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Factor Structure and Predictive Utility of the Binge Eating Scale in Bariatric Surgery Candidates

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Abstract

Background—Screening for binge eating prior to bariatric surgery is a component of recommended clinical practice for bariatric surgery candidates. The Binge Eating Scale (BES) is one of the most commonly used self-report measures of eating behaviors in pre-surgical evaluations, yet the factor structure of this measure has not been evaluated in this population.

Objectives—The aims of this study were to report the means, standard deviations, and reliability of the BES for patients seeking bariatric surgery; to evaluate the two-factor structure of the BES using confirmatory factor analysis; and to investigate the association between the BES and its factors with surgical weight loss.

Setting—Academic Medical Center.

Methods—530 patients completed the BES as a component of their psychological evaluation prior to undergoing Roux-en-Y gastric bypass surgery.

Results—Approximately one-third of patients reported at least mild to moderate binge eating, with 9% of patients reporting severe binge eating on the BES. The BES demonstrated good internal consistency. Results of a confirmatory factor analysis indicated that a two-factor structure, consisting of Feelings/Cognitions related to binge eating and Behavioral manifestations of binge eating, was the best fit to the data. Non-significant correlations were found between the BES and its two factors with short-term post-surgical weight loss.

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Conclusions—The BES measures two aspects of binge eating in bariatric surgery candidates, feelings/cognitions and behavioral manifestations of binge eating. Consideration of these factors in patients presenting for bariatric surgery may allow for a more detailed understanding of binge eating in this population.

Keywords

Binge eating; Binge eating disorder; Binge Eating Scale; Bariatric; Gastric bypass; Psychological assessment

Clinical or subclinical levels of binge eating are common in patients presenting for bariatric surgery, found in between six and 64% of patients¹. Best practices for the behavioral and psychological care of bariatric surgery candidates include the use of standardized empirically validated assessments of binge eating prior to surgery, consisting of self-report screening questionnaires and follow-up with a brief standardized interview². A survey of actual clinical practices in the assessment of bariatric surgery candidates found that among those who use a self-report screening questionnaire of eating behaviors, the Binge Eating Scale (BES) was the most commonly used measure³.

The BES⁴ is a 16-item self-report measure that was designed to assess two components of binge eating: behavioral manifestations (e.g., eating quickly, overeating) and emotions/cognitions that precede or follow a binge (e.g., feeling out of control, guilt). The BES items were created based on the Diagnostic and Statistical Manual of Mental Disorders, third edition (DSM-III) criteria for binge eating and the clinical experiences of the measure's authors. The BES was found to have good validity and internal consistency in the original normative samples, consisting of overweight women seeking behavioral treatment for obesity⁴. Subsequent research has shown that the BES is particularly accurate in identifying non-binge eaters, making it beneficial for screening purposes⁵. While the BES is not designed to assess for the presence of binge eating disorder (BED), in one of the few studies that has evaluated the concordance between the BES and BED in bariatric surgery candidates, we previously found the BES to have a high sensitivity (and adequate specificity) in identifying individuals with BED⁶. This association further supports the potential benefits of using the BES as a screening measure in pre-bariatric surgery psychological evaluations.

Despite its wide use, the psychometric properties of the BES in bariatric surgery candidates are not well known. Few studies have reported basic descriptive statistics and reliability data for the BES for this patient population. Furthermore, although the BES was designed to assess two components of binge eating, it has almost exclusively been used as a unidimensional measure of binge eating severity through the measure's total score. The total score is used to differentiate between individuals with absent to minimal binge eating, mild to moderate binge eating, and severe binge eating^{4,7}. When the measure was initially developed, Gormally and colleagues⁴ suggested that eight of the BES items described feelings/cognitions and eight items described behavioral manifestations of binge eating. However, this initial study did not report the scale assignment for each item, which may be a factor in its common use as a uni-dimensional measure. In one exception, Timmerman⁸

analyzed “behavior” and “feelings” items separately in order to establish the validity and reliability of the BES in a sample of binge eaters (defined as individuals who endorsed binge eating as least twice per month). Items were categorized based on their face-validity (e.g., attending to words such as “habit” and phrases such as “I feel”). To our knowledge, despite the frequent use of the BES in weight loss research^{8,9}, no studies to date have confirmed the two factor structure proposed in the initial development of the BES.

