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Factor Structure and Clinical Utility of the Beck Depression Inventory in Patients with Binge Eating Disorder and Obesity

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Abstract

Objective—The Beck Depression Inventory (BDI) is often used to assess depression symptoms, but its factor structure and clinical utility have not been evaluated in patients with binge eating disorder (BED) and obesity.

Methods—882 treatment-seeking obese patients with BED were administered structured interviews (SCID-I/P) and completed self-report questionnaires.

Results—Exploratory and confirmatory factor analyses supported a brief 16-item BDI version with a three-factor structure (affective, attitudinal, and somatic). Both 21- and 16-item versions showed excellent internal consistency (both $\alpha=0.89$) and had significant correlation patterns with different aspects of eating disorder psychopathology; three factors showed significant but variable associations with eating disorder psychopathology. Area under the curves (AUC) for both BDI versions were significant in predicting major depressive disorder (MDD; AUC=0.773 [16-item], 73.5% sensitivity/70.2% specificity, AUC=0.769 [21-item], 79.5% sensitivity/64.1% specificity) and mood disorders (AUC=0.763 [16-item], 67.1% sensitivity/71.5% specificity, AUC=0.769 [21-item], 84.2% sensitivity/55.7% specificity). 21-item BDI (cut-off score 16) showed higher negative predictive values (94.0% vs. 93.0% [MDD]; 92.4% vs. 88.3% [mood disorders]) than brief 16-item BDI (cut-off score 13).

Conclusions—Both BDI versions demonstrated moderate performance as a screening instrument for MDD/mood disorders in obese patients with BED. Advantages and disadvantages for both versions are discussed. A three-factor structure has potential to inform the conceptualization of depression features.

Keywords

Obesity; Binge Eating Disorder; Depression; Factor Structure

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1. Introduction

Binge-eating disorder (BED), now a formal eating-disorder category in the DSM-5 [1], is defined by regular binge-eating (eating large quantities of food while experiencing a subjective sense of loss of control), marked distress about the binge-eating, and the absence of extreme weight compensatory behaviors that define bulimia nervosa. BED is prevalent (estimated as 2.6% in the United States) [2] and associated strongly with obesity [3]. BED is also associated with heightened biopsychosocial problems and high rates of psychiatric comorbidity [2–4].

Increased risk for psychiatric comorbidity, particularly mood disorders, has been found for obesity [5] and for BED [2, 3]. Individuals with obesity and BED are significantly more likely to have comorbid mood disorders, other psychiatric disorders [6, 7] and medical problems [6] than individuals with obesity without BED. Current mood disorders overall and major depressive disorder (MDD) are generally reported to be found in roughly 20% of patients with BED [4, 8]. The presence of mood disorders and of elevated depressed levels are both associated with more severe BED symptoms [4, 9]. Depression has also been associated with poorer weight loss outcomes after lifestyle modifications [8, 10] and bariatric surgery [10, 11] and with BED outcomes [12], although some have reported no association [13–15]. Some have also suggested that depression symptoms may mediate the relationship between BED and weight loss [16, 17]. Thus, proper screening and identification of mood disorders is important for treatment formulation and intervention for persons with obesity and persons with BED.

Self-report measures of depression symptoms are often used as a quick screening tool. The Beck Depression Inventory (BDI; revised in 1987 as the BDI-1A) [18, 19] remains a widely used measure of depressive symptoms and features in the mental health and obesity fields, including the major Look AHEAD study [20]. The BDI was originally designed as a unidimensional measure, but factor analyses with healthy and medical samples have suggested multi-factor structure with great variations in items representing the factors [see 21, for a review]. The reliability and validity of BDI in assessing depression symptoms and discriminating clinical depression has been well-established in normal and psychiatric populations although there is some variability in the factor structure across psychiatric samples [21]. However, the psychometric properties and validity of the BDI in populations with other medical conditions, including obesity, has been questioned due to difficulties disentangling true depression symptoms from somatic symptoms associated with medical conditions [22, 23]. This issue seems especially important in the case of BED – a psychiatric disorder associated strongly with obesity.

