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# Factorial invariance and latent mean differences of the Beck Depression Inventory – second edition (BDI-II) across gender in South African university students

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This study examined the measurement invariance of scores from the BDI-II as well as the differences in latent mean scores by gender. Participants were 919 South African university students (females = 72%). They completed the BDI-II, which is a measure of Negative Attitude (NA), Performance Difficulty (PD), Somatic Complaints (S) and Depression (D). The data were analysed utilising multigroup confirmatory factor analyses (MCFA). Evidence of factorial invariance was established at the level of configural, metric and scalar invariance, across gender groups. Females scored significantly higher latent means on measures of NA and S compared to males.

**Keywords:** depression, factorial invariance, gender differences, latent mean

## Introduction

The female gender carries a well-documented risk for lifetime experience of depression (Delisle, Beck, Dobson, Dozois, & Thombs, 2012; Kockler & Heun, 2002; Ngcobo & Pillay, 2008). However, questions remain as to the differentiation in depression presentation between males and females to inform depression screening for treatment. Although the existence of gender differences in depressive symptoms is widely established (Blore, Schulze, & Lessing, 2004; Fernander et al., 2006; Hamad, Fernald, Karlan, & Zinman, 2008; Herman, Stein, Seedat, Heeringa, Moomal, & Williams, 2009; Mkhize & Mayekiso, 1993; Mosotho, Louw, Calitz, & Esterhuyse, 2008; Ngcobo & Pillay, 2008; Nduna, Jewkes, Dunkle, & Jama Shai, 2010; Rapmund & Moore, 2000), the reasons for these differences are not yet well understood. It is generally considered that gender differences in the symptoms of depression reflect gender differences in the perception and the expression of depressive syndromes (Kockler & Heun, 2002).

Commonly used instruments for diagnosing depression such as the BDI-II (Beck, Steer, & Brown, 1996) are in need of investigation for their use across gender, especially in developing country settings like South Africa. For instance, results of measurement invariance (MI) across gender would provide evidence of score validity of the BDI-II in South Africa and rule out bias or construct-irrelevant variance (e.g. group affiliation) of the test scores. Latent mean analysis (Cheung & Rensvold, 2000) would assist in accounting for possible measurement bias and error, and yield more accurate and reliable gender difference results. This study sought to investigate the validity of the BDI-II among male and female South African university students.

## Studies on gender-related MI of the BDI-II

Only a few studies have considered MI of the BDI-II by gender (Byrne, Stewart, Kennard, & Lee, 2007; Carmody 2005; Campbell, Roberti, Maynard, & Emmanuel, 2009; Hooper, Qu, Crusto, & Huffman, 2012; Osman, Kopper, Barrios, Gutierrez, & Bagge, 2004; Whisman, Judd, Whiteford, & Gelhorn, 2013; Wu, 2009). Most of these studies reported MI with non-invariant items (i.e. Items 1, 2, 3, 4, 5, 7, 8, 9, 10, 15, 16, 17 and 18) within the Negative Attitude (NA), Performance Difficulty (PD), and Somatic Complaints (S) factors of the BDI-II.

However, Byrne et al. (2007), Campbell et al. (2009), and Whisman et al. (2013), using university students, revealed no gender differences on the BDI-II factor scores. While, Hooper et al. (2012) found that items of the BDI-II endorsed by female and male United States students were almost invariant. Data from South Africa would further clarify the MI findings from other international settings. Accordingly, the purpose of the current study was to use multigroup confirmatory factor analysis (MCFA) to examine the factorial invariance and latent mean differences of the BDI-II across gender in a university sample. Previous South African studies investigated gender differences on overall depression (e.g. Mosotho et al., 2008; Herman et al., 2009; Nduna et al., 2010; Schuch et al., 2014). The present study examined group differences at specific factor levels.

