyses indicated that varying elevations (i.e., scores at or above 55T, 60T, or 65T) on a number of internalizing and an externalizing dysfunction scale indicated an increased risk (1.55–2.55 times the risk) of belonging to the ED group (Table 4). For example, a score at or above 65T on RC7 was associated with a 2.55 times increased risk of being in the ED risk group. Additionally, elevations on EID, RCd, RC2, SUI, HLP, SFD, NFC, STW, AXY, ANP, BRF, SUB, and NEGE-r were associated with an increased risk for being in the ED risk group. The RRR analyses also indicated that varying elevations on a number of internalizing scales and an externalizing scale indicated an increased risk (1.62–2.20 times the risk) of SBE (Table 5). For example, a score at or above 60T on SUI was associated with 2.20 times increased

**Table 3** MMPI-2-RF scale score differences between the SBE groups

Scale	No SBE ( <i>n</i> = 106)		SBE ( <i>n</i> = 55)		<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
EID	46	10.69	51	12.49	.01	.42
BXD	46	7.84	48	8.47	.12	
RCd	48	9.75	53	11.92	.003	.49
RC2	48	11.06	51	12.52	.05	
RC4	47	8.27	49	8.52	.09	
RC7	45	9.31	49	10.65	.01	.41
RC9	44	8.22	46	8.37	.11	
SUI	48	7.80	52	12.98	.05	.36
HLP	48	8.97	53	11.98	.002	.50
SFD	48	9.42	51	12.45	.09	
NFC	48	9.67	53	10.90	.003	.50
STW	49	9.33	52	11.29	.03	.34
AXY	49	9.41	50	11.87	.49	
ANP	47	9.21	50	11.54	.08	
BRF	47	7.07	48	8.60	.27	
MSF	51	9.15	53	8.98	.15	
JCP	49	9.08	51	10.49	.16	
SUB	45	6.72	47	6.45	.15	
AGG	45	8.35	46	7.87	.81	
ACT	43	8.23	47	10.12	.01	.41
AGGR-r	52	9.83	52	9.46	.84	
DISC-r	45	7.12	47	7.10	.12	
NEGE-r	48	9.65	52	11.90	.01	.41
INTR-r	52	9.83	54	10.97	.27	

risk of BE. Additionally, elevations on EID, RCd, RC2, HLP, SFD, NFC, STQ, ACT, and NEGE-r were associated with an increased risk for BE.

## Discussion

The current study examined weight loss differences between postoperative patients classified as at-risk or not at-risk for an ED and patients who did or did not report SBE. Overall, patients exhibited significant long-term total weight loss (17.98–25.57%). However, patients in the ED risk and SBE groups lost significantly less total weight than the patients not at ED risk or not engaging in SBE. These results are consistent with previous research that found worse weight loss trajectories were associated with ED symptoms and behaviors [7, 9, 10, 13, 14]. The current study adds to the long-term outcome literature and highlights an important area for clinical focus. Preoperative assessment of ED symptoms and behaviors is common in bariatric evaluations. Postoperative re-assessment is less common but may be a critical opportunity to intervene to optimize surgical outcomes.

The current study also examined MMPI-2-RF scale score differences between the ED and SBE groups. Several

MMPI-2-RF scale score cut-offs were also examined as indicators of ED group membership. As hypothesized, scores on MMPI-2-RF scales measuring internalizing and externalizing dysfunction were associated with greater likelihood of ED risk and engaging in SBE. This is consistent with previous research that found associations between ED symptoms and both internalizing and externalizing psychopathology [20, 21, 31–34]. Research has also found that a considerable number of patients experience postoperative psychosocial dysfunction [35–38].

Within the emotional/internalizing domain, facets of the Demoralization and Dysfunctional Negative Emotions scales were associated with ED risk and SBE. Higher scores on the Demoralization and facet scales (i.e., Suicidal/Death Ideation, Helplessness/Hopelessness, Self-Doubt, and Inefficacy) are indicative of feeling sad and unhappy, dissatisfaction with one's life circumstances, feeling overwhelmed, feeling insecure and inferior, having a lack of confidence, feeling useless, passivity, and indecisiveness [39]. Higher scores on Dysfunctional Negative Emotions and its associated facet scales (i.e., Stress/Worry, Anxiety, Anger Proneness, and Negative Emotionality/Neuroticism-revised) are indicative of experiencing various negative emotions such as anxiety, anger, and fear. Moreover, patients with higher scores on