Despite the frequent assessment of binge eating as part of pre-surgical evaluations, the impact of pre-surgery binge eating on post-surgical weight loss is unclear. A recent review article reported that the majority of studies suggest no association between pre-surgical binge eating and post-surgical weight loss, though multiple studies have also found either negative or positive associations¹⁰. These variations in results may be due to a number of factors, including methodological differences between studies (e.g., use of different assessment measures of binge eating and weight loss, retrospective versus prospective designs) and the timing of follow-up weight loss measurements.

Interpreting post-surgical outcomes is further complicated by the fact that the restrictive components of bariatric surgeries limit the ability for patients to meet the behaviorally-focused “large amount of food” criteria for binge eating post-surgery. For example, multiple studies of binge eating behavior found that rates of BED over 10 years post-surgery increased (even doubling) when modified criteria omitting the “large amount of food” component was used versus use of the full BED criteria^{11,12}. In their 4-year post-surgery follow-up, Kalarchian and colleagues¹³ focused on the “loss of control” rather than the “large amount of food” criteria to define binge eating via a self-report measure. In doing so, they found that 46% of their participants qualified as “binge eaters” using the modified “loss of control” criteria. While binge eaters and non-binge eaters did not differ in post-operative body mass index (BMI) change in that study, those classified as “binge eaters” had regained significantly more weight than their non-binge eater counterparts. Together these data suggest that reliable assessment of binge eating, including the aspects of binge eating (i.e., behaviors versus feelings/cognitions) that may be differentially associated with post-operative eating behaviors, is needed. Better understanding of the association between binge eating and bariatric surgery outcomes will facilitate the best long-term care for bariatric surgery patients.

The aims of this study were 1) to report mean, standard deviation, and reliability data for the BES in patients seeking bariatric surgery, 2) to evaluate the two-factor structure of the BES using confirmatory factor analysis, and 3) to evaluate the association between the BES factors and surgical weight loss outcomes up to 12 months post surgery.

Methods

Participants

Participants were 530 consecutive patients presenting for psychological evaluation prior to undergoing Roux-en-Y gastric bypass surgery (RYGB) at an urban academic medical center. The majority of participants (84.0%) were female, with BMIs ranging from 34.9–84.4 ($M = 50.7$, $SD = 9.2$) and ages ranging from 18–67 ($M = 41.9$, $SD = 10.4$). Approximately half of

participants (52.3%) were African American, 36.6% were Caucasian, and 9.4% were Hispanic.

Measures

The Binge Eating Scale (BES⁴)—Each of the BES's 16 items contains 3 to 4 response options reflecting a range of severity for each characteristic measured (see Table 1 for sample items). Possible total scores range from 0 to 46, with higher scores indicating more severe binge eating symptoms. Scores are categorized as absent or minimal binge eating (score = 17), mild to moderate binge eating (score of 18 to 26), and severe binge eating (score = 27)⁷. In previous studies using the BES in bariatric surgery candidates, average pre-surgical mean scores ranged from 12.4 to 22.3, with 9% to 33% of patients scoring in the severe binge eating range and 30% to 55% endorsing at least some binge eating symptoms (scores >17)^{14–19}. The BES has been shown to have adequate two-week test-retest reliability ($r=.87$)⁸. While not designed as a measure of BED, we previously found the BES to have a high sensitivity (correctly identifying 78% of patients with BED using a cut-score of 17) and adequate sensitivity for identifying BED in bariatric surgery patients⁶.

