The Confirmatory Factor Analysis of the Original Brief Intellectual Disability Scale and Alternative Models

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ABSTRACT

Objective: Brief Intellectual Disability Scale (BIDS) is a measure validated for identification of children with intellectual disabilities (IDs) in countries with low disability resources. Following the publication of the exploratory factor analysis of BIDS, the authors have documented the confirmatory factor analysis (CFA) of BIDS in this study. Materials and Methods: A prospective cross-sectional study was conducted to document the CFA of the BIDS. Primary caregivers (N = 124) of children with ID were recruited and rated the BIDS. We used alternative fit indices for the evaluation of comparative fit index (CFI) and root mean square error of approximation (RMSEA) to evaluate the model fit. The 2-index fit strategy was used to select the best factor model. Results: The model fit index for the original 3-factor model and alternative 2-factor and 1-factor models with 9 items of the BIDS was under identified along with another 3-factor, 7-item model. Another 1-factor, 7-item model was identified but did not satisfy the 2-index fit strategy. A short version of the scale with a 2-factor and 7-item model of BIDS presented the best fit indices of CFI = 0.952 and RMSEA = 0.069. Conclusion: Although the original factor structure of BIDS was not confirmed in this study, another alternative a priori model for the construct validity of BIDS was confirmed. Therefore, the BIDS factor structure has been revised, refined, and trimmed to the final 2-factor, 7-item shorter version. Further documentation of the diagnostic accuracy, validity, and reliability of this shorter version of BDI is recommended.

Key words: Brief Intellectual Disability Scale, confirmatory factor analysis, India, intellectual disability, low- to middle-income countries

INTRODUCTION

Brief Intellectual Disability Scale (BIDS) was developed and validated for identification of intellectual disability (ID) in countries with high disability burden but low human resources for disability. The previous

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paper presented the diagnostic accuracy, reliability, and validity of a 9-item, 3-factor model. It focused on the exploratory factor analysis (EFA) to determine the construct validity of BIDS. The EFA and confirmatory factor analysis (CFA) use completely different statistical methods of factor reduction and structural equation modeling, respectively, to study the construct validity. Although both use a normally distributed sample and include quantified variables and latent constructs, CFA specifically uses a priori model(s) where the number of factors, the decision on which items load on each factor, is supported by theory or previous research with overtly mentioned error terms.[1] Thus, the logical next step in the psychometric maturation of BIDS is to document CFA-based information about its construct validity.[1] Therefore, in this article, we document the CFA of the original BIDS and five other alternative a priori models to explain the construct of ID in BIDS.

MATERIALS AND METHODS

The detailed methodology on the development and validation of BIDS, the recruitment of participants and data collection are given elsewhere,[1] and here, we present only the details relevant to CFA. In this prospective cross-sectional study, we included all children attending a facility for children with ID, in a tertiary care teaching hospital, from November 2006 to November 2008 if they fulfilled the selection criteria. Participants were the primary caregivers of children with suspected ID. The data with BIDS and other measures were collected after the primary caregiver provided written informed consent. Verbal assent from their children with ID was acquired whenever possible. The local Institutional Review Board of Christian Medical College reviewed and provided approval for the study.

BIDS is a 9-item scale which is administered by a clinician in a face–face interview to the primary caregiver, the respondent. The endorsement pattern is in the form of a 3-point Likert scale presented as “not true (0),” “sometimes true (1),” and “often true (2).” The final scoring of the BIDS is based on the addition of the raw scores to get the total item scores. Higher BIDS scores indicated a higher level of ID. It takes <10 min to administer this scale. The EFA of this scale demonstrated a 3-factor structure - visceral cognitive factor: wets self during the day, speech problems, acts too young for his/her age, cannot concentrate and cannot pay attention for long, and clings to adults or too dependent (5 items); kinesthetic social: gets teased a lot, does not get along with other kids (2 items); and interpersonal factor: prefers being with younger kids, poor schoolwork (2 items). This measure has an internal consistency (Cronbach’s α) of 0.80.[1]

