FIFTY YEARS STUDYING THE BECK DEPRESSION INVENTORY (BDI) FACTORIAL STABILITY WITHOUT CONSISTENT RESULTS: A FURTHER CONTRIBUTION

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Abstract

Objective: The Beck Depression Inventory (BDI) is one widely used self-report measure of depressive symptoms employed as both a clinical scale and a research tool. For decades an extensive body of literature has focused on the factor structure of the BDI. However, previous research yielded inconsistent results. The lack of clear replicability of the identified solutions suggests the need for further investigations. To this end, we aimed at examining the BDI factorial structure in order to contribute to test the scale factorial stability across cultures and samples.

Method: A total of 318 nonclinical participants (48.3% males and 51.7% females, with a mean age of 28.44 years, SD = 12.49, range: 18-64) completed the BDI. Both exploratory and confirmatory factor analyses were performed.

Results: Principal axis factoring analyses revealed a single-factor solution with good internal consistency reliability (α = .83). The maximum likelihood confirmatory factor analysis with robust estimation performed on a random subsample of participants (n = 194) showed satisfactory goodness-of-fit for a one-factor model.

Conclusions: In the current study we derived and then confirmed the factorial structure of the BDI. Multiple solutions which met statistical criteria converged on a single-factor solution. Because only nonclinical group of participants was used, it is suggested that additional factor analyses be conducted that focus on clinical sample in order to confirm the reported findings.

Key words: Beck Depression Inventory, BDI, factorial structure, depression, psychometrics, exploratory factor analysis, confirmatory factor analysis, factorial replicability, factorial invariance, factorial stability

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Introduction

The Beck Depression Inventory (BDI; Beck et al. 1961) is a widely used self-report measure of depressive symptoms. A large body of literature suggests that it exhibits good internal consistency and acceptable temporal stability in both clinical and nonclinical samples. Besides, BDI adequately discriminates depressed patients from control participants (Beck and Beamesderfer 1974; Beck et al. 1961, 1988; Bernal et al. 1995; Bosse et al. 1975; Gallagher et al. 1983; Nietzel et al. 1987; Oliver and Simmonds 1984; Sanz and Vázquez 1993; Scilligo 1983; Turner and Romano 1984; Vázquez and Sanz 1991; Weeks and Heimberg 2005). Although the scale reliability and validity in different cultural contexts as well as in different samples is extensively established, however the assumption that its factorial structure is invariant across populations is not tenable.

Beck et al. (1988) stated that "An understanding of the factorial composition of the BDI is crucial when the instrument is used to screen for depression in medical patients" (p. 92). In line with this recommendation, previous research has broadly explored the factor structure of the scale but yielding inconsistent and conflicting results. Various factor solutions have been proposed. Cropley and Weckowicz (1966) conducted a maximum likelihood factor analysis and orthogonal rotation on a sample of 100 depressed psychiatric patients, and distinguished six meaningful factors. Based on responses from a sample of 405 Iranian college students, Tashakkori et al. (1989) performed a principal component analysis with varimax rotation and identified five factors: the first factor regarded pessimism, sense