## Method

### *Participants and setting*

Nine hundred and nineteen students ($M_{age}$ = 21.70 yrs.; SD = 13.51; females = 72%) were selected from both the University of Limpopo (*n* = 493; females = 66%) and the University of Pretoria (*n* = 425; females = 76%). The participants were undergraduate students from the faculties of Humanities, Natural Sciences, Statistics, Law and Management Sciences. Sixty-seven per cent of the participants identified themselves as black, while 33 % said they were white. The mean score (11.45; SD = 7.74) of the sample on the total BDI-II is outside the symptomatic range of the BDI-II (Beck et al., 1996).

***Measures***

The students completed the Beck Depression Inventory (BDI-II: Beck et al., 1996). The BDI-II is a 21-item self-report measure used to measure the severity of depressive symptoms in adolescents and adults. Items are scored from 0 to 3. The total raw score is the sum of the 21 items, with the highest possible score 63. Overall scores in the range of 17 and above suggest the presence of clinical depression. Scores from the BDI-II achieved a Cronbach's alpha of 0.84 in the present study.

***Procedure***

Approval for the research was granted by the research and ethics committees of the University of Limpopo and University of Pretoria. Students individually consented to the study. Students were recruited from undergraduate classes at both the University of Limpopo and the University of Pretoria. The objectives of the study and instructions on completing the questionnaire were also provided. With written consent from the students, the instrument was administered to them in English and in a group format outside of their normal university hours. The students were not remunerated for taking part in the study, and they were debriefed at the end of the data collection session.

***Data analysis***

Data analysis was conducted using the EQS 6.1 program (Bentler, 2007). MI was examined within the framework of MCFA modelling (i.e. means and covariance structures [MACS]). The robust maximum likelihood estimation method (Yuan-Bentler scaled method; Yuan & Bentler, 2000) was used since the BDI-II data represented a non-normal distribution (i.e. item-level skewness > 1.5 and item-level kurtosis > 2.5; Kolmogorov-Smirnov $z$ = 0.09, $p$ < 0.001; Mardia multivariate kurtosis = 184.21; c.r. = 89.69). The scaled chi-square and 'robust' standard errors using ML estimation was utilised to address non-normality.

The hypothesised hierarchical four-factor model of the BDI-II comprised three lower-order factors (i.e. NA, PD, and S) and one higher-order general factor (Depression), established in university students (see Makhubela & Mashegoane, 2016). This is presented in Figure 1. Once this baseline model was shown to be consistent with the data, the analyses then proceeded to test the equivalence of this model across gender groups, using a series of ordered steps (see Chen, Sousa, & West, 2005; Byrne, 2006). Results of MI and MACS analyses were reported based on the following criteria: the Y-B $\chi^2$ < 1.5 ($\chi^2$/df) < 1.5 (Yuan & Bentler, 2000), CFI ≥ 0.95, SRMR ≤ 0.05, and RMSEA ≤ 0.06 and its 90% CI (Hu & Bentler, 1999).

With this baseline model, the tenability of invariance across gender groups was evaluated by fitting a series of increasingly restrictive models. The tenability of each restriction was assessed based on the differences in fits between the restricted model and the less restricted model (Δ*CFI & Δ*RMSEA) (Chen, 2007). With evidence for MI, the MACS were then separately estimated to test latent mean differences for each latent construct by means of setting the latent mean value to zero for males and freely estimating for females. The differences between the latent means were evaluated on the basis of the $z$ statistic (Wald's significance test) (Aiken, Stein, & Bentler, 1994; Makhubela, 2016).