We are unaware of any psychometric studies of the BDI in BED, but there are relevant recent studies with severely obese patients. Hayden and colleagues [24] performed confirmatory factor analyses on BDI data from 285 bariatric surgery candidates testing five different factor solutions reported in the literature for various samples. This study supported two three-factor models; one model consisted of three factors labeled negative self-attitudes, negative mood, and performance impairment, and another with negative self-attitudes, negative mood, and somatic concerns. The clinical utility of the BDI as a screening measure

for mood disorders has also been supported in bariatric surgery candidates with some variation in cut-off score [25, 26], but noted that it significantly over-estimated the potential presence of mood disorders.

To our knowledge, the factor structure and clinical utility of BDI has not yet been tested in obese patients with BED despite the clinical relevance reviewed above (i.e., high co-morbidity rates between BED and mood disorders and heightened severity of BED associated with mood disturbances). Thus, the present study had three aims. First, the study evaluated the factor structure of BDI in treatment-seeking obese patients with BED using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to test and validate it in the other half of the study group. Second, the study evaluated the criterion-related validity of the identified structure in addition to the original 21-item structure. Third, the study assessed the performance of the BDI for identifying current mood disorders and major depressive disorder against the criterion standard of diagnoses generated independently using semi-structured diagnostic interviews.

2. Method

2.1. Participants

Participants were 882 treatment-seeking obese ($BMI \geq 30$ [kg/m²]) patients with DSM-IV-TR [27] BED. Participants were respondents to media ads for treatment studies at a university-based medical school in an urban center. Exclusion criteria included: current treatments for eating/weight disorders (including current anti-depressant medication), severe psychiatric problems (lifetime bipolar disorders and schizophrenia, and current substance dependence), severe medical problems (e.g., cardiac and liver diseases), and uncontrolled hypertension, thyroid conditions, or diabetes. Mean body mass index (BMI) was 38.2 ($SD = 6.5$) (based on measured height and weight using a high capacity digital scale). Participants' mean age was 45.0 ($SD = 10.3$) years, and racial/ethnic composition was 63.1% Caucasian, 22.5% African American, and 14.4% Hispanic/other. 18.5% completed high school, 34.6% attended some college, and 45.5% completed college. Written informed consent was obtained from participants and the research was approved by the Yale Human Investigation Committee.

2.2. Assessment and Measures

Participants were assessed by doctoral-level research-clinicians who were trained and 'certified' by CMG in axis I psychiatric disorder classification, differential diagnosis, eating disorder psychopathology, and in the specific nature and clinical administration of the research assessment interviews. Assessors received on-going supervision and were monitored (e.g., taped) throughout the study to prevent interviewer and diagnostic drift.

The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I/P) [28] was used to assess axis I psychiatric disorders, including BED and non-bipolar mood disorders (major depressive disorder (MDD), dysthymic disorder, and depressive disorder not otherwise specified [NOS]) – which were the focus of this study. Kappa coefficients for MDD and for other mood disorders were 0.80 and 0.76, respectively.

The Eating Disorder Examination interview (EDE) [29] was used to assess eating-disorder psychopathology and to confirm the BED diagnosis. The EDE interview assesses eating-disorder psychopathology with a focus on the previous 28 days, except for diagnostic items that are rated for the DSM-based duration stipulations. The EDE assesses the frequency of different forms of overeating, including objective bulimic episodes (OBE; i.e., binge eating defined as unusually large quantities of food coupled with a subjective sense of loss of control), which corresponds to the DSM-based definition of binge eating. The EDE also comprises four subscales: Restraint, Eating Concern, Shape Concern, and Weight Concern. Questions related to these four scales were rated on a 7-point scale (0–6 range), with higher scores reflecting greater severity or frequency. An EDE global score was calculated as the mean of the four scales. The EDE interview is a well-established measure [30] with good inter-rater and test-retest reliability in studies with BED [31]. Based on 71 subjects, spearman rho coefficient was 0.94 for OBE frequency and .91 for EDE global (range .73 to .93 for the EDE scales).

The BDI (BDI-1A) [18, 19] is a 21-item self-report measure of depression symptoms and levels. Respondents rate the 21 questions regarding severity of depression symptoms for the past week on a 4-point scale (0–3). Although the BDI was further modified (BDI-II) in 1996, the BDI (1-A version revised in 1987) remains a widely used measure of depression symptoms and levels given with its demonstrated reliability and validity across many clinical and non-clinical adult groups [21]. The two versions perform well psychometrically and generally converge [32, 33]. The BDI (1-A) is the depression measure used in the major Look AHEAD obesity study [20] and across clinical [21] and treatment studies of BED [34–36].

