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ORIGINAL CONTRIBUTIONS

Overvaluation of Shape and Weight (Not BMI) Associated with Depressive Symptoms and Binge Eating Symptoms Pre- and Post-bariatric Surgery

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Abstract

Purpose Overvaluation of shape and weight (OSW) involves defining self-worth by body shape/weight. Among persons seeking bariatric surgery, cross-sectional studies have found associations between OSW, depressive symptoms, and disordered eating.

Materials and Methods Relationships among OSW, depressive symptoms, binge eating symptoms, and BMI were analyzed both cross-sectionally and over time among 145 adults who had bariatric surgery. Participants completed the following measures pre-surgery and 1.5 to 3 years post-surgery: Eating Disorder Examination Questionnaire (EDE-Q), Binge Eating Scale, Patient Health Questionnaire, and body weight and height. OSW was measured by averaging two items on the EDE-Q which ask participants to rate how much their weight/shape influences how they judge themselves as a person. Analyses included Wilcoxon signed-ranks, bootstrapped Pearson correlations, and bootstrapped hierarchical linear regressions.

Results OSW was significantly associated with depressive symptoms and binge eating symptoms both pre- and post-surgery, but was not associated with BMI at either timepoint. Improvements in OSW were associated with concurrent changes in depression and binge eating; reductions in BMI were not significantly associated with changes in any of these variables.

Conclusions Findings suggest that self-evaluation is more important in regard to changes in depressive and binge eating symptoms than is BMI (and vice versa), and support the importance of assessing and treating psychological considerations among persons seeking bariatric surgery.

Keywords Bariatric Surgery · Obesity · overvaluation · depression · Binge eating · Outcomes · body image

Key Points
- Overvaluation of shape/weight was associated with depression and binge eating pre- andpost-bariatric surgery.
- Reduction in overvaluation over time was associated with improved depression and binge eating post-surgery.
- Reduction in BMI post-surgery was not related to improvements in overvaluation, depression, or binge eating.

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Introduction

Overvaluation of shape and weight (OSW) is characterized by disproportionately basing one's self-worth on body shape and weight [1, 2]. It is a core component of eating disorder psychopathology [1, 3–5], but individuals without an eating disorder can also present with OSW. For example, 23–53% of adults with obesity who deny disordered eating report experiencing OSW [6–8], and up to a third of bariatric surgery candidates report poor body image as a primary reason for pursuing surgery [9]. OSW is associated with depressive symptoms and maladaptive eating behaviors (e.g., loss of control eating) both pre- and post-bariatric surgery [2, 10, 11]. Binge eating is the most commonly studied disordered eating behavior among bariatric surgery candidates [12], with 14–56% of patients reporting this behavior pre-surgery and 3–37% post-surgery [13]. Women who report both binge eating symptoms *and* OSW experience higher levels

of psychological distress, poorer psychosocial functioning, and greater eating disorder pathology compared to women with binge eating symptoms *without* OSW [14].

The term OSW falls under the umbrella construct of body image disturbance, which encompasses several subtypes such as OSW, dissatisfaction with shape and weight, preoccupation with shape and weight, and fear of weight gain [15–17]. The most commonly studied sub-categories have shown both similarities and differences in their potential clinical significance. For example, OSW has been shown to differentiate participants with eating disorders from those without to a greater degree than other body image constructs such as weight/shape concern and body dissatisfaction [18, 19]. Additionally, Grilo and colleagues [17] found that in a sample of adults with overweight/obesity, OSW was more strongly related to depressive symptoms than were other body image variables. Wade and associates [20] also found that OSW was more related to self-esteem than were body dissatisfaction or BMI and other studies have reported similar findings (e.g., [19, 21, 22]). The connection between OSW and depressive symptoms such as low self-esteem is not surprising, as OSW goes deeper than simply disliking one's appearance: it is believing that one's shape and weight is central to self-worth.