**Table 4** Significant MMPI-2-RF relative risk ratios for ED Risk

Scale	Cutoff	SR	Risk if elevated	Risk if not elevated	RRR	95% CI
EID	65	11.2%	72.2%	33.6%	2.15	(1.49, 3.11)
EID	60	13.7%	72.7%	32.4%	2.25	(1.58, 3.19)
EID	55	25.5%	61.0%	30.0%	2.03	(1.41, 2.93)
RCd	65	11.8%	73.7%	33.1%	2.23	(1.56, 3.18)
RCd	60	18.6%	60.0%	32.8%	1.83	(1.25, 2.68)
RCd	55	28.0%	60.0%	29.3%	2.05	(1.41, 2.96)
RC2	65	9.3%	66.7%	34.9%	1.91	(1.25, 2.91)
RC2	60	16.8%	59.3%	33.6%	1.76	(1.19, 2.61)
RC2	55	23.0%	59.5%	31.5%	1.89	(1.30, 2.74)
RC7	65	5.6%	88.9%	34.9%	2.55	(1.86, 3.5)
RC7	60	14.3%	60.9%	34.1%	1.79	(1.20, 2.67)
RC7	55	19.3%	64.5%	31.5%	2.05	(1.42, 2.94)
SUI	65	17.4%	64.3%	32.3%	1.99	(1.37, 2.88)
SUI	60	17.4%	64.3%	32.3%	1.99	(1.37, 2.88)
SUI	55	17.4%	64.3%	32.3%	1.99	(1.37, 2.88)
HLP	65	9.9%	68.8%	34.5%	1.99	(1.34, 2.97)
HLP	60	20.5%	63.6%	31.3%	2.04	(1.41, 2.93)
HLP	55	20.5%	63.6%	31.3%	2.04	(1.41, 2.93)
SFD	65	14.9%	66.7%	32.8%	2.03	(1.40, 2.94)
SFD	60	14.9%	66.7%	32.8%	2.03	(1.40, 2.94)
SFD	55	22.4%	58.3%	32.0%	1.82	(1.25, 2.66)
NFC	60	16.8%	70.4%	31.3%	2.25	(1.58, 3.19)
NFC	55	22.4%	61.1%	31.2%	1.96	(1.36, 2.83)
STW	65	16.1%	65.4%	32.6%	2.01	(1.39, 2.9)
STW	60	16.1%	65.4%	32.6%	2.01	(1.39, 2.9)
STW	55	24.8%	60.0%	30.6%	1.96	(1.36, 2.84)
AXY	65	7.5%	75.0%	34.9%	2.15	(1.45, 3.19)
AXY	60	7.5%	75.0%	34.9%	2.15	(1.45, 3.19)
AXY	55	28.6%	54.3%	31.3%	1.74	(1.19, 2.54)
ANP	65	10.6%	64.7%	34.7%	1.86	(1.23, 2.83)
ANP	60	10.6%	64.7%	34.7%	1.86	(1.23, 2.83)
ANP	55	15.5%	60.0%	33.8%	1.77	(1.19, 2.64)
BRF	55	28.0%	51.1%	32.8%	1.56	(1.06, 2.30)
SUB	55	13.0%	57.1%	35.0%	1.63	(1.06, 2.52)
NEGE-r	65	9.3%	66.7%	34.9%	1.91	(1.25, 2.91)
NEGE-r	60	14.9%	75.0%	31.4%	2.39	(1.70, 3.35)
NEGE-r	55	25.5%	61.0%	30.0%	2.03	(1.41, 2.93)

SR selection ratio, RRR relative risk ratio, CI confidence interval

these scales are likely to be stress-reactive, anger-prone, guilt-prone, self-critical and experience excessive worrying and intrusive ideation [39]. While fewer and smaller in magnitude, scores on the behavioral/externalizing dysfunction scales measuring substance abuse, activation, and disconstraint were associated with ED risk and SBE. Higher scores on the Substance Abuse scale are indicative of a history of or current problematic substance use. Higher scores on the Activation scale are indicative of heightened excitation and energy levels. Higher scores on the Disconstraint-revised

scale are indicative of under-controlled behaviors, engaging in acting-out behaviors, and sensation- and excitement-seeking. These results are consistent with previous literature finding significant comorbidity between BED and substance abuse [40, 41]. Moreover, these results are consistent with previous research indicating that disinhibited behavior is associated with loss of control over eating (a component of BE) and is also thought to play a role in Substance Use Disorders [8, 42]. Overall, the current findings are consistent with previous research and demonstrate that sub-clinical