2.3. Analysis

First, with randomly-split half of the sample, exploratory factor analysis was completed (EFA) for one to four factor structures ($n = 441$). Next, using the second half of the sample ($n = 441$), confirmatory factor analysis (CFA) was performed to validate the factor structure identified through EFA. Factor analyses were performed using the Mplus version 7 [37]. For both EFA and CFA, a weighted least squared means and variance adjusted (WLSMV) estimator was used because it is suitable for ordinal data [38]. For EFA, a geomin oblique rotation was used, which is a default option in the Mplus. EFA and CFA model fits were evaluated based on the following fit-indices: the comparative fit index (CFI; 0.95), the Tucker-Lewis index (TLI; 0.95), the root mean square error of approximation (RMSEA; 0.05), and the standardized root mean square residual for EFA (SRMR; 0.07) or the weighted root mean square residual for CFA (WRMR; 1.00) [39]. As alternative competing models, the identified model was also compared with the two three-factor models with bariatric surgery candidates showing good fit statistics in the Hayden et al. [24] study. This analysis was completed to evaluate the similarity and differences in the factor structure of the BDI across between treatment-seeking individuals with comorbid BED and obesity and bariatric surgery candidates.

The criterion-related validity of the identified subscales were then examined through correlation analysis between BDI and eating-disorders features, as well as comparison of

BDI scores between those with current MDD vs. no current MDD, and current any mood disorder vs. no current mood disorder. These analyses were completed by the Statistical Analysis System (SAS) (release 9.3, 2002–2010, SAS Institute). Finally, using the receiver operating characteristics (ROC) analysis, we evaluated the accuracy of BDI as a diagnostic tool for MDD and mood disorder in the participants. The area under the curve (AUC) is a measure of the accuracy of the test, suggested as small ($0.5 < \text{AUC} \leq 0.7$), moderate ($0.7 < \text{AUC} \leq 0.9$), and high ($0.9 < \text{AUC} \leq 1$) [40]. The sensitivity, specificity, positive predictive value (PPV; the percentage of truly depressed out of those identified as being depressed), and negative predictive value (NPV; the percentage of those truly nondepressed out of those identified as nondepressed) were calculated for criterion-related validity. The optimal cut-off score was determined by maximizing Youden index ($Y^b = \text{sensitivity} + \text{specificity} - 100$) [41]. The MetCalc (version 12.7.7.0, 1993–2014, MedCalc Software, Belgium) was used for ROC analysis. All validation analyses were completed with the entire sample ($N=882$).

3. Results

3.1. Exploratory Factor Analysis and Confirmatory Factor Analysis

Table 1 summarizes the fit statistics for different factor solutions. While the four-factor solution demonstrated the best overall fit statistics, it was deemed invalid as one of the “factors” comprised only one item. Therefore, the three-factor solution was determined as the best model. Table 2 illustrates the standardized factor loadings of all 21 items for the three-factor solution. Items were assigned to one of the three factors only when they had factor loadings greater than or equal to 0.40. If an item loaded on more than one factor, it was assigned to the factor with higher factor loading. Based on these criteria, the following items did not adequately load on any of the three factors: agitation (item 11), worthlessness (item 14), changes in appetite (item 18), concentration (item 19), and loss of interest in sex (item 21). Thus, the revised BDI consisted of 16 items. Based on the items assigned, we labeled three factors as affective (8 items), attitudinal (4 items), and somatic (4 items).

The CFA indicated that the 3-factor model suggested by the EFA produced an excellent fit ($\text{CFI}=0.980$, $\text{TLI}=0.976$, $\text{RMSEA}=0.048$ [90% $\text{CI}=0.039\text{--}0.058$], $\text{WRMR}=0.885$). Table 2 summarizes the factor loadings of the CFA. All loadings are above 0.40. The study also conducted CFA on the two three-factor models in Hayden et al. [17] with bariatric surgery candidates, and found that our 16-item, three-factor solution had better overall fit statistics (Model 1: $\text{CFI}=0.624$, $\text{TLI}=0.577$, $\text{RMSEA}=0.177$ [90% $\text{CI}=0.170\text{--}0.183$], $\text{WRMR}=3.404$; Model 2: $\text{CFI}=0.961$, $\text{TLI}=0.905$, $\text{RMSEA}=0.083$ [90% $\text{CI}=0.077\text{--}0.099$], $\text{WRMR}=1.652$) (see Table 3 for comparison of item mapping).