The handful of studies that have evaluated OSW among persons seeking bariatric surgery have shown significant cross-sectional associations between OSW, depressive symptoms, and binge eating symptoms both pre- [1, 10] and post-surgery [2]. Additionally, in a pre-post study, Masheb and colleagues [11] found that OSW significantly correlated with negative affect and low self-esteem pre- and 6 months post-surgery. However, despite improvements in both OSW and BMI, improvements in OSW were *not* significantly associated with reductions in BMI. Similarly, a cross-sectional study by Ivezaj and colleagues [2] found a significant association between OSW and loss-of-control eating, depressive symptoms, and disordered eating symptoms but *not* BMI post-surgery. In contrast, Felske and colleagues [23] reported improvements in weight-related self-esteem (a different, but related, construct to OSW) were significantly associated with percent total weight loss 1 year post-bariatric surgery.

Improvements in body image in general have been shown to be significantly related to weight loss post-surgery [24–26], particularly within the first postoperative year [25]. For example, in their sample of patients receiving gastric bypass surgery, Sarwer and colleagues [26] found significant improvements in body image and reported that changes in body image correlated with percent weight lost post-surgery. Furthermore, in a systematic review of the literature, Bertoletti and colleagues [27] concluded that while general body image evaluation improves after surgery, these improvements may not be equal across all dimensions of the construct (e.g., 28). For example, Yiu and associates [29] reported that while overall body dissatisfaction was associated with both binge eating disorder and overweight status in a sample of women, overvaluation was related to BED diagnostic status *independent* of weight status. Overall, these findings suggest that while the general body image construct has been associated with weight change in bariatric samples, OSW in particular is more related to psychological constructs such as mood and disordered eating than to body weight.

The current study builds upon prior research by assessing the changes in and relationships among OSW, depressive symptoms, and binge eating symptoms 1.5 to 3 years post-bariatric surgery. Specifically, this study sought to (1) replicate cross-sectional associations among these variables pre- and post-surgery; (2) describe changes in OSW and its relationship to changes in depressive and binge eating symptoms from pre- to post-surgery; and (3) determine whether pre-surgery OSW and/or changes in OSW predict depressive and binge eating symptoms post-surgery beyond baseline measurement of these variables, BMI, and time since surgery. The authors hypothesized that (1) OSW would be correlated with higher levels of depressive and binge eating symptoms pre- and post-surgery; (2) reductions in OSW would be associated with reductions in depressive and binge eating symptoms from pre- to post-surgery; and (3) higher pre-surgical OSW and smaller improvements in pre- to post-OSW would predict depressive and binge eating symptoms post-surgery.

Methods

Patients and Procedures

All patients pursuing bariatric surgery through a large academic medical center completed pre-surgical measures as part of their routine preoperative standardized comprehensive clinical psychological evaluations. De-identified data were entered into an encrypted clinical research database [30, 31]. Patients who completed the pre-surgical assessments and underwent bariatric surgery (Roux-en-Y gastric bypass or sleeve gastrectomy; $n = 354$) were contacted by mail and email 1.5 to 3 years post-surgery and invited to participate in a follow-up study. Of these, 148 participants provided consent and completed the survey (41.8% response rate). There were no differences between patients who did and did not respond to the follow-up study based on baseline demographics, binge eating, or attendance of follow-up surgical visits. However, rates of baseline depressive symptoms were higher among patients who did not respond to the follow-up questionnaires ($t(244.58) = 2.19$, $p = 0.02$, $r_{pb} = 0.153$; see McGarrity et al., 2019 [32] for additional details on study procedures). Of those who responded,

three participants did not have body weight data available and were excluded from the current analyses, resulting in a final sample of 145 participants (81.4% female; 87.6% White; mean baseline age = 42.0 ± 12.3 years; mean baseline BMI = 45.0 ± 6.5 kg/m^2). All study procedures were approved by the University of Utah IRB.