**Table 5** Significant MMPI-2-RF relative risk ratios for subjective binge eating

Scale	Cutoff	SR	Risk if elevated	Risk if not elevated	RRR	95% CI
EID	65	11.2%	61.1%	30.8%	1.99	(1.28, 3.09)
EID	60	13.7%	59.1%	30.2%	1.96	(1.27, 3.01)
RCd	65	11.8%	52.6%	31.7%	1.66	(1.02, 2.71)
RC2	65	9.3%	60.0%	31.5%	1.90	(1.18, 3.07)
RC2	60	16.8%	55.6%	29.9%	1.86	(1.22, 2.85)
SUI	65	17.4%	50.0%	30.8%	1.62	(1.03, 2.54)
SUI	60	17.4%	50.0%	30.8%	1.62	(1.03, 2.54)
SUI	55	17.4%	50.0%	30.8%	1.62	(1.03, 2.54)
HLP	65	9.9%	62.5%	31.0%	2.01	(1.28, 3.16)
HLP	60	20.5%	54.5%	28.9%	1.89	(1.25, 2.85)
HLP	55	20.5%	54.5%	28.9%	1.89	(1.25, 2.85)
SFD	65	14.9%	54.2%	30.7%	1.77	(1.13, 2.76)
SFD	60	14.9%	54.2%	30.7%	1.77	(1.13, 2.76)
NFC	60	16.8%	51.9%	30.6%	1.69	(1.09, 2.64)
NFC	55	22.4%	52.8%	28.8%	1.83	(1.21, 2.77)
STW	55	24.8%	50.0%	28.9%	1.73	(1.14, 2.62)
ACT	65	4.3%	71.4%	32.5%	2.20	(1.31, 3.70)
ACT	60	4.3%	71.4%	32.5%	2.20	(1.31, 3.70)
NEGE-r	60	14.9%	54.2%	30.7%	1.77	(1.13, 2.76)
NEGE-r	55	25.5%	48.8%	29.2%	1.67	(1.10, 2.54)

psychopathology (i.e., < 65T) is associated with ED-related symptoms and behaviors.

Assessing and targeting postoperative psychosocial dysfunction could reduce postoperative PEBs and EDs and subsequently improve other surgical outcomes (e.g., weight loss). The current study has several clinical implications through the identification of specific and narrowly-defined targets of postoperative clinical intervention within the broad internalizing and externalizing dysfunction domains. Patients scoring higher on facets of Demoralization, with lower self-esteem and self-efficacy, may be more prone to feel dissatisfied with the change, or lack of change, in their body shape and weight and may feel overwhelmed by and ineffective at managing their diet and weight postoperatively. As such, postoperative interventions aimed at increasing self-esteem and self-efficacy may help improve body image satisfaction and patients' belief about their abilities to implement long-term, sustainable diet and lifestyle changes. Postoperatively, patients' attention is likely to shift to focus on eating, body composition, and weight management. Patients scoring higher on facets of Dysfunctional Negative Emotions may excessively worry and ruminate about eating and their body given their pre-operative disposition to experience negative emotions and self-evaluation. This may manifest in ways such as guilt about eating, fear of weight gain, dissatisfaction with body weight and shape, and avoidance or rules about eating. Additionally, the associations between these scales and SBE are consistent with the emotion regulation

theory of Binge Eating Disorder (BED); [43]. Therefore, postoperative interventions focused on increasing stress management, decreasing excessive rumination and worry, and increasing coping skills may decrease susceptibility to ED symptoms and behaviors. Patients with disinhibited behavior who score higher on scales measuring substance abuse, activation, and disconstraint are at risk of treatment nonadherence [39]. A lack of adherence and engagement with treatment may lead to problematic eating behaviors postoperatively, as these patients may be less likely to follow recommendations and and/or rebel against team guidelines. These patients may also be less likely to reach out to the bariatric team if they do experience problematic eating and/or psychosocial dysfunction. Thus, patients may benefit from enhanced postoperative outreach (e.g., routine check-ins, additional interventions) to reinforce and sustain their adherence to the recommended postoperative protocol.