3.2. Descriptive and Psychometric Measures

Internal consistency of the 16-item was as good as the original 21-item BDI (Table 4). The affective and attitudinal factors also showed good internal consistency, but the somatic factor was only in the acceptable range. The affective and attitudinal factors were correlated highly with each other. The somatic factor was correlated moderately with the affective and attitudinal factors.

3.3. Criterion-Related Validity of the 16-item BDI

Both of the 21-item and 16-item BDI total scores were significantly associated with more severe eating-disorder symptoms for total and subscales of EDE (Table 5). The three factors were correlated moderately with the EDE total score and the eating, shape, and weight concern subscales, but not with the restraint subscale. Correlations were generally slightly lower for the somatic factor than the other two factors. This was not surprising given its lower internal consistency. Greater somatic factor, however, was significantly associated with greater BMI.

Compared with those without current MDD diagnosis, those with current MDD diagnosis reported significantly higher scores on the total BDI (both 21- and 16-items) and three factors (Table 6). The average BDI score of those with current MDD diagnosis fell within the moderate range for the 21-item BDI. Similarly, those with current diagnosis of any mood disorder (MDD, dysthymic disorder, depressive disorder NOS) reported significantly greater BDI scores than those without current diagnosis that fell within the moderate range.

3.4. Receiver Operating Curve Analysis

3.4.1. Predicting Current Major Depressive Disorder—Table 7 summarizes the results of ROC analyses. The brief 16-item BDI and the original 21-item BDI both had moderate discriminating accuracies (AUC=0.773 [$p < .01$, 95% CI=0.727–0.811] and 0.769 [$p < .01$, 95% CI=0.720–0.818], respectively). At the optimal cut-off score of 16, as determined by maximizing Youden index, the overall accuracy of the original 21-item BDI was 66.7%. The overall accuracy of the brief 16-item BDI was slightly better at a cut-off score of 13 (70.8%). The PPV was low for both versions (30.6% [21-item] and 33.0% [16-item], respectively). Thus, of the 211 patients who screened positive based on the 21-item BDI, 64 individuals did not meet criteria for MDD based on the SCID. Of the 175 patients who screened positive based on the 16-item BDI, 58 individuals did not meet criteria for MDD based on the SCID. The NPV was high (94.0% [21-item] and 93.0% [16-item], respectively). This means that of 401 patients who screened negative based on the 21-item BDI, 24 individual met MDD criteria but missed; for the 16-item BDI, of 444 patients screened negative, 31 individuals met MDD criteria but missed.

3.4.2. Predicting Current Mood Disorder—Both BDI versions demonstrated moderate discriminating accuracies (AUC=0.763 [$p < .01$, 95% CI=0.720–0.805] for the 21-item BDI and 0.769 [$p < .01$, 95% CI=0.724–0.821] for the 16-item BDI, respectively). At the optimal cut-off score of 14, the overall accuracy of the original 21-item BDI was 62.0%. The overall accuracy of the brief 16-item BDI was better at the cut-off score=13 (70.5%). The PPV was better than for mood disorder, but still low for both versions (35.4% [21-item] and 40.5% [16-item], respectively). Of the 243 patients who screened positive based on the 21-item BDI, 86 individuals did not meet criteria for mood disorder based on the SCID. Of the 156 patients who screened positive based on the 16-item BDI, 63 individuals did not meet criteria for mood disorder based on the SCID. The NPV was high (92.4% [21-item] and 88.3% [16-item], respectively). Thus, of 330 patients who screened negative based on the 21-item BDI, 25 individual met mood disorder criteria but missed; for the 16-item BDI, of 444 patients who screened negative, 52 individuals met mood disorder criteria but missed.