Measures

Demographics and Covariates

Self-reported age, sex, race/ethnicity, and height were collected at pre-surgery assessments. Pre-surgery weight was collected via electronic medical record at the timepoint closest to the patient's surgery. Self-reported weight was collected via post-surgery questionnaire; when self-reported weight was not available (2 participants), data was pulled from participants' medical record. Body mass index (BMI) was calculated using weight and height pre- and post-surgery.

Overvaluation of Shape and Weight

As described in prior studies [1, 5, 11, 33], OSW was measured using items 22 and 23 on the Eating Disorders Examination-Questionnaire (EDE-Q): "On how many of the past 28 days has your *weight* influenced how you think about (judge) yourself as a person?" and "On how many of the past 28 days has your *shape* influenced how you think about (judge) yourself as a person?" Similar to previous studies [1, 5, 11, 33], these two items were averaged to create an OSW score. The two items were correlated at $r(143) = 0.89$, and 0.85 at baseline and follow-up, respectively ($ps < 0.001$). Prior studies have reported good test–retest reliability for these items (Spearman rho = 0.68 for weight and 0.78 for shape) [34] and have found them to be a valid measure of weight/shape overvaluation [18]. While most studies looking at OSW in bariatric samples have used the average score described above (pre-surgery means ranging from 3.5 ± 2.0 to 3.7 ± 1.8) [1, 11, 33], Ivezaj and colleagues [2] reported weight and shape overvaluation scores separately (weight overvaluation: 6 months post-surgery mean = 2.8 ± 2.0; shape overvaluation: $M = 2.7 \pm 2.1$). Therefore, the current study analyzed results using both approaches. A cutoff score of 4 (moderate to marked influence of shape and weight on self-concept) for clinical significance was used in the current study, consistent with Ivezaj and colleagues [2].

Depressive Symptoms

The Patient Health Questionnaire (PHQ-9) was used for measuring depressive symptoms. The 9 items in this questionnaire are based on diagnostic criteria for depression from the DSM-5 including anhedonia, depressed mood, sleep disturbance, fatigue, appetite changes, low self-esteem, concentration difficulty, psychomotor changes, and suicidal ideation. This scale has been validated for use in medical populations, including bariatric surgery candidates [35]. Cronbach's α for the current study was 0.88, and 0.89 for baseline and follow-up, respectively.

Binge Eating Symptoms

The 16-item Binge Eating Scale (BES) [36] was used to measure propensity toward binge eating. Symptoms include eating past fullness, emotional or boredom eating, cravings, preoccupation with food, and perceived control over food intake. The BES has high internal consistency and is reliable and valid in identifying persons both in the general population [37] and seeking bariatric surgery [38, 39] who may be at risk for binge eating disorder. Cronbach's α for the current study was 0.89 and 0.90 for baseline and follow-up, respectively.

Analyses

Analyses were conducted using SPSS Version 27. Sample characteristics and hypotheses were analyzed using descriptives, Pearson correlations, one-way ANOVAs, *T*-tests, and hierarchical linear regressions. Non-parametric corrections (e.g., Wilcoxon signed-ranks or bootstrapping to 1,000 samples) were used for variables that were not normally distributed. For the BES and PHQ-9 analyses, mean scores were used in place of sum scores as outcome variables for each participant (e.g., if a participant scored 9 on the PHQ-9, their response mean of 1 would have been used in all analyses). These were calculated by dividing each participant's sum score by the number of questions answered.