The current study has several limitations and considerations for future research. The psychosocial data used in this study were based solely on self-report. Future research should aim to include other sources of information such as clinician or informant ratings. The current study was limited to one outcome timepoint. Future research should include multiple assessments of postoperative eating behaviors and psychopathology to examine longitudinal changes and relationships. Another limitation is the sample. The majority of patients contacted did not participate in the study. It is possible that patients experiencing greater postoperative

distress were more or less likely to participate in the study. Future research is warranted to examine the replicability and generalizability of the current results.

Overall, patients exhibited significant weight loss at approximately 6-years postoperative. However, patients who experienced postoperative ED symptoms and behaviors lost significantly less total weight compared to patients without ED symptoms. Additionally, postoperative ED symptoms and behaviors are related to, and may be impacted by, higher levels of internalizing and externalizing dysfunction. Postoperative assessment of and interventions targeting psychosocial dysfunction could decrease ED symptoms and behaviors and increase engagement in the postoperative treatment protocol to maximize surgical outcomes and improve patients' overall well-being.

## What is already known on this subject?

Although research has demonstrated that problematic eating behaviors (PEBs) and eating disorders (EDs) generally decrease pre- to post-bariatric surgery, a considerable number of patients still report PEBs and/or meet criteria for an ED postoperatively. PEBs and EDs have been found to be associated with worse weight loss trajectories. Therefore, this study aimed to identify psychosocial variables associated with ED symptoms and behaviors to identify targets for postoperative interventions to reduce these behaviors and further optimize surgery outcomes.

## What your study adds?

Patients in the ED groups lost significantly less total weight than the patients not at ED risk. Scores on MMPI-2-RF scales measuring facets of internalizing (demoralization and dysfunctional negative emotions) and externalizing dysfunction (substance abuse, activation, and disconstraint) were associated with greater likelihood of ED risk. Postoperative assessment of and interventions targeting these specific facets of psychosocial dysfunction could decrease ED symptoms and behaviors, maximize surgical outcomes, and improve patients' overall well-being.

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**Data availability** The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Code availability** Not applicable.

## Compliance with ethical standards

**Conflict of interest** Yossef Ben-Porath is a paid consultant to the MMPI-2-RF publisher, the University of Minnesota Press, and distributor, Pearson Assessments. As co-author of the MMPI-2-RF, he receives royalties on sales of MMPI-2-RF materials, consulting fees, and research grants from the MMPI-2-RF publisher.

**Ethics approval** The study was approved by the Cleveland Clinic's Institutional Review Board (IRB). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

**Consent to participate** Informed consent was obtained from all individual participants included in the study.

**Consent for publication** Participants consented to publishing data from this study.

## References

1. Chang S, Stoll C, Song J, Varela J, Eagon C, Colditz G (2014) The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003–2012. *JAMA Surg* 149(3):275–287
2. Nancy P, Thomas B, Helen G, Ryan G, Steven H, Edward H (2014) Long-term follow-up after bariatric surgery: a systematic review. *JAMA* 312(9):934–942
3. O'Brien P, MacDonald L, Anderson M, Brennan L, Brown W (2013) Long-term outcomes after bariatric surgery: fifteen-year follow-up of adjustable gastric banding and a systematic review of the bariatric surgical literature. *Ann Surg* 257(1):87–94
4. Mechanick J, Apovian M, Brethauer S (2020) Clinical practice guidelines for the perioperative nutritional, metabolic, and non-surgical support of the bariatric surgery patient—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* 16:175–247
5. Sogg S, Lauretti J, West-Smith L (2016) Recommendations for the presurgical psychosocial evaluation of bariatric surgery patients. *Surg Obes Relat Dis* 12:731–749
6. Conceição E, Utzinger L, Pisetsky E (2015) Eating disorders and problematic eating behaviours before and after bariatric surgery: characterization, assessment and association with treatment outcomes. *Eur Eat Disord Rev* 23(6):417–425. <https://doi.org/10.1002/erv.2397>
7. Pizato N, Botelho P, Gonçalves V, Dutra E, De Carvalho K (2017) Effect of grazing behavior on weight regain post-bariatric surgery: a systematic review. *Nutrients* 9(12):1322. <https://doi.org/10.3390/nu9121322>
8. Sarwer D, Allison K, Wadden T et al (2019) Psychopathology, disordered eating, and impulsivity as predictors of outcomes of bariatric surgery. *Surg Obes Rel Dis* 15(4):650–655
9. Devlin M, King W, Kalarchian M et al (2016) Eating pathology and experience and weight loss in a prospective study of bariatric surgery patients: 3-year follow-up. *Int J Eat Disord* 49(12):1058–1067
10. Conceição E, Mitchell J, Vaz A, Bastos A, Ramalho S, Silva C et al (2014) The presence of maladaptive eating behaviors after