Procedure

Patients completed a pre-surgical psychological evaluation with a clinical psychologist. The evaluation consisted of written questionnaires, including the BES as the standard measure of binge-eating-related cognitions and behaviors, and a semi-structured psychosocial interview. The interview assessed areas of functioning relevant for bariatric surgery patients, including weight and diet history, current eating habits, emotional eating, DSM-IV-based assessment of binge eating disorder, psychiatric history (including presence of anorexia, bulimia, and night eating syndrome), and knowledge about surgery. Weight loss data were obtained for patients who attended follow up appointments with the bariatric surgeon at 3-, 6-, and 12-months post-surgery. This study was Institutional Review Board approved.

Statistical Analysis

Based on Gormally's initial description of the measure, it was hypothesized that the BES included two factors: a Feelings/Cognitions factor and a Behavioral factor. Given that the item loading for each factor was not described in the original scale development paper, a four-person panel (including three clinical psychologists and one research assistant who have extensive training and experience working with individuals with binge eating concerns) independently assigned each item to one of the two proposed factors based on clinical and research knowledge of binge eating. Full consensus was reached on 14 of 16 items. Encouragingly, factor assignment ratings on these 14 items were also identical to the factor assignments given by Timmerman⁸. For the two items for which the panel had initial non-convergent ratings (items 12 and 16), consensus was ultimately reached following group discussion and these items were assigned to the Feelings/Cognitions factor.

Based on this information, confirmatory factor analysis (CFA) was conducted to examine the factor structure of the BES using Mplus version 6²⁰. Full information maximum likelihood estimation was applied to handle missing data (covariance coverage exceeded .96%) and the robust weighted least squares estimator (WLSMV; this estimator accounts for non-normal

categorical distributions) was used given the categorical response options in the BES²¹. Five goodness-of-fit indices were used to evaluate the adequacy of the models tested: the comparative fit index (CFI)²², the Tucker Lewis Index (TLI)^{23,24}, the weighted root mean square residual (WRMR), and the root mean square of approximation (RMSEA)²⁵. Values equal to, or greater than, .95 for the CFI and TLI, and values equal to or lower than .05 for the RMSEA and values close to 1.0 for the WRMR, were considered indicators of excellent model goodness-of-fit^{22,26–28}. Nested CFA models were compared with mean and variance adjusted χ^2 difference tests using the DIFFTEST option in Mplus 6.1, with a *p* value set at .05.

In order to evaluate the predictive utility of the BES, Pearson correlations were calculated between the BES and post-operative weight loss, measured in percentage of excess weight loss (%EWL).

Results

BES Descriptives

The mean total score on the BES was 13.4 (SD=8.5, range 0 to 39). The distribution of responses within the established cutoffs were: 67% “absent to minimal binge eating” (scores of 0 to 17), 24% “mild to moderate binge eating” (scores of 18 to 26), and 9% “severe binge eating” (scores greater than 26). In this sample, the Cronbach’s alpha for the total score was .87, indicating good internal consistency.

Factor Structure of the BES

First we specified a base model against which several alternative nested models were evaluated. The fit statistics of all models tested are shown in Table 2. Model 1 was a one-factor model that specified that all items loaded on a single factor, consistent with the common interpretation of the scale as a summative score. We next specified Model 2, which loaded each item on either a Feelings/Cognitions or Behaviors factor based on the content of the item (see Table 3). As can be seen in Table 2, both models evidenced adequate model fit. However, given the initial lack of consensus among our panel members regarding scale assignment for items 12 and 16, we decided to further evaluate the model by examining the CFA modification indices. There were large modification indices for item 16 that suggested this item was best allocated to the Behaviors factor and that item 10, despite initially being labeled as a Feelings/Cognitions item by our panel, was most appropriate on the Behaviors factor as well. We fit a modified two-factor model (Model 3) that incorporated these changes and inspection of the various fit indices indicated that Model 3 demonstrated superior fit to the data. Furthermore, the results of the chi-square difference test supported the overall superior fit of this particular model when compared to the one-factor model ($\chi^2 = 47.17$, *df* 1, *p* < .001). The factor loadings for each item in Model 3 are shown in Table 3. Based on scores calculated from items found in the best-fitting model, mean scores were 7.6 (SD=5.4, range of 0 to 25) on the Feelings/Cognitions factor and 5.7 (SD=3.8, range of 0 to 16) on the Behaviors factor. The Feelings/Cognitions factor was composed of items 1, 3, 6, 7, 12, 14, and 15, while the Behaviors factor included items 2, 4, 5, 8, 9, 10, 11, 13, and 16. The Cronbach’s alpha was .79 for each of the two factors, indicating good internal consistency.