of failure, self-dislike, suicidal ideas, indecisiveness, and work retardation, the second factor was associated with guilt feeling, expectation of punishment, and self-accusation, the third factor was related with crying, body image change, insomnia, dissatisfaction, suicidal ideas, and sadness, factor 4 concerned weight loss, somatic preoccupation, and fatigability, and factor 5 regarded irritability, insomnia, and anorexia. Bonilla et al. (2004) performed a principal component factor analysis with a varimax rotation on responses from a Spanish sample of 351 undergraduate students from the University of Puerto Rico, founding evidence for a four-factor structure: Somatic, including items regarding loss of interest, loss of energy, and problems with sleeping, appetite, and weight, Sadness or hopelessness, including sadness, hopelessness, failure, dissatisfaction, deception, crying, and ideas of suicide, Poor self-esteem, including irritability, lack of personal interest, and poor self-esteem, and Negative thoughts, including guiltiness, punishment, difficulty making decisions, and physical appearance. Based on the responses of 254 significantly depressed hospital patients, Weckowicz et al. (1967) found evidence for the existence of at least three factors. These factors were labelled: Guilty depression, Retarded depression, and Somatic disturbance. Beck and Beamesderfer (1974) found three factors, labelled Negative view of self and future, Physical withdrawal, and Physiological. Campbell et al. (1984) performed a principal component analysis with varimax rotation on a sample of 214 cardiac outpatients yielding three dimensions interpreted as negative self-attitudes, physiological symptoms and sadness. Williams and Richardson (1993) investigated the dimensionality of BDI using a principal component factor analysis with orthogonal rotation with a sample of 240 mixed chronic pain patients and found evidence for a three-factor structure: Sadness about health, Self-reproach, and Somatic disturbance. Novy et al. (1995) used confirmatory factor analytic procedures on a sample of 247 pain sufferers treated at a large multidisciplinary pain centre in the southern United States and found support for a three-factor solution: Negative Attitudes/Suicide, Performance Difficulty, and Physiological Manifestations. Miles et al. (2001) used a confirmatory factor analysis with maximum likelihood estimation on data from two chronic pain groups (a facial pain sample comprised of a total of 157 consecutive patients attending the Eastman Dental Hospital, and a pain clinical sample comprised of a total of 173 consecutive patients attending pain clinics at the Whittington and Middlesex Hospitals) and provided support for both Novi et al. and William and Richardson models. Morley et al. (2002) identified a two-factor solution (Negative view of the self and Somatic and physical function) using data gathered from a large sample of 1947 patients. Golin and Hartz (1979) performed a principal axis factor analysis with varimax rotation with a sample of 446 college students from the University of Pittsburgh and found only one small well-defined factor (Hopelessness), which was characterized by sadness, a pessimistic attitude about future outcomes, dissatisfaction and suicidal thoughts. Welch et al. (1990) administered the BDI to two patient sample (606 depressed patients from an American university hospital and 113 eating disorder patients from an American eating disorders outpatient clinic) and three non-patient samples (192 university psychology students; 243 nurse trainees; 142 members of an aerobic dance class) and clearly identified a large general factor that resulted in high internal reliability for the measure as a whole.

Based on this framework, there clearly remains some doubts as to the accurate nature of the factor structure of the BDI both among patients and nonclinical samples. Thus, in line with much earlier research suggesting the need to test the factor structure stability across cultures and samples of commonly used instruments in several fields of psychological research (Caretti et al. 2011; Craparo et al. 2013a, 2013b; Faraci et al. 2013; Gori et al. 2013; Manna et al. 2013; Triscari et al. 2011), we consider valuable to report further empirical data regarding the evaluation of the psychometric properties of the BDI.

Specifically, what is needed is empirical evidence concerning the BDI underlying dimensionality. To this end, the current study examined the factor structure of the scale within a non-clinical sample of participants. Our strategy was to conduct a series of exploratory factor analyses on the whole sample and then to use confirmatory factor analyses on a randomly selected subsample to check the models emerging from the exploratory factor analyses.

Methods

Participants

A total of 318 participants (college students: 67.6%, employers: 30.2%, free lancers: 1.9%, and pensioners: .3%) completed the BDI. They were 48.3% males and 51.7% females with a mean age of 28.44 years (SD = 12.49; range: 18-64). The most common marital status was engaged (39.9%), followed by single (35.8%) and married (21.7%), with 1.9% divorced and .6% widowed. Educational level ranged from lower school certificate (2.5%) to college graduate (degree) (14.2%), with 83.3% high school degree. Data were collected at the University of Palermo, where students completed the questionnaire as a part of a class. The remaining participants were approached at their homes or workplaces. All participants were asked to answer to the following question: "Have you ever been diagnosed with a psychological disorder or any kind of mental health disease?" Only non-patients were selected for inclusion.

Confirmatory factor analysis was performed on a random subsample of participants (sample 2). They were 194 (college students: 61.3%, employers: 37.1%, free lancers: 1%, and pensioners: .5%) (53.6% male and 46.4% female), ranging in age from 18 to 64 years (M = 30.05, SD = 13.65).

Instrument

The BDI (Beck et al. 1961) is a 21-item self-report questionnaire consisting of a series of statements relating to specific depressive symptoms with four responses options for each item presented in an ordered sequence to reflect increasing intensity of experience. Each statement is rated on a scale ranging from 0 (not intense) to 3 (very intense), with 0 indicating absence of the symptom and 3 the most intense statement. The responses to each item are summed giving an overall score, which ranges from 0 to 63. The cut-off points for the BDI symptoms are as follows: 10-18 indicates mild depressive symptoms, 19-29 corresponds to moderate depressive symptoms and 30-63 indicates severe depressive symptoms (Beck et al 1961).

Items for the BDI, which were derived from both clinical and research sources, cover the main features of depression as observed in psychiatric settings. Specifically, the 21 items sample four categories of

symptoms observed in depressed patients, namely, emotional, cognitive, motivational, and vegetative and physical manifestations.

Data analyses

In order to determine the dimensional structure underlying the questionnaire, both exploratory and confirmatory factor analyses were performed.