- bariatric surgery in a cross sectional study: importance of picking or nibbling on weight regain. *Eat Behav* 15(4):558–562. <https://doi.org/10.1016/j.eatbeh.2014.08.010>
11. Marino J, Ertelt T, Lancaster K, Steffen K, Peterson L, de Zwaan M, Mitchell J (2012) The emergence of eating pathology after bariatric surgery: a rare outcome with important clinical implications. *Int J Eat Disord* 45(2):179–184
  12. White M, Kalarchian M, Masheb R, Marcus M, Grilo C (2010) Loss of control over eating predicts outcomes in bariatric surgery patients: a prospective, 24-month follow-up study. *J Clin Psychiatry* 71(2):175–184. <https://doi.org/10.4088/JCP.08m04328blu>
  13. Meany G, Mitchell J, Conceição E (2014) Binge eating, binge eating disorder and loss of control eating: effects on weight outcomes after bariatric surgery. *Eur Eat Dis Rev* 22(2):87–91
  14. Sheets C, Peat C, Berg K, White E, Bocchieri-Ricciardi L, Chen E, Mitchell J (2015) Post-operative psychosocial predictors of outcome in bariatric surgery. *Obes Surg* 25:330–345. <https://doi.org/10.1007/s11695-014-1490-9>
  15. Himes S, Grothe K, Clark M, Swain J, Collazo-Clavell M, Sarr M (2015) Stop regain: a pilot psychological intervention for bariatric patients experiencing weight regain. *Obes Surg* 25(5):922–927. <https://doi.org/10.1007/s11695-015-1611-0>
  16. Papalazarou A, Yannakoulia M, Kavouras S, Komesidou V, Dimitriadis G, Papakonstantinou A, Sidossis L (2010) Lifestyle intervention favorably affects weight loss and maintenance following obesity surgery. *Obesity* 18(7):1348–1353. <https://doi.org/10.1038/oby.2009.346>
  17. Marek R, Ben-Porath Y, Van Dulmen M, Ashton K, Heinberg L (2017) Using the preoperative psychological evaluation to predict 5-year weight loss outcomes in bariatric surgery patients. *Surg Obesity Relat Dis* 3(3):514–21
  18. Ben-Porath Y, Tellegen A (2008/2011) The Minnesota multiphasic personality inventory-2 restructured form (MMPI-2-RF): manual for administration, scoring, and interpretation. Minneapolis, Minnesota: University of Minnesota Press
  19. Tellegen A, Ben-Porath YS (2008/2011) The Minnesota multiphasic personality inventory-2 restructured form (MMPI-2-RF): technical manual. Minneapolis, Minnesota: University of Minnesota Press
  20. Marek R, Ben-Porath Y, Merrell J, Ashton K, Heinberg L (2014) Predicting one and three month postoperative somatic concerns, psychological distress, and maladaptive eating behaviors in bariatric surgery candidates with the Minnesota Multiphasic Personality Inventory-2 Restructured Form (MMPI-2-RF). *Obes Surg* 24(4):631–639
  21. Marek R, Ben-Porath Y, Ashton K, Heinberg L (2014) Minnesota multiphasic personality inventory-2 restructured form (MMPI-2-RF) scale score differences in bariatric surgery candidates diagnosed with binge eating disorder versus BMI-matched controls. *Int J Eat Disord* 47(3):315–319. <https://doi.org/10.1002/eat.22194>
  22. Marek R, Tarescavage A, Ben-Porath Y, Ashton K, Rish J, Heinberg L (2015) Using presurgical psychological testing to predict 1-year appointment adherence and weight loss in bariatric surgery patients: predictive validity and methodological considerations. *Surg Obes Rel Dis* 11:1171–1181
  23. Marek R, Williams G, Mohun S, Heinberg L (2017) Surgery type and psychosocial factors contribute to poorer weight loss outcomes in persons with a body mass index greater than 60 kg/m<sup>2</sup>. *Surg Obes Rel Dis* 13(12):2021–2026
  24. Tarescavage A, Wygant D, Boutacoff L, Ben-Porath Y (2013) Reliability, validity, and utility of the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) in assessments of bariatric surgery candidates. *Psychol Assess* 25(4):1179–1194