4. Discussion

MDD and mood disorders are common comorbid psychiatric disorders among individuals with obesity and BED [8]. The BDI is frequently used to screen for possible presence of mood disorders, but its psychometric properties and clinical utility may vary across specific medical conditions [21]. This was the first study to evaluate the factor structure and clinical utility of the BDI for screening and assessing depression specifically among to individuals with obesity with BED. First, EFA revealed that five items did not load on any of three factors, and the subsequent CFA supported a brief 16-item BDI. Both the 21-item and 16-item BDI showed high internal consistency and greater scores on both BDI versions were significantly correlated with greater levels of eating-disorder psychopathology. In addition, those who met clinical diagnosis of current MDD or any current mood disorder reported significantly greater scores for both versions. Thus, the criterion-related validity of 16-item BDI appears comparable to the original 21-item BDI.

We also found that the brief 16-item BDI had a three-factor structure, which we labeled as affective, attitudinal, and somatic factors. These three factors represent the pattern of clustering of different depression symptoms that is unique to comorbid obesity and BED, and can be informative, for example, in evaluating the effectiveness of treatment on different symptomatology [42]. The affective and attitudinal factors were highly correlated with each other. Moderate correlations were found between the affective and somatic factors, and between the attitudinal and somatic factors. Higher scores for all three factors were associated with severity of eating-disorder psychopathology, except between restraint eating and the somatic factor. These findings might suggest that the somatic factor may represent a more distinctive dimension of depression than the other two factors. However, greater somatic factor score was significantly associated with greater BMI. In addition, among three factors, the average score of the somatic factor was higher relative to its possible score range, compared with the affective and attitudinal factors. Greater endorsement of somatic symptoms has also been reported in bariatric patients [43]. Thus, caution may be needed in interpretation when an individual endorses somatic items as they may be a result of physical aspects associated with obesity.

Both BDI versions showed moderately good prediction as a screening instrument for MDD (AUCs = ~0.77). This supports their utility for screening for MDD and mood disorders among patients with obesity and BED although the AUC is clearly not high enough to be suitable for generating clinical diagnoses of MDD or mood disorders [37, 38]. We emphasize that the optimal cutoff for any screening test depends on the clinical context that it will be used in [44], including, for example, the potential costs of different misclassifications. Mood disorders are common and serious disorders with readily available effective treatments and these considerations may be viewed as having a higher benefit than the cost of a false positive screen. Both versions had good NPVs, indicating that they are less likely to miss true cases of mood disorders. While both versions showed similar sensitivity to detect MDD, the sensitivity for any mood disorder was better for the 21-item BDI than the 16-item BDI. However, the specificity was particularly low for the 21-item BDI, and both versions showed low PPV. Low specificity and PPV indicate the increased likelihood of overestimating depression. When there is time and resources, overestimation of

cases may be preferable to underestimating true cases., Thus, using a 16-item BDI version to save patients' time may be an option in settings where there exist clinical resources to perform additional and more definitive diagnostic interviewing. On the other hand, from the perspective of comprehensive care and greater confidence in identifying potentially serious co-occurring mood disorders, the 21-item BDI has greater NVP than the 16-item BDI, thus resulting in fewer individuals with true cases of depression to be missed. Finally, of the three factors, the affective factor appears to best discriminate the presence of MDD and any mood disorder.

The item mapping for the brief 16-item BDI was distinctively different from the models supported by Hayden et al. [24] with extremely obese bariatric surgery candidates. Model fit statistics were excellent for our three-factor, 16-item model, whereas the fit statistics for the two models in Hayden et al. [24] were less than adequate. This is not surprising given that the present study aimed to identify the factor structure unique to patients with BED and comorbid obesity whereas Hayden et al. [24] found the best fitting solution from five factor solutions previously identified in studies with severely obese bariatric surgery candidates. Thus, even among obese population, the psychometric properties of the BDI may differ by comorbid psychiatric and/or medical conditions. On the other hand, loss of appetite and weight loss did not load on any factor in all three models, suggesting that these two items may not be informative in describing underlying construct of depression in treatment-seeking obese population. These two items were part of the items that were removed or modified when the BDI was revised to correspond with the *DSM-IV* (i.e., BDI-II) [45]. The BDI-II removed three items and assessing both increases and decreases in sleep and appetite. We note, however, that major studies of obese patient groups, including the landmark LookAhead study [20] continue to use earlier BDI versions. Similar to research with the BDI, emerging studies of the factor structures of the BDI-II have also reported variable findings, but generally support a 3-factor structure consisting of affective, cognitive, and somatic factors [46]. In particular, the item mapping of the current study is similar to a three-factor model of the BDI-II found as a best fitting model in bariatric surgery candidates [47]. Collectively, these studies suggest that the three factors identified in our study should reasonably represent underlying construct of clinical depression.