Results

Table 1 includes descriptive statistics for the sample. At baseline, 40.7% of the sample endorsed OSW above the cutoff score of 4 (moderate to marked influence of shape and weight on self-concept) for clinical significance [2], and the mean OSW response was 3.20 ± 1.75 on a scale of 0 to 6 (just below "moderate" influence). Baseline shape overvaluation

Table 1 Participant baseline demographics ($n = 145$)

	M ± *SD*
Age (years)	42.0 ± 12.3
BMI (kg/m^2)	45.0 ± 6.5
Time since surgery (years)	2.3 ± 0.4
	N (%)
Sex	
Female	118 (81.4%)
Male	27 (18.6%)
Race	
African-American	3 (2.1%)
Caucasian	127 (87.6%)
Hispanic	10 (6.9%)
Other	3 (2.1%)
No response	2 (1.4%)

BM body mass index

and weight overvaluation means were 3.12 ± 1.80 and 3.21 ± 1.82, respectively. Bootstrapped bivariate Pearson correlations and one-way ANOVAs showed no significant associations between baseline OSW and BMI, age, gender, or race ($ps > 0.05$).

Pre-surgery OSW, depressive symptoms, and binge eating symptoms were all positively correlated, but none were associated with BMI. Post-surgery, OSW was correlated with depression and binge eating symptoms, but not BMI. Post-operative depression and binge eating symptoms were positively correlated with each other and with BMI (Table 2). Wilcoxon signed-rank tests showed significant reductions in OSW ($Z = -3.55$, $p < 0.001$), depressive symptoms ($Z = -2.89$, $p = 0.004$), binge eating symptoms ($Z = -5.41$, $p < 0.001$), and BMI ($Z = -10.44$, $p = < 0.001$) from pre- to post-surgery (Table 3).

In hierarchical regression analyses, full models were run investigating the association of pre-surgery OSW with post-surgery depression and binge eating symptoms, while accounting for pre-surgery depression or binge eating (in corresponding model), and covariates (time since surgery, change in BMI). The following blocks were entered in separate hierarchical regressions predicting post-surgery depressive symptoms and binge eating symptoms: (1) baseline depressive and binge eating symptoms, respectively; (2) time since surgery, BMI change; (3) baseline OSW. In these models, only baseline depressive symptoms and binge eating symptoms were significant predictors of post-surgery depressive and binge eating symptoms, respectively ($ps < 0.001$). Identical models replacing baseline OSW with pre- to post-surgery changes in OSW were then run, and results indicated that *changes* in OSW were significantly associated with post-surgery depressive symptoms and binge eating symptoms. In other words, greater improvements in OSW were associated with concurrent improvements in depression and binge eating symptoms, above and beyond the effects of covariates and baseline measure of the outcome (Table 4).

Finally, post hoc analyses of the opposite direction were conducted to better understand the directional relationships between variables. The same hierarchical regression analyses were used in four additional models: (1) baseline depressive symptoms predicting post-surgery OSW, (2) baseline binge eating symptoms predicting post-surgery OSW, (3) change in depressive symptoms predicting post-surgery OSW, and (4) change

Table 2 Correlations between OSW, depression, binge eating, and BMI

Pre-surgery	1	2	3	4
1. OSW	–	.582***	.497***	.038
2. Depressive symptoms			.422***	.065
3. Binge eating symptoms				.119
4. BMI				-
Post-surgery				
1. OSW	–	.481***	.400***	.087
2. Depressive symptoms			.529***	.301***
3. Binge eating symptoms				.352***
4. BMI				-
Change				
1. OSW	–	.520***	.481***	.013
2. Depressive symptoms			.527***	.055
3. Binge eating symptoms				.117
4. BMI				-

***$p < .001$; **$p < .01$; *$p < .05$; $df = 143$

Table 3 Changes in disordered eating, depressive symptoms, and BMI

	Pre-surgery M ± SD *(n)*	Post-surgery M ± SD *(n)*
BMI (kg/m^2)	45.0 ± 6.5 *(145)*	31.3 ± 6.5 *(145)***
Overvaluation of shape and weight (EDE-Q)	3.2 ± 1.8 *(144)*	2.6 ± 1.9 *(145)***
Overvaluation of shape	3.1 ± 1.8 *(147)*	2.5 ± 2.0 *(148)***
Overvaluation of weight	3.2 ± 1.8 *(148)*	2.6 ± 1.9 *(148)***
Depressive symptoms (PHQ-9)	6.7 ± 5.3 *(135)*	5.7 ± 5.6 *(143)***
Binge eating symptoms (BES)	14.7 ± 7.4 *(139)*	11.3 ± 7.5 *(139)***