Principal axis factoring was selected as the method of factor extraction. We decided to extract the number of factors determined by random data parallel analyses. Both Kaiser's criterion (items with eigenvalues greater than 1) and the Scree Test were secondarily checked for agreement. A criterion of at least three loading items (with a cut-off value of .30) on a factor (with a difference of .30 between loading on the primary factor and loading on other factors, when an item loaded simultaneously on two factors) was deemed desirable for an acceptable solution.

A confirmatory factor analysis, using ML (Maximum Likelihood) robust estimation procedures, was performed using the EQS Structural Equation Program Version 6.1 (Bentler 2006). The closeness of the hypothetical model to the empirical data was tested through multiple goodness-of-fit indexes, including the ratio of the chi-square to degrees of freedom (χ^2/df), the Non-Normed Fit Index (NNFI), the Comparative Fit Index (CFI), the Standardized Root Mean Square Residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA). These measures generally range between .00 and 1.00, with larger values reflecting better fit. Based on the traditional body of literature, CFI and NNFI values of .90 or greater are generally interpreted as evidence of models that fit well (Bentler and Bonett 1980). Nevertheless, the more recent literature suggests that acceptable fitting models produce values greater than .95, with values greater of .97 indicating good fit (Hu and Bentler 1995). Conversely, smaller SRMR and RMSEA values support better fitting models, with SRMR values of .10 or less and RMSEA values of .08 or less suggesting acceptable fit, and SRMR and RMSEA values less than .05 indicating good fit (Hu and Bentler 1999). The Satorra-Bentler scaled chi-square statistic, which adjust the chi-square value for nonnormal data, was also reported (Hu et al. 1992).

The internal consistency of the BDI was measured by Cronbach's alpha coefficient. For item selection it was decided that adjusted item-total correlations for each item of a scale should exceed .30, which is recommended as the standard for supporting item-internal consistency (De Vellis 2003). Correlations were computed for each item to measure the relationship between the items and the total score.

Results

The mean and standard deviation of the BDI scores of the group of participants were 8.69 and 7.02, respectively (range = 0-48), indicating minimal depressive symptoms.

With the 21-item scale, we were able to satisfy the minimum ten participants-per-item ratio, ensuring that reliable factors would emerge. The Kaiser-Meyer-Olkin Test of Sampling Adequacy was .87 and Bartlett's Test of Sphericity (chi-square = 1315.483; *df* = 210) was significant (*p* = .000), indicating that the BDI items were suitable for factor analysis.

Both parallel analysis and Kaiser's criterion

determined 6 factors to be extracted. Visual inspection of the scree plot identified 2 factors. Nevertheless, the resulting number of factor is evidently over-defined, with several factors comprised by only one or two indicators and five factors explaining less than 5% of the total variance. The principal axis analysis was repeated with both varimax and promax rotation fixing numbers of factors to extract to two to six factors. All the factor solutions presented problems of overextraction and multiple loadings.

Only the single-factor solution was well-defined and capable of interpretation. Items 11 "Irritability", item 17 "Fatigability", and item 19 "Weight loss", which failed to load .30 or greater on the extracted factor, were removed. The factor matrix is shown in **table 1**. The relatively low percentage of explained variance could be probably due to the prevalence of the response "0" (symptom not present) given by our participants to all BDI items. Item 1 "Sadness" (74.2%), item 2 "Pessimism" (56%), item 3 "Sense of failure" (87.4%), item 4 "Dissatisfaction" (54.7%), item 5 "Guilt" (81.1%), item 6 "Punishment" (65.7%), item 7 "Self-dislike" (85.8%), item 8 "Self-accusation" (48.1%), item 9 "Suicidal ideas" (87.1%), item 10 "Crying" (73.2%), item 11 "Irritability" (47.2%), item 12 "Social withdrawal" (68.9%), item 13 "Indecisiveness" (69.5%), item 14 "Body image changes" (72.6%), item 15 "Work difficulty" (63.8%), item 16 "Sleep disturbance" (61.3%), item 17 "Fatigability" (49.7%), item 18 "Loss of appetite" (83%), item 19 "Weight loss" (77.4%), item 20 "Somatic preoccupation" (75.4%), item 21 "Loss of libido" (86.2%).

The identified factor was defined by lack of satisfaction, self-dislike, sadness, guilty feeling, work difficulty, a pessimistic attitude about future outcomes, social withdrawal, indecisiveness, sleep disturbance, body image change, sense of failure, self-accusation, suicidal thoughts, loss of libido, sense of punishment, loss of appetite, crying, and somatic preoccupation.

The extracted factor demonstrated good level of internal consistency reliability (α = .83).