There are several strengths and limitations of the current study. A large sample size allowed for adequate EFA and CFA of randomly split-half samples and for ROC analyses testing for detection of cases with sufficient number of mood diagnoses. The presence of current mood disorders was determined using rigorous semi-structured diagnostic interviews by highly trained research clinicians. Our sample was reasonably diverse in terms of sex, ethnic/racial distribution, and educational attainment, which allows for reasonable generalizability to treatment-seeking adults with co-existing obesity and BED. Our findings, however, may not generalize to different age groups, community samples, or persons uninterested in treatment or research. We also excluded participants with who reported current anti-depressant use and major or uncontrolled medical conditions and such physical problems. The prevalence of a current mood disorder (22%) is similar to the rate reported in BED (~20%) [4, 8] although these exclusion criteria might have contributed to underestimation of the prevalence rate in this study by excluding potential participants taking anti-depressant medications. We

emphasize, however, that the observed variability and range in both the BDI and SCID-I/P should have allowed adequately for the primary aim of this study on psychometric analyses of the BDI. One could also raise a concern regarding the ability of the SCID-I/P to differentiate between true depression and somatic symptoms due to the coexisting obesity. We used clinical diagnoses generated by experienced clinicians who were intensively trained and monitored in the use of the semi-structured diagnostic interviews. The use of skilled and well-trained research clinicians administering such semi-structured diagnostic interviews training has been found to help disentangle and minimize potential “state-trait” artifacts across challenging clinical problems [48]. We note, however, that inter-rater reliability, while good and favorably comparable to the psychiatric literature, is less than perfect. Thus, we examined the performance of the BDI against a diagnostic standard that – although considered the “gold standard” – is less than perfect. It should be kept in mind that the diagnostic reliability represents an upper limit on the psychometric performance of a screening test. Studies have also suggested the possibility that the instrument’s factors might actually measure specific depression symptoms of a more general, higher order depression factor [49, 50], which could be explored through use of bifactor or second-order factor model. Further research is needed to replicate and extend our findings in different patient groups and clinical settings.

4.1. Conclusions

Comorbid mood disorders are common among persons with BED and obesity [6, 7] and are associated with more severe symptoms of BED [12]. In addition, depression has been associated with poor weight loss [8, 10, 11] and BED outcomes [12]. Proper screening and identification of mood disorders can inform treatment strategies for intervention of obese patients with BED. Our findings suggest that the BDI performs moderately well as a screening tool depression, but it cannot be used to generate diagnoses of mood disorders. The current study identified three factors that represented distinctive group of symptomatology (affective, attitudinal, and somatic) that are unique to treatment-seeking patients with obesity and BED. Further study is needed to validate the utility of the 21- vs. 16-item BDI, and whether three clusters of symptomatology are associated with disease prognosis or treatment outcomes in comorbid BED and obesity.

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CMG conceived and carried out the study. All authors contributed to data analysis, data interpretation, and writing of the paper, and had final approval of the submitted and published versions.

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Table 1

Fit Statistics for the Exploratory Factor Analysis

	CFI	TLI	RMSEA (90% CI)	SRMR
2 factor solution	0.979	0.974	0.045 (0.037–0.052)	0.051
3 factor solution	0.994	0.992	0.025 (0.013–0.035)	0.041
4 factor solution	0.997	0.995	0.020 (0.000–0.032)	0.035

Notes. CFI = comparative fit index (CFI = 0.95); TLI = Tucker-Lewis index (TLI = 0.95); RMSEA = root mean square error of approximation (RMSEA = 0.05); SRMR = standardized root mean square residual (SRMR = 0.07) [39].

