

Factorial structure of the Beck Depression Inventory for depression in university students

Estrutura fatorial do Inventário de Depressão Beck para depressão em estudantes universitários

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ABSTRACT

Objective: To explore the dimensionality of the Beck Depression Inventory (BDI) among Colombian college students. **Methods:** A validation study was designed, involving the participation of a sample of 786 health science students (medicine, nursing, and psychology) aged between 18 and 27 ($M=20.0, SD=1.9$). The participants completed the 21-item BDI. Internal consistency was calculated (Cronbach's alpha and McDonald's omega) and dimensionality was demonstrated using factorial confirmatory analysis (CFA). **Results:** The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was high (0.898) and the Bartlett's sphericity test gave excellent results (chi-square = 3,102.60; $df = 210$; $p < 0.001$). One-, two- and three-dimensional models were used. The unidimensional model performed best, representing 24.8% of the total variance, high internal consistency, a Cronbach's alpha of 0.83 and a McDonald's omega of 0.84. However, the CFA did not fit adequately (chi-square = 583.79; $df = 189$; $p < 0.001$, RMSEA = 0.052, CI 90% 0.047-0.056, CFI = 0.87, TLI = 0.85 and SMSR = 0.04). **Conclusions:** The best factor solution for the BDI is given by the unidimensional model, which presents high internal consistency. However, its adjustment in the CFA is not acceptable.

Keywords

Students, universities, depressive symptoms, validation studies.

RESUMO

Objetivo: Avaliar a dimensionalidade do Inventário de Depressão Beck (BDI). **Métodos:** Trata-se de um estudo de validação envolvendo a participação de uma amostra de 786 estudantes de Ciências da Saúde (Medicina, Enfermagem, Psicologia) entre 18 e 27 anos, com idade média de 20,0 (DP = 1,9). Os participantes completaram o BDI de 21 itens. A consistência interna foi calculada (alpha de Cronbach e ômega de McDonald's) e a dimensionalidade foi demonstrada usando análise confirmatória fatorial (ACF). **Resultados:** A medida Kaiser-Meyer-Olkin (KMO) da adequação da amostragem foi alta (0,898) e o teste de esfericidade de Bartlett foi excelente (qui-quadrado 3,102.60; $df = 210$; $p < 0,001$). Foram utilizados modelos uni, bi e tridimensionais. O modelo unidimensional foi o que melhor se apresentou estatisticamente, representando 24,8% da variância total, alta consistência interna, alpha de Cronbach de 0,83 e omega de McDonald's de 0,84. No entanto, o CFA não se ajustou adequadamente (qui-quadrado = 583,79; $gl = 189$; $p < 0,001$, RMSEA = 0,052, IC 90% 0,047-0,056, CFI = 0,87, TLI = 0,85 e SMSR = 0,04). **Conclusões:** O modelo unidimensional mostrou-se como melhor solução, apresentando alta consistência interna. No entanto, seu ajuste no CFA não é aceitável.

Palavras-chave

Estudantes, universidades, depressão, estudos de validação.

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INTRODUCTION

Major depressive disorder is a global public health problem that leads to great impairments in school, work, family and social functioning and years of healthy life lost^{1,2}. As such, it is important to be able to rely on the availability of valid and reliable instruments that allow us to screen depressive symptoms with possible clinical importance in different contexts³.

Currently, there are many screening instruments for major depressive episodes in different contexts for clinical or research purposes⁴. One of the most commonly used surveys is the Beck Depression Inventory (BDI)⁵, which has different versions with different numbers of items that quantify the cognitive symptoms of major depressive episodes⁶⁻⁸.

It has been tested the psychometric performance of the BDI, internal consistency values within the acceptable range (between 0.84 and 0.92) have been observed⁹⁻¹⁵. However, the dimensional or factorial structure has shown different numbers of dimensions or factors from 1 to 3 factors^{9-12,16-18}.

It is a well-known fact that these variations can present themselves in the psychometric performance of instruments such as the BDI, especially so in the response pattern that determines the dimensionality of the measurement scale¹⁹. As well as its theoretical implications, this also implies a need to interpret the results according to the characteristics of the people responding to the instruments²⁰.

The purpose of this study was to test the dimensionality (AFC) of the BDI in a sample of health sciences students in Santa Marta, Colombia.

METHODS

Design

A psychometric study was implemented to evaluate the performance of a construct quantification scale. Such studies are also known as instrumental methodological studies or evaluation screening or diagnostic tests according to the area of knowledge²¹. The study received the approval of the research ethics committee. Despite not presenting any risks according to the Ministry of Health Resolution 8,430 of 1993, all the participants signed the informed consent form. Confidentiality was guaranteed throughout the application and analysis of the socio-demographic data and findings²².

Population

A probabilistic sampling of health sciences students in Santa Marta, Colombia, was carried out in different phases. Probabilistic sampling was used given that this study is a secondary analysis of a cross-sectional research in which a number of different scales are applied. The sample was made up of a total of 706 students: 186 (23.7%) from nursing, 275 (35.0%) from medicine, and 325 (41.3%) from psychology. The stu-

dents' ages ranged between 18 and 37 ($M = 20.0$, $DE = 1.9$). There was a participation rate of 616 women (78.4%) and 170 men (21.7%). The number of participants was sufficient for the calculation of internal consistency and to carry out a confirmatory factor analysis (CFA), which requires a minimum number of 400 participants²⁰.

Instruments

The students completed the 21-item BDI. The items were originally qualified in two dimensions. The first (cognitive) was made up of the first 14 sections, and the second (somatic) was made up of the remaining seven sections. Each of the items offers four answer options ranging from "never" to "almost always", which are then qualified from 1 to 4. The higher the score, the higher the possibility of having presented a major depressive episode in the past two weeks⁵.

Procedure

The students completed the instrument in the classroom, in a group application. The objectives of the research were explained, as were the ethical considerations, voluntary participation, and the fact that the exercise would not be compensated with any kind of incentive beyond the usefulness of the findings for science and for knowledge generation.

Statistical analysis

Confirmatory factorial analyses were carried out using the maximum likelihood method. The analyses were carried out for the two dimensions proposed originally and for one and three dimensions, as suggested by more recent research^{16,17}. The typical coefficients for the beginning of the factorial analysis were used, along with Bartlett's sphericity coefficient²³ and the KMO index²⁴.

In the CFA, we determined the Satorra-Bentler chi square test, with degrees of freedom (DF) and probability value (p), the RMSEA coefficients (*Root Mean Square Error of Approximation*), and a confidence interval of 90% (CI 90%), CFI (*Comparative Fit Index*), TLI (*Tucker-Lewis Index*) and SMSR (*Standardized Mean Square Residual*). For the chi squared, we expected the probability value to be above 5%; for RMSEA and SRMR, below 0.06; and for CFI and TLI, values below 0.89 were expected.

Cronbach's alpha²⁵ and McDonald's omega²⁶ were calculated to find out the internal consistency according to the conceptualized dimensions. The McDonald test is more precise in estimating the internal consistency when the equivalence principle is not fulfilled²⁶. Data analysis was carried out using STATA for Windows²⁷.

RESULTS

Initially, we examined the indicators to determine CFA pertinence. The analysis indicated sampling adequacy through

coefficient KMO = 0.898, and Bartlett’s test showed a chi square = 1,301.17; df = 210; p < 0.001.

The first test was carried out for a unidimensional scale. The communality analysis in Table 1 shows coefficients higher than 0.400 except for items 11, 16, 17, 18, 19, 20 and 21. For one dimension, we recorded: Factor I = Eigen value 5.2 that explained a variance of 24.8%, a Cronbach’s alpha of 0.83 and McDonald’s omega of 0.84.

Table 1. Communalities and loadings of the BDI for single confirmatory factor analysis

Item	Communality	Loadings
1	0.450	0.671
2	0.188	0.434
3	0.298	0.546
4	0.329	0.573
5	0.380	0.617
6	0.191	0.437
7	0.300	0.537
8	0.289	0.538
9	0.249	0.499
10	0.277	0.529
11	0.078	0.280
12	0.223	0.472
13	0.214	0.462
14	0.183	0.428
15	0.203	0.450
16	0.126	0.354
17	0.151	0.389
18	0.113	0.337
19	0.076	0.276
20	0.071	0.266
21	0.086	0.293

The goodness of fit calculated for this CFA model indicates a chi squared of 583, 8; p = 0.01, RMSEA = 0.05, CI 90% 0.04-0.06; CFI = 0.87; TLI = 0.85; SMSR = 0.04.

The second test corresponds to a two-dimensional model. The communality analysis in Table 2 shows: Factor I with a Cronbach’s alpha of 0.80 and McDonald’s omega of 0.82. Factor II with a Cronbach’s alpha of 0.56 and McDonald’s omega of 0.58.

The goodness of fit calculated for this CFA model, showed chi-square = 538.1; df = 188; p < 0.001; RMSEA = 0.05, CI 90% 0.04 -0.06; CFI = 0.88; TLI = 0.87; and SMSR = 0.04.

The test for three dimensions showed Factor I with a Cronbach’s alpha of 0.79 and McDonald’s omega of 0.81. Factor II presented a Cronbach’s alpha of 0.58 and McDonald’s omega of 0.57. Finally, Factor III had a Cronbach’s alpha of 0.55 and McDonald’s omega of 0.52.

Table 2. Communalities and loadings of the BDI in a two-dimensional confirmatory factor analysis

Item	Communality	Factor I Loadings	Factor II Loadings
1	0.445	0.675	
2	0.207	0.455	
3	0.314	0.560	
4	0.294	0.542	
5	0.396	0.629	
6	0.196	0.441	
7	0.317	0.563	
8	0.290	0.538	
9	0.277	0.507	
10	0.279	0.529	
11	0.070	0.265	
12	0.219	0.468	
13	0.209	0.457	
14	0.166	0.407	
15	0.140		0.374
16	0.253		0.503
17	0.298		0.546
18	0.183		0.428
19	0.162		0.402
20	0.097		0.312
21	0.044		0.209

Table 3. Communalities and loadings of the BDI in a three-dimensional confirmatory factor analysis

Item	Communality	Factor I Loadings	Factor II Loadings	Factor III Loadings
1	0.447	0.671		
2	0.258	0.434		
3	0.341	0.546		
4	0.380		0.468	
5	0.389	0.617		
6	0.200	0.437		
7	0.320	0.537		
8	0.300	0.538		
9	0.367	0.499		
10	0.274	0.529		
11	0.088		0.196	
12	0.222	0.472		
13	0.241	0.462		
14	0.185	0.428		
15	0.238		0.357	
16	0.258		0.549	
17	0.321		0.648	
18	0.285			0.442
19	0.553			0.732
20	0.112		0.318	
21	0.086	0.236		

The goodness of fit calculated for this CFA model, showed a chi-squared = 394.6; $df = 167$; $p < 0.001$; RMSEA = 0.04, CI 90% 0.03-0.05; CFI = 0.92; TLI = 0.90; SMSR = 0.04.

DISCUSSION

This study demonstrates that the factorial solutions for one-, two- and three-dimensional BDI do not adjust adequately to the sample of health sciences students in Santa Marta, Colombia.

We can see that the BDI presented a Cronbach's alpha of 0.84 when measured across the 21 items. This observation is consistent with previous research that has shown values within the desired range which falls between 0.70 and 0.95⁹⁻¹⁵. This approach is correct if we consider a BDI with a unidimensional scale²⁸.

The original proposal of the BDI was for a bi-dimensional scale. In this study, the internal consistency for the first dimension was of 0.79 and for the second, it was 0.61. This finding is inconsistent with research using other populations that showed internal consistency values within the desired range for both dimensions⁹⁻¹⁵. It is evident that this disparity found in terms of the values of the coefficients has practical implications for the acceptance of the dimensionality of the scale^{19,28}. We recommend the use of internal consistency only for one-dimensional scales. The calculation should be carried out separately for each dimension in bi- or multi-dimensional scales²⁸. Furthermore, it is highly likely that a consistency of above 0.80 for the 21 items as a set may be given directly by the number of items and not the high correlation between them^{19,28}. It is known that this coefficient is very sensitive to the number of items and, as such, the calculation is not recommended for a set of over 15 items for the more conservative, or up to 20 items for the more liberal. The reason is simple: as from 15 items, the internal consistency increases rapidly and tends to steer away from the real value¹⁹.

For the CFA, this analysis shows that in none of the three factorial solutions do the five goodness of fit models adjust to the data, with high chi squared and CFI, and TLI of lower than 0.90. Other research has shown that not all goodness of fit coefficients were adequate for the BDI^{16,17}. However, it was concluded that the solution for one, two or three factors was the most promising¹²⁻¹⁸. These divergences in the conclusions are caused for many different aspects. The first is that there is no absolute agreement for the quantitative and qualitative interpretation of the factorial solutions. The second is that there is an evident lack of consensus in terms of the interpretation of the goodness of fit coefficients¹⁹. Finally, the third is that there is notable variability of the factorial solutions according to the characteristics of the population for those scales with more than 15 items^{19,28}.

These findings encourage a consideration of the current limitations of factorial analyses and, as such, the factorial structure of the BDI-21. The weaknesses of this approach have led to the reduction of the number of items in the instrument and, as a result, currently, 10 or less item scales which measure the essential part of the construct and that show greater stability and better performance indicators are preferred^{20,29}. A 7-item version is now available for the BDI, which has one dimension confirmed in CFA, achieving very good fit indices (RMSEA = 0.058, and both CFI and TLI = 0.99)³⁰. The findings encourage us to consider the reduction of the number of items in the BDI-21 for this population²⁹.

This study's strength is that it involved a large sample of participants chosen at random and that it considered strict interpretation criteria for the indicators, in particular, the goodness of fit indicators. However, the study was limited in that the number of students in the possible segments did not allow for a reliable analysis.

CONCLUSIONS

We conclude that for the BDI, the one-, two- and three-dimensional factorial solutions do not adequately adjust to the health sciences students in Santa Marta, Colombia. Care should be taken in the interpretation of BDI results for this population. This performance needs to be corroborated in another group of university students.

INDIVIDUAL CONTRIBUTIONS

Adalberto Campo-Arias – Contributed substantially to design, analysis and interpretation of data, make substantially contributed to and the drafting of the article. He also gave final approval of the version to be published.

Yuly Suárez-Colorado – Contributed substantially to conception, design and interpretation of data, and to the intellectual content. She also gave final approval of the version to be published.

Carmen C. Caballero-Dominguez – Contributed substantially to conception, design, and interpretation of data, and critically reviewed the paper for important intellectual content. She also gave final approval of the version to be published.

CONFLICTS OF INTEREST

Drs. Adalberto Campo-Arias, Yuly Suárez-Colorado and Carmen C Caballero-Domínguez have no conflicts of interest to declare.

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