The confirmatory factor analysis conducted on sample 2 (n = 194) showed the satisfactory goodness-of-fit indexes for the one-factor measurement model, describing the relationship between specific items and latent factors: (χ^2 = 142.84; p = .284), χ^2/df = 1.07, NNFI= .97, CFI = .97, RMSEA = .02 (90% CI [.000, .040]), and SRMR = .07. All manifest variables loaded significantly (*p*<.05) on their hypothesized latent factors. The completely standardized factor loadings are reported in **table 2**. Fit indices are reported in **table 3**.

Discussion

The psychometric properties of the BDI has been fully documented in American and European contexts (Beck et al. 1961, Bernal et al. 1995, Vazquez and Sanz 1991, Bonilla et al. 2004). The literature reviews suggests that reliability and validity of the BDI are supported in different cultural contexts as well as in different samples.

Nevertheless, concerns about the factorial validity of the BDI have taxed research for several decades with conflicting findings, which confirm the necessity of others studies to evaluate the BDI structure model. A number of problems, which are common to most psychometric studies, are evident in the exploratory factor analyses performed in the BDI investigations (e.g., the number of participants needed for the analyses, the procedure for determining the correct number of

Table 1. *Factor loadings of the BDI items and corrected item-total correlations*

Items	Loadings	Item-total correlations
4. Dissatisfaction	.678	.608
7. Self-dislike	.648	.581
1. Sadness	.584	.519
5. Guilt	.546	.488
15. Work difficulty	.533	.481
2. Pessimism	.504	.455
12. Social withdrawal	.489	.443
13. Indecisiveness	.488	.451
16. Sleep disturbance	.482	.440
14. Body image changes	.463	.428
3. Sense of failure	.460	.393
8. Self-accusation	.450	.422
9. Suicidal ideas	.406	.390
21. Loss of libido	.382	.344
6. Punishment	.378	.355
18. Loss of appetite	.374	.344
10. Crying	.366	.338
20. Somatic preoccupation	.340	.301
% explained variance	23.55	
Cronbach's alpha		.83

Table 2. *Standardized factor loadings of the BDI items*

Items	Loadings
1. Sadness	.599
2. Pessimism	.508
3. Sense of failure	.703
4. Dissatisfaction	.723
5. Guilt	.674
6. Punishment	.443
7. Self-dislike	.706
8. Self-accusation	.501
9. Suicidal ideas	.382
10. Crying	.426
12. Social withdrawal	.558
13. Indecisiveness	.512
14. Body image changes	.415
15. Work difficulty	.591
16. Sleep disturbance	.448
18. Loss of appetite	.364
20. Somatic preoccupation	.300
21. Loss of libido	.356

Table 3. *Fit indices for the BDI one-factor model*

Model	χ^2	*df*	*p*	NNFI	CFI	SRMR	RMSEA	90% CI
One-factor model	142.84	134	.285	.966	.970	.065	.019	.000-.040

factors to be extracted, the rotation criterion to be used to achieve the simple solution). It is noteworthy that the factorial structure inconsistent results may confound BDI scores leading the possibility of misinterpretations. Such issue is of both clinical and theoretical importance, as the BDI is frequently used to test theories. Hence, factorial stability research will benefit the future testing of theoretical models.

In the current study we derived and then confirmed the factorial structure of the BDI using a nonclinical sample. Multiple solutions which met statistical criteria converged on a single-factor solution. The exploratory factor analysis revealed one large general factor that was reasonably consistently supported in the confirmatory phase, demonstrating also good internal consistency for the measure as a whole.

To summarize, BDI structure derived from analyses conducted on our sample of participants was characterized by a single factor that contained affective, cognitive, motivational, and somatic elements as a wide-ranging construct rather than specific subdimensions.

Although promising, our findings should be interpreted with some caution. First, our sampling methodology did not permit us to know how representative our sample was of the population. Second, only nonclinical participants were included. Further work needs to be done to establish the stability of the reported factor solution. Replication of the present findings in a large sample of clinical patients would allow for an examination of the factorial validity of the BDI in this population.

A significant issue in the dimensional structure of BDI is its factorial stability over time. Indeed, invariance of factor solutions over time is necessary before differences in factor scores over occasions can be meaningfully evaluated. This may be particularly important for establishing the clinical utility and interpretability of the measure, given its usefulness for tracking changes over time or across treatment through repeated administrations. That being said, further research on the longitudinal stability of measures of BDI is clearly needed.

In conclusion, based on the present findings and given the inconsistency of the factor analytic literature of the BDI, it seems apparent that researchers should be aware of these psychometric issues and exercise caution when using the BDI dividing the scale into factors or subscales. Additional research examining the cross-cultural stability of factor solutions is still needed.

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