Table 2
Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) of the BDI items

	Affective			Attitudinal			Somatic		
	EFA	CFA		EFA	CFA		EFA	CFA	
1. Sadness	0.617	0.775	0.226					0.057	
2. Pessimism	0.680	0.754	0.243					-0.036	
3. Feel Like Failure	0.468	0.780	0.441					0.009	
4. Loss of Pleasure	0.518	0.785	0.034					0.403	
5. Guilty Feelings	0.007		0.757	0.772			0.131		
6. Punishment Feelings	0.300		0.455	0.679			-0.035		
7. Disappointment and Self-Dislike	0.247		0.548	0.786			0.130		
8. Self-Criticalness	0.227		0.637	0.814			-0.006		
9. Suicidal Thoughts or Wishes	0.610	0.566	0.222				-0.015		
10. Crying	0.452	0.533	0.199				0.123		
11. Irritability	0.316		0.168				0.306		
12. Loss of Interest in Others	0.569	0.729	-0.035				0.322		
13. Indecisiveness	0.565	0.701	-0.011				0.373		
14. Negative Body Image	0.000		0.379				0.358		
15. Work Difficulty	0.336		-0.015				0.604	0.811	
16. Insomnia	-0.084		0.118				0.457	0.471	
17. Fatigue	0.035		0.134				0.699	0.716	
18. Loss of Appetite	0.004		0.138				0.291		
19. Weight Loss	0.080		0.070				-0.050		
20. Somatic Concern	-0.031		0.402				0.439	0.627	
21. Loss of Interest in Sex	0.173		0.102				0.331		

Notes: For EFA, factor loading had to be greater than or equal to 0.40. If loaded on more than one factor, the item was assigned to the factor with higher factor loading. Items loaded on each factor are highlighted in bold.

Table 3**Item Mapping for Confirmatory Factor Analysis of the Beck Depression Inventory**

	Model 1	Model 2	Model 3
1. Sadness	NM	NM	AF
2. Pessimism	NM	NA	AF
3. Feel Like Failure	NA	NA	AF
4. Loss of Pleasure	NM	NA	AF
5. Guilty Feelings	NA	NA	AT
6. Punishment Feelings	NA	NA	AT
7. Disappointment and Self-Dislike	NA	NA	AT
8. Self-Criticalness	NA	NA	AT
9. Suicidal Thoughts or Wishes	NM	NM	AF
10. Crying	NM	NM	AF
11. Irritability	PI	NM	–
12. Loss of Interest in Others	PI	NA	AF
13. Indecisiveness	PI	NM	AF
14. Negative Body Image	NA	NA	–
15. Work Difficulty	PI	SC	S
16. Insomnia	–	SC	S
17. Fatigue	PI	SC	S
18. Loss of Appetite	–	–	–
19. Weight Loss	–	–	–
20. Somatic Concern	PI	SC	S
21. Loss of Interest in Sex	PI	SC	–

Notes. Model 1 = modified Shafer in Hayden et al. (2010); Model 2 = proposed 3-factor model in Hayden et al. (2010); Model 3 = our proposed model. NA = negative self-attitude; NM = negative mood; PI = performance impairment; SC = somatic concerns; AF = affective; AT = attitudinal; S = somatic.

Table 4

Psychometric, descriptive, and correlational characteristics of the original BDI, the 16-item BDI and three factors

	α	Mean $\pm$ S.D.		
21-item BDI	0.89	16.31 $\pm$ 9.09 (0 – 49)		
16-item BDI	0.89	12.21 $\pm$ 7.49 (0 – 42)		
			Correlations	
16-item BDI factors	α	Mean $\pm$ S.D.	1	2
Affective	0.83	4.75 $\pm$ 3.93 (0 – 21)	—	
Attitudinal	0.75	3.55 $\pm$ 2.49 (0 – 12)	0.70*	—
Somatic	0.68	3.92 $\pm$ 2.18 (0 – 11)	0.59*	0.54*

Notes. BDI = Beck Depression Inventory. Possible score ranges: 0–63 (21 items), 0–48 (16 items), 0–24 (affective factor), 0–12 (attitudinal factor), and 0–12 (somatic factor). The numbers in parentheses are the range of scores for the study sample.

* = significant correlation at $p < .05$.