Skewness (0.39 to 0.64) and kurtosis (−0.26 to −0.62) were acceptable for the BES total and each factor.

BES and Bariatric Surgery Outcome

Pearson correlations were conducted to examine the association between the BES and its factors with weight loss outcomes at 3-, 6-, and 12-months post-surgery. Weight loss data were available for a subset of patients at each time point (N=204 at 3 months, N=178 at 6 months, N=142 at 12 months). Data were missing primarily due to patients not undergoing surgery or failing to schedule or attend follow up appointments. T-test comparisons indicated that patients with outcome data did not significantly differ from patients without outcome data on the total BES score ($p=.88$) or the behavioral ($p=.93$) or feelings/cognitions ($p=.74$) factors scores, suggesting that the groups were not significantly different in terms of binge eating at baseline. Average weight loss at each time point was as follows: 24.8 kg (8.9 BMI reduction, 17.6% weight lost, 37.4% excess weight lost) at 3 months, 38.2 kg (13.7 BMI reduction, 26.6% weight lost, 54.3% excess weight lost) at 6 months, and 47.4 kg (17.2 BMI reduction, 33.7% weight lost, 69.3% excess weight lost) at 12 months. No significant correlations were found between the BES total score or either of its factors with percent excess weight lost at any time point (Table 4).

Discussion

Results of this study suggest that the Binge Eating Scale (BES) is a reliable measure that identifies approximately one third of patients seeking bariatric surgery at an urban medical center as having at least mild to moderate self-reported binge eating behaviors or cognitions. Notably, this number might underrepresent the true presence of binge eating in this population, as there is the potential for socially desirable responding in patients presenting for a required psychological evaluation. A previous study of this sample found that only 7% of the sample responded to objective measures in a way that would suggest the presence of positive impression management²⁹. However, the rate of binge eating found in this study is consistent with rates found in other studies of bariatric surgery candidates¹.

To our knowledge, the BES has never undergone a formal factor analysis despite the fact that Gormally and colleagues⁴ initially suggested that the measure was designed to assess two components of binge eating. Results of the confirmatory factor analysis indicated that in this population of bariatric surgery candidates, one-factor and two-factor models provided adequate fit to the data, though the two factor model of Feelings/Cognitions and Behaviors provided a statistically superior fit. This suggests that, in addition to the commonly used unidimensional interpretation of the BES total score to determine severity of binge eating symptoms, clinicians may gain further detail about binge eating symptoms by evaluating scores on the Feelings/Cognitions and Behaviors factors. Evaluating patients' responses on both factors may lead to more tailored and effective treatment approaches.

Agreement on the fit of each item in the model based on the opinions of a panel of raters and on the factor analysis was reached on 13 of 16 items. Full agreement was not reached for three items (10, 12, and 16). An examination of these items revealed elements of both behaviors and feelings/cognitions, particularly in the response options that indicate more

significant pathology. For example, the first response option for item 10, which measures participants' control of their eating, describes the observable behavior of ceasing to eat. However, the latter response options tap into the notion that not feeling in control of one's behaviors is distressing. This may reflect the complexity of the binge eating experience, with the complicated interaction of emotions (such as embarrassment, disgust, guilt, etc.), cognitions, and behaviors.