Psychosocial questionnaires presented above as total/sum scores; however, analyses used mean scores to preserve sample size ($n = 145$ for all variables in analyses)

***$p < .001$; **$p < .01$; *$p < .05$

EDE-Q Eating Disorders Examination-Questionnaire, *PHQ-9* Patient Health Questionnaire, *BES* Binge Eating Scale

Table 4 Hierarchical linear regressions with change in overvaluation as independent variable

Depression as outcome	*b*	SE	*β*	ΔR^2	*p*
Step 1					
Constant	.305	.072			
Pre-surgery depressive symptoms	.432	.089	.404	.163	< .001
Step 2					
Constant	.452	.355			
Pre-surgery depressive symptoms	.424	.091	.397		
BMI change	.011	.011	.096		
Years since surgery	.002	.115	.001	.009	.459
Step 3					
Constant	.415	.319			
Pre-surgery depressive symptoms	.587	.084	.341		
BMI change	.009	.010	.099		
Years since surgery	-.011	.106	.010		
Overvaluation change	.133	.027	.096	.142	< .001
Binge eating as outcome					
Step 1					
Constant	.317	.083			
Pre-surgery binge eating symptoms	.401	.089	.386	.149	< .001
Step 2					
Constant	.259	.246			
Pre-surgery binge eating symptoms	.396	.088	.380		
BMI change	.009	.008	.112		
Years since surgery	.086	.087	.079	.020	.179
Step 3					
Constant	.227	.228			
Pre-surgery binge eating symptoms	.519	.083	.498		
BMI change	.009	.007	.110		
Years since surgery	.073	.083	.068		
Overvaluation change	.095	.017	.379	.130	< .001

in binge eating symptoms predicting post-surgery OSW. Results mirrored those in the above models, in that neither baseline depressive nor binge eating symptoms significantly predicted post-surgery OSW, but *changes* in both variables were significantly associated with post-surgery OSW. In other words, improvements in depressive symptoms and improvements in binge eating symptoms were associated with improvements in OSW post-surgery. Again, BMI change and time since surgery were insignificant in all models. Finally, all hierarchical regression models were used again to evaluate shape and weight overvaluation separately. These analyses produced the same pattern of results as the above a priori and post hoc tests.

Discussion

The current findings replicate and extend those in previous studies, which have reported significant associations of OSW with depressive symptoms and binge eating symptoms both pre- [1, 10, 11] and post-surgery [2, 11]. While the hypothesis regarding pre-surgery OSW as a predictor of depressive and binge eating symptoms post-surgery was not supported, pre- to post-surgery *reductions* in OSW were associated with reduced depressive symptoms and binge eating symptoms 1.5 to 3 years post-surgery. Post hoc analyses showed similar results in the opposite direction: neither pre-surgery depression nor binge eating predicted post-surgery OSW, but *changes* in these variables were significant, indicating concurrent improvements among these variables independent of changes in BMI.

These findings suggest that there may be a common factor (or multiple factors) contributing to the results that were not controlled for in the current study. Masheb et al. [11] found that the relationship between OSW and negative affect 6 months post-bariatric surgery was no longer significant after controlling for self-esteem. The authors concluded that low self-esteem may explain much of the relationship between OSW and depressive symptoms. This is not surprising, considering that OSW involves basing one's self-esteem largely on body shape and weight, which surgical patients are actively working to change. Self-esteem has also been associated with disordered eating, including binge eating [40], and is worth examining in future studies to determine its potential predictive value in regard to changes in OSW, depression, and binge eating post-bariatric surgery.