Table 5

Correlations between BDI and eating related variables

	21-item BDI		16-item BDI		
	Total	Total	Affective	Attitudinal	Somatic
BMI	0.02	0.01	-0.05	-0.01	0.14 [‡]
Binge eating frequency	0.11 [‡]	0.11 [‡]	0.11 [‡]	0.09 [‡]	0.09 [‡]
EDE					
Total Global	0.43 [‡]	0.42 [‡]	0.44 [‡]	0.32 [‡]	0.30 [‡]
Restraint	0.10 [‡]	0.09 [‡]	0.07 [‡]	0.13 [‡]	0.03
Eating concern	0.38 [‡]	0.37 [‡]	0.32 [‡]	0.36 [‡]	0.27 [‡]
Shape concern	0.47 [‡]	0.46 [‡]	0.38 [‡]	0.43 [‡]	0.30 [‡]
Weight concern	0.43 [‡]	0.41 [‡]	0.38 [‡]	0.41 [‡]	0.29 [‡]

Notes. BMI = body-mass-index; EDE = eating disorder examination.

[‡] $p < .05$;

^{‡‡} $p < .01$.

Table 6

Comparison of BDI scores based on SCID diagnosis

Factor	Current diagnosis	No current diagnosis	<i>t</i> -test	Effect size
Current MDD diagnosis (<i>n</i> = 117 for yes, <i>n</i> = 588 for no)				
21-item BDI	23.98 (10.10)	14.58 (8.13)	9.48 [†]	1.03
16-item BDI	18.78 (8.61)	10.71 (6.57)	9.60 [†]	1.05
Affective	8.48 (4.82)	3.89 (3.26)	9.85 [†]	1.12
Attitudinal	5.12 (2.85)	3.16 (2.29)	7.01 [†]	0.76
Somatic	5.18 (2.24)	3.65 (2.10)	7.10 [†]	0.70
Current any mood disorder diagnosis (<i>n</i> = 158 for yes, <i>n</i> = 548 for no)				
21-item BDI	23.15 (9.83)	14.16 (7.97)	10.53 [†]	1.00
16-item BDI	18.08 (8.34)	10.34 (6.40)	10.79 [†]	1.04
Affective	8.09 (4.62)	3.68 (3.42)	11.29 [†]	1.08
Attitudinal	4.91 (2.80)	3.08 (2.26)	7.54 [†]	0.72
Somatic	5.08 (2.22)	3.58 (2.08)	7.86 [†]	0.70

Notes. Cohen's *d* effect size: 0.2 = small, 0.5 = medium, 0.8 = large (Cohen, 1988).

[†] = significantly different at $p < .05$;

[‡] = significantly different at $p < .01$. Due to missing data, $N = 705$ for MDD, and $N = 706$ for any current mood disorder.

Table 7
Sensitivity and specificity of the BDI to MDD and any mood disorder according to the SCID

	AUC	Cutoff	Sensitivity	Specificity	y^b	PPV	NPV
MDD ($n = 117$ with current diagnosis)							
21-item BDI	0.769	16	79.49 (71.0–86.4)	64.12 (60.1–68.0)	43.61	30.6	94.0
16-item BDI	0.773	13	73.50 (64.5–81.2)	70.24 (66.4–73.9)	43.74	33.0	93.0
Affective	0.780	6	62.39 (53.0–71.2)	81.46 (78.1–84.5)	43.86	40.1	91.6
Attitudinal	0.701	3	67.52 (58.2–75.9)	60.54 (56.5–64.5)	28.07	25.4	90.4
Somatic	0.695	5	46.15 (36.9–55.6)	82.14 (78.8–85.2)	28.30	34.0	88.5
Any mood disorders ($n = 158$ with current diagnosis)							
21-item BDI	0.763	14	84.18 (77.5–89.5)	55.66 (51.4–59.9)	39.83	35.4	92.4
16-item BDI	0.769	13	67.09 (59.2–74.3)	71.53 (67.6–75.3)	38.62	40.5	88.3
Affective	0.783	6	58.86 (50.8–66.6)	83.58 (80.2–86.6)	42.44	50.8	87.6
Attitudinal	0.691	2	81.65 (74.7–87.3)	44.71 (40.5–49.0)	26.35	29.9	89.4
Somatic	0.691	4	59.49 (51.4–67.2)	67.88 (63.8–71.8)	27.38	34.8	85.3

Notes. AUC = area under the curve. y^b = Youden index. PPV = positive predictive value. NPV = negative predictive value. AUC is interpreted as small (0.5 < AUC 0.7), moderate (0.7 < AUC 0.9), and high (0.9 < AUC 1) (Swets, 1988). Due to missing data, $N = 705$ for MDD, and $N = 706$ for any current mood disorder.