The role of different facets of binge eating is particularly of interest in understanding the experience of patients undergoing bariatric surgery, given the impact of restrictive surgeries on the likelihood that patients will meet the behaviorally-focused "large amount of food" criteria for binge eating post-surgery. In her study of the validity and reliability of the BES in overweight binge eaters, Timmerman⁸ found that the BES was associated with measures of subjective and objective binge eating, but not with total caloric intake. From this, she posited that the most appropriate use of the BES may be to measure uncontrolled eating episodes when the amount consumed is not of interest, making use of the BES particularly appropriate with bariatric surgery patients. Timmerman's findings support other studies that have identified the "loss of control" criterion for binge eating as persisting following bariatric surgery and being predictive of post-surgical weight regain¹³. This loss of control criterion is likely to be captured by the Feelings/Cognitions factor of the BES, rather than the Behavioral factor. Thus, examining the BES factor scores identified in this study may aid in isolating specific aspects of binge eating that are predictive of poorer post-surgical outcomes.

Results from this study suggest that pre-surgical binge eating symptoms were not significantly associated with weight loss up to one year post-surgery. This is consistent with conclusions from a recent meta-analysis¹⁰ and a prospective observational study³⁰ suggesting that pre-surgical binge eating does not negatively impact weight loss outcomes one year post surgery. Given that loss of control has been suggested as the most appropriate criterion by which to measure binge eating pathology post-surgery and that binge eating has been associated with greater long-term weight regain, future research should evaluate the association between different binge eating factors and long-term weight loss maintenance to determine whether the two BES factors found in this study are differentially predictive of weight regain. Such analyses should investigate weight loss and regain beyond 2 years post-surgery, as research suggests that it is around this time that the negative impact of loss of control on weight outcomes begins to occur.^{1,12}

It is important to note that the participants in this study all underwent Roux-en-Y gastric bypass surgery, therefore these results can not necessarily be generalized to patients who have undergone other bariatric surgeries. This is an important area for future research given the varying impact of eating behaviors on outcomes in different surgeries. The potential impact of pre-operative psychological treatment on weight loss outcomes is an additional important factor to consider in interpreting this study's results, as studies suggest that patients with BED who respond positively to pre-operative treatment for binge eating achieve improved weight loss outcomes compared to non-responders^{31,32}. Of the participants in this study who had outcome data available, a small percentage (N=5) underwent psychotherapeutic treatment (range of 1 to 14 sessions) with the study authors

prior to surgery. Correlational analyses excluding these participants did not change the results found in the study (all correlations increased slightly but remained non-significant). It is possible that other participants received treatment for binge eating at outside facilities; therefore the potential impact of such treatment on the study results is unknown at this time.

Conclusion and Future Directions

As the original BES scale development paper does not specify the item assignment for each binge eating component measured by the scale, we recommend additional evaluation of the factor structure of the BES in other populations. Based on the empirical results from the present study, however, the BES does appear to measure feelings/cognitions and behaviors in bariatric surgery patients. If further validation studies support this factor structure, this would support the interpretation of the BES as consisting of two subscales, in addition to the commonly used unidimensional interpretation. Future research should explore whether identification of these factors can improve prediction of post-surgical binge eating symptoms and long-term weight reduction. Compared to other studies using the BES with bariatric surgery candidates, the mean total BES score for this sample was on the lower end in terms of severity. This restriction of range may have impacted our ability to identify associations between the BES and short-term surgical weight loss; therefore future research should also investigate these associations in other samples.

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Table 1

Sample BES items

Item	Text*
1	<p>1 I don't feel self-conscious about my weight or body size when I'm with others.</p> <p>2 I feel concerned about how I look to others, but it normally does not make me feel disappointed with myself.</p> <p>3 I do get self-conscious about my appearance and weight which makes me feel disappointed in myself.</p> <p>4 I feel very self-conscious about my weight and frequently, I feel intense shame and disgust for myself. I try to avoid social contacts because of my self-consciousness.</p>
2	<p>1 I don't have any difficulty eating slowly in the proper manner.</p> <p>2 Although I seem to "gobble down" foods, I don't end up feeling stuffed because of eating too much.</p> <p>3 At times, I tend to eat quickly and then I feel uncomfortably full afterwards.</p> <p>4 I have the habit of bolting down my food, without really chewing it. When this happens, I usually feel uncomfortably stuffed because I've eaten too much.</p>
3	<p>1 I feel capable of controlling my eating urges when I want to.</p> <p>2 I feel like I have failed to control my eating more than the average person.</p> <p>3 I feel utterly helpless when it comes to feeling in control of my eating urges.</p> <p>4 Because I feel so helpless about controlling my eating, I have become very desperate about trying to get in control.</p>