Moreover, a body of work has previously demonstrated that patients' expectations of postoperative outcomes tend to be unrealistic, often expecting weight loss and quality of life outcomes that exceed those commonly possible after surgery [41]. Researchers have hypothesized that these unrealistic expectations may also play a role in the relationship between bariatric surgery and negative postoperative psychological outcomes, as failure to achieve a particular "goal" weight or quality of life negatively impacts psychological health [42]. Future research is necessary to examine whether the postoperative change in OSW, depressive symptoms, and binge eating symptoms are influenced by unrealistic expectations prior to surgery, and whether providers' attempts to facilitate a more grounded understanding of possible outcomes can soften this relationship.

None of the analyses found a significant relationship between BMI and OSW, or change in BMI and change in OSW. Prior research on OSW has reported similar findings [2], and the literature shows an inconsistent relationship

between body image and weight [23, 43, 44]. Furthermore, BMI reduction was not significantly associated with improvements in depressive symptoms or binge eating. Together, these results suggest that changes in patients' self-concept were more closely tied to mood and eating behaviors than weight loss, and that mood and eating behaviors were in turn more closely tied to self-concept than weight loss. These findings are consistent with prior literature in bariatric samples [45, 46].

A few limitations should be acknowledged. First, this study used validated self-report measures of symptoms, rather than standardized clinical interviews assessing diagnostic criteria for depression and binge eating disorder. Hence, shared method variance could contribute to the observed associations. Relatedly, there is a possibility of reporter bias in that patients may be less likely to report symptoms to their bariatric team that could be seen as inconsistent with their weight loss goals (e.g., binge eating). There is also the potential of self-selection bias, as less than half of patients who were eligible for this study decided to participate (low response rate), and those who did may have had more confidence in their postoperative outcomes. Relatedly, self-reported weights were used post-surgery due to participants filling out the follow-up measures outside of the medical clinic. However, prior research has demonstrated a high degree of agreement between self-reported and measured body weight among bariatric samples [47–49], and suggests that self-reported weights can be used when measured weights are unavailable [49]. Another limitation is that the current study did not account for amount of weight regain post-surgery, and thus could not control for patients' current trajectory of weight loss or regain. Additionally, the main findings are an association between concurrent changes at two time points and there was no control/comparison group; thus, causation cannot be determined. Finally, while the sample's demographics were similar to the overall patient population, as well as patients in the local catchment area of this program, generalizability to the general population (with greater racial/ethnic diversity in particular) is limited. Despite limitations, the current study builds upon prior research on OSW in bariatric samples by describing the changes in and relationships between OSW, depressive symptoms, and binge eating symptoms pre- and post-bariatric surgery.

The current study documented significant associations between changes in OSW, depressive symptoms, and binge eating symptoms pre- and post-bariatric surgery, independent of changes in BMI. These results suggest that self-evaluation is more important in regard to changes in depressive and binge eating symptoms than is BMI, and vice versa. Future studies should identify factors other than weight (e.g., self-esteem, adherence, coping strategies, post-surgical expectations) that may contribute to changes in OSW, depression, and binge eating post-bariatric surgery. Future research may also evaluate the effects of therapeutic interventions for OSW, depressive symptoms, and binge eating symptoms on long-term psychological outcomes.

Declarations

Ethics Declaration Institutional Review Board approval was obtained prior to the conduct of this research. As this was a retrospective study, informed consent for research participation was deemed exempt by the Institutional Review Board. This work has not been previously published, and consent to submit has been received from all co-authors and responsible authorities at the institution where this work has been carried out. 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 declaration and its later amendments or comparable ethical standards.

Conflict of Interest Paige Martinez was a site coordinator for a clinical trial led by Rhythm Pharmaceuticals. All other authors (Gordon, Terrill, Smith, Ibele, and McGarrity) declare that they have no conflict of interest.

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