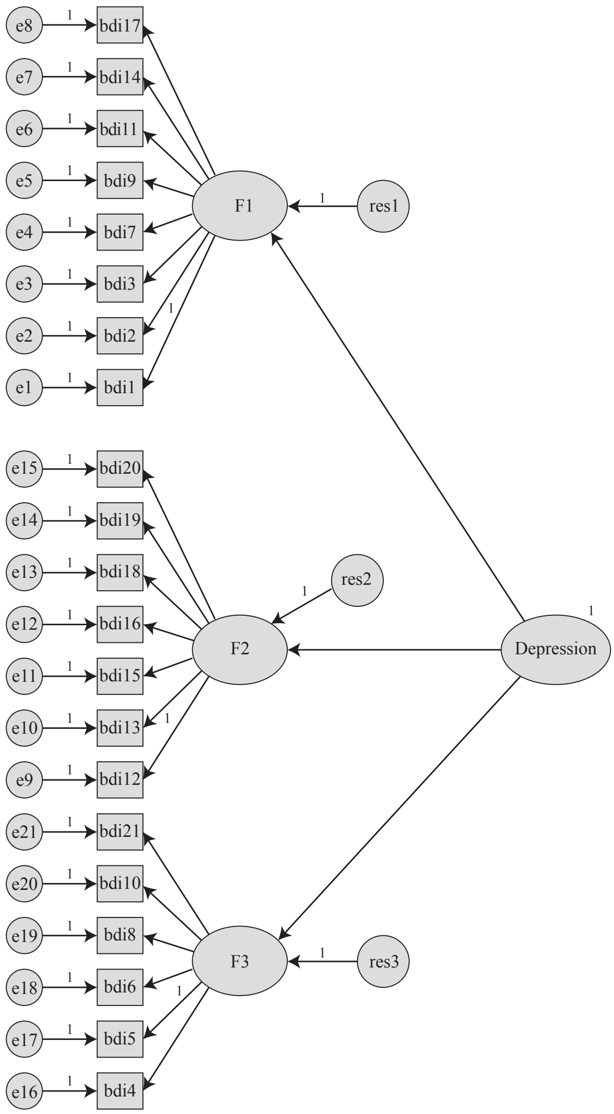


**Figure 1:** Pattern coefficients for the hierarchical four-factor model

**Results**

***Gender-related invariance***

Table 1 presents results of tests of the hypothesised BDI-II structure. The configural model, revealed an acceptable fit to the data for both males and females (Y-B $\chi^2_{[367]}$ = 526.42; *CFI = 0.93; SRMR = 0.05; *RMSEA = 0.03, with 90% CI = 0.03 to 0.04). All parameter estimates were viable and statistically significant. This model serves as the baseline against which all remaining models are compared in the process of determining evidence of invariance. Likewise, all MCFA results for MI across gender show that all four nested models represented a good fit to the data ($p$ < 0.001, *CFIs = 0.93, SRMRs = 0.05-0.06, *RMSEAs = 0.03). These multigroup models also retained the same acceptable fit with the Δ*CFI and Δ*RMSEA values never exceeding 0.01. That is, both metric and scalar invariance were achieved for gender. The satisfaction of both metric and scalar invariance implies that all items of BDI-II have measurement equivalence between male and female participants.

### *Latent mean difference*

Table 2 shows that, there were significant latent mean and observed mean differences on the NA factor ($z$ = 3.95, $p$ < 0.05) and the S factor ($z$ = 4.63, $p$ < 0.05), with females endorsing higher scores. However, latent mean differences on the PD factor ($z$ = 1.27, $p$ > 0.05) were not significant, although females had significantly higher observed scores on the PD factor than males when conducting one-tailed hypothesis testing ($p$ < 0.05).

## Discussion

Findings replicated the BDI-II hierarchical four-factor structure to provide a robust fit with the data. Evidence of MI across gender at the level of configural, metric and scalar invariance was also established. Our findings are consistent with past research in student populations (Byrne et al., 2007; Campbell et al., 2009; Hooper et al., 2012; Whisman et al., 2013; Wu, 2010; Wu & Huang, 2012). Nevertheless, there was evidence of significant latent mean differences on NA factor and the S factor, with females endorsing higher scores under these factors.