* Instructions: Below are a group of numbered statements. Read all of the statements in each group and circle the one that best describes the way you feel about the problems you have controlling your eating behavior.

Note. Full text of all BES items can be found in Gormally, Black, Daston, and Rardin (1982).

Table 2

Binge Eating Scale Confirmatory Factor Analysis

Model	df	χ^2	CFI	TLI	RMSEA	WRMR	χ^2 test comparing model 1 and 3
1	104	298.78	.96	.96	.06	1.17	
2	103	291.09	.96	.96	.06	1.16	
3	103	236.10	.97	.97	.05	1.03	47.17, df 1, $p < .001$

Note. χ^2 = chi-square test. CFI = comparative fit index. TLI = Tucker Lewis Index. RMSEA = root mean square of approximation. WRMR = weighted root mean square residual. Model 1 = All items on one factor. Model 2 = Items on 2 factors with items 12 and 16 on Feelings/Cognitions. Model 3 = Items on 2 factors with items 10 and 16 on Behaviors. Model in bold is the best fitting model. χ^2 test was not conducted to compare model 2 and 3 as they are non-nested.

Table 3

Item level means, standard deviations, skewness and kurtosis values with standardized factor loadings for the BES two-factor model

BES items	Mean (SD)	Skew	Kurtosis	Factor ^a loadings
Feelings/Cognitions				
1 Self-consciousness about appearance/weight	0.82 (1.09)	1.17	−0.04	0.55
3 Controlling urges to eat	0.90 (1.04)	1.08	−0.01	0.74
6 Feelings of guilt/self-hate	0.87 (0.92)	1.21	0.81	0.65
7 Losing control followed by over eating	1.31 (1.21)	0.02	−1.65	0.75
12 Eating habits in public/private	0.50 (0.73)	1.65	2.71	0.64
14 Thoughts about urges to eat	0.96 (0.93)	0.63	−0.55	0.73
15 Thoughts about food	0.86 (0.86)	0.93	0.38	0.73
Behaviors				
2 Difficulty eating slowly, rate of intake	1.15 (1.06)	0.20	−1.38	0.56
4 Eating when bored	0.16 (0.54)	3.13	7.83	0.65
5 Hunger cues	0.86 (0.70)	0.53	0.25	0.61
8 Quantity of food, feeling “stuffed” after eating	1.02 (0.90)	0.25	−1.15	0.71
9 Patterns of restricting/overeating	1.04 (0.98)	0.16	−1.49	0.64
11 Stopping eating when satiated	0.58 (0.78)	1.23	0.86	0.78
13 Regularity of eating habits	0.62 (0.65)	0.67	−0.19	0.50
10 Hunger cues/urges to eat	0.91 (1.21)	0.71	−1.25	0.87
16 Knowledge about nature of own physical hunger	0.83 (1.04)	0.78	0.30	−1.29

^aBased on best fitting model (Model 3)

Table 4

Pearson correlations between total BES score, factor scores, and weight loss

	Pre-Surgical BMI	%EWL		
		3 mos	6 mos	12 mos
Total BES	.06	.08	.04	-.04
Feelings/Cognitions	.06	.05	.002	-.02
Behaviors	.04	.10	.07	-.05

Note. BMI = Body Mass Index. %EWL = percent excess weight loss. BES = Binge Eating Scale.

N at each time point= 204 (3 mos), 178 (6 mos), 142 (12 mos)

All correlations *ns* ($p>.05$)