  25. Fairburn CG, Cooper Z (1993) The eating disorder examination. In: Fairburn CG, Wilson GT (eds) *Binge eating: nature, assessment and treatment*. New York, NY, Guilford, pp 317–360
  26. Elder K, Grilo C, Masheb R, Rothschild B, Burke-Martindale C, Brody M (2006) Comparison of two self-report instruments for assessing binge eating in bariatric surgery candidates. *Behav Res Ther* 44(4):545–560
  27. Kalarchian M, Wilson G, Brolin R, Bradley L (2000) Assessment of eating disorders in bariatric surgery candidates: self-report questionnaire versus interview. *Int J Eat Disord* 28(4):465–469
  28. Marek R, Heinberg L, Lavery M, Rish J, Ashton K (2016) A review of psychological assessment instruments for use in bariatric surgery evaluations. *Psych Assess* 9:1142–1157
  29. Carter J, Stewart D, Fairburn C (2001) Eating disorder examination questionnaire: norms for young adolescent girls. *Behav Res Ther* 39(5):625–632. [https://doi.org/10.1016/S0005-7967\(00\)00033-4](https://doi.org/10.1016/S0005-7967(00)00033-4)
  30. Mond J, Hay P, Rodgers B, Owen C (2006) Eating Disorder Examination Questionnaire (EDE-Q): norms for young adult women. *Behav Res Ther* 44(1):53–62. <https://doi.org/10.1016/j.brat.2004.12.003>
  31. Farstad S, McGeown L, von Ranson K (2016) Eating disorders and personality, 2004–2016: a systematic review and meta-analysis. *Clin Psych Rev* 46:91–105. <https://doi.org/10.1016/j.cpr.2016.04.005>
  32. Goodpaster K, Marek R, Lavery M, Ashton K, Merrell Rish J, Heinberg. (2016) Graze eating among bariatric surgery candidates: prevalence and psychosocial correlates. *Surg Obes Rel Dis* 12(5):1091–1097. <https://doi.org/10.1016/j.soard.2016.01.006>
  33. Martin-Fernandez K, Ben-Porath Y (2019) Associations among eating disorder symptoms and the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) in college students. *Eat Weight Disord—Stud Anorex Bulim Obes*
  34. Wonderlich S, Connolly K, Stice E (2004) Impulsivity as a risk factor for eating disorder behavior: assessment implications with adolescents. *Int J Eat Disord* 36(2):172–182. <https://doi.org/10.1002/eat.20033>
  35. Castaneda D, Popov V, Wander P, Thompson C (2019) Risk of suicide and self-harm is increased after bariatric surgery—a systematic review and meta-analysis. *Obes Surg* 29(1):322–333
  36. King W, Chen J, Mitchell J, Kalarchian M, Steffen K, Engel S et al (2012) Prevalence of alcohol use disorders before and after bariatric surgery. *JAMA* 307(23):2516–2525
  37. Mitchell J, King W, Chen J, Devlin M, Flum D, Garcia L et al (2014) Course of depressive symptoms and treatment in the longitudinal assessment of bariatric surgery (LABS-2) study. *Obesity* 8:1799
  38. Morgan D, Kwok H, Platell C (2019) Incidence and determinants of mental health service use after bariatric surgery. *JAMA Psychiatry* 77(1):60–67
  39. Ben-Porath Y (2012) *Interpreting the MMPI-2-RF*. University of Minnesota Press, Minneapolis, Minnesota
  40. Becker D, Grilo C (2015) Comorbidity of mood and substance use disorders in patients with binge-eating disorder: associations with personality disorder and eating disorder pathology. *J Psychosom Res* 79(2):159–164. <https://doi.org/10.1016/j.jpsychores.2015.01.016>
  41. Bulik C, Klump K, Thornton L, Devlin B, Kaye W, Kaplan A et al (2004) Alcohol use disorder comorbidity in eating disorders: a multicenter study. *J Clin Psychiatry* 65(7):1000–1006. <https://doi.org/10.4088/JCP.v65n0718>
  42. Smith J, Mattick R, Jamadar S, Iredale J (2014) Deficits in behavioural inhibition in substance abuse and addiction: a meta-analysis. *Drug Alcohol Depend* 145:1–33. <https://doi.org/10.1016/j.drugalcdep.2014.08.009>
  43. Kenny T, Singleton C, Carter J (2017) Testing predictions of the emotion regulation model of binge-eating disorder. *Int J Eat Disord* 50(11):1297–1305