Statistics

All participants (that is, with and without ID) were included in the analyses to maximize item variability. CFA was used to verify the original 3-factor model and five alternative models. The three CFA models tested, with 9 items, were a 1-factor model (alternative model) representing “ID;” a 2-factor model (alternative model) representing “cognitive” and “social;” and our original 3-factor model representing “visceral-cognitive,” “kinesthetic-social,” and “interpersonal.” Furthermore, another 1-, 2-, and 3-factor but only with 7-item model was evaluated as alternative models. The 1 factor, 2 factors, and 3 factors in these three alternative models were similar to those in the 9-item models. In our building the CFA, the oval and square boxes represent the latent factors and observed factors, respectively. For all models, we specified error terms (denoted by “e” within small circle and arrow) and allowed the factors to be correlated. Furthermore, in our models, the arrows connecting the factors to the categorical indicators represent factor loadings, and the curved connections between the factors represent correlations. In all models, maximum likelihood estimation method was used. We used 2-index fit strategy to evaluate the goodness of fit indices for various models as suggested.[1] Thus, the model 0.95 for the incremental fit, and the root mean square error of approximation (RMSEA) value of ≤0.06 for the absolute fit. The factor structure that had better fit indices was considered the final factor structure for BIDS. The statistical analyses were performed using IBM SPSS (version 19) IBM SPSS AMOS (version 18).

RESULTS

The 1-, 2-, and 3-factor models with 9-item models under identified the factor structure, and thus even the original 3-factor, 9-item construct for BIDS was under identified. Therefore, the models were respecified (with heavier factor weights), and the 1-, 2- as well as 3-factor models with 7 items were tested. The 3-factor, 7-item model was under identified. The 1-factor and 7-item model was identified with a CFI of 0.883 and RAMSEA of 0.221, but the last 2-factor, 7-item model had the best-fit indices. This last model had a CFI of 0.952 and RAMSEA of 0.069. The results of CFA with the best fit indices are presented in Table 1 and Figure 1.

DISCUSSION

In the present study, we used CFA to further test the construct validity of the BIDS in relation to its original 3-factor, 9-item model and five other alternative models. CFA showed that the original 3-factor, 9-item model of item loading is not consistent with the structure of the
In this paper, we used a secondary analysis of items in BIDS, which represents the signs, symptoms, and epiphenomenon associated with ID, to confirm the structural relationships between them and the factors derived from the previous exploratory factor analysis. Six a priori models were analyzed. We used the standard goodness of fit criteria for selecting the confirmatory model.\cite{4} We found that all models with 9 items were under identified, which could have been because the constraints we imposed on the model were inconsistent with the sample data, and the models were rejected. In addition, it could have been that the 2 items (out of the 9 items) of “poor school-work” and “incoordination” had a poor correlation with various factors in different models resulting in their under identification. Thus, the original 3-factor structure identified by the EFA was not supported by the CFA.

Instead, the 7-item model’s results showed varied outcomes. While the 3-factor model with 7 items was under identified, the 1-factor model was identified, but the goodness of fit indices did not satisfy the 2-index fit strategy.\cite{4,5} Thus, in our study, the best fit was noted for the 2-factor, 7-item model, which had the CFI of 0.952 and the root mean square error of approximation (RMSEA) ≤0.069. Thus, the CFI is interpreted as great (>0.95 = great; >0.90 = traditional, and >0.80 = permissible) and RMSEA as moderate (<0.05 = good; between 0.06 and 0.09 = moderate, and <0.10 = bad). We used these fit indices because of the possible sample size concern, and these alternative indices adjust for the effect of sample size and degrees of freedom.\cite{6} The sample size calculation for CFA continues to be a challenging task with no definitive method. The post hoc sample size calculation based on Kline’