One explanatory model, for the gender differences on depression, suggests that females are more prone to exhibit a cognitive style characterised by negative self-evaluation and ruminative coping, which in turn may predispose them to depression (Garber & Martin, 2002; Nolen-Hoeksema, Larson, & Grayson, 1999). The presence of gender-based differences in cognitive symptoms is documented among both psychiatric patients and normal controls. Based on these findings, females have typically shown greater vulnerability to negative self-evaluation, more mood symptoms and self-deprecation than males (Hankin & Abramson, 2001).

Higher endorsement of depressive symptoms among females may be explained by their historical experience of adverse life events and less control over essential domains of their lives compared to their male counterparts (Rapmund & Moore, 2000). Typically, females are inclined to openly acknowledge and express emotional challenges or negative affect, whereas males tend to deny these feelings (Nolen-Hoeksema & Girgus, 1994).

Scalar invariance was established providing empirical evidence of construct validity for the BDI-II for purposes of assessing for depression in male and female South African students. However, latent mean scores for NA and S factors were elevated among the female students. These findings are explicable if one considers that most symptoms associated with the NA factor are cognitive in nature. Findings from previous studies suggest that women are more apt to exhibit a cognitive symptom pattern characterised by negative self-evaluation; this may prejudice them to be depressed on cognitively inclined depression instruments such as the BDI-II (e.g. Hankin & Abramson, 2001; Nolen-Hoeksema et al., 1999).

The findings suggest females to self-report NA and S compared to male students. Prospective research in this area should sample non-student and clinical populations to further clarify the measurement proprieties reported for the BDI-II from this study.

## Authors' note

This article is an extension of a paper presented by M. Makhubela as 'Gender invariance and latent mean differences of the BDI-II with South African university students' at the 9th Annual International Conference on Psychology, 25–28 May 2015, in Athens, Greece.

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**Table 1:** Goodness-of-fit statistics for tests of invariance of BDI–II hierarchical structure for males and females

| | Model and constraints | Y-B $\chi^2$ | *df* | *CFI | SRMR | *RMSEA | 90% *RMSEA CI | Model comparison | Δ*CFI | Δ*RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Configural invariance | 526.42 | 367 | 0.93 | 0.05 | 0.03 | 0.02, 0.04 | | | |
| 2. | Higher and lower order factor loadings invariant | 555.18 | 385 | 0.93 | 0.06 | 0.03 | 0.03, 0.04 | 2 vs. 1 | 0.00 | 0.00 |
| 3. | Intercepts invariant | 617.97 | 406 | 0.93 | 0.06 | 0.03 | 0.03, 0.04 | 3 vs. 1 | 0.00 | 0.00 |
| 4. | Latent factor means invariant | 593.07 | 403 | 0.93 | 0.06 | 0.03 | 0.03, 0.04 | 4 vs. 1 | 0.00 | 0.00 |

Note: $p$ < 0.001; *df* = degrees of freedom; Y-B $\chi^2$ = Yuan-Bentler scaled chi-square test; *CFI = robust Comparative Fit Index; *RMSEA = robust root mean square error of approximation and its 90% confidence interval; SRMR = Standardised Root Mean-Square Residual; Δ*CFI = Comparative Fit Index difference value; Δ*RMSEA = robust root mean square error of approximation difference value.

**Table 2:** Differences between males and females on latent constructs

| Dimension | Latent mean analyses | Observed mean analyses | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 3 z | Males | | Females | | *t* | *d* |
| | | M | SD | M | SD | | |
| Negative attitude | 3.95* | 2.35 | 2.63 | 3.04 | 3.09 | -3.16* | 0.24 |
| Performance difficulty | 1.27 | 4.40 | 3.03 | 5.46 | 3.23 | -4.57* | 0.34 |
| Somatic complaints | 4.63* | 3.16 | 3.03 | 3.61 | 3.06 | -1.99* | 0.15 |

Note: $z$ = Wald significance test; *$p$ < 0.05; $d$ = effect size (Cohen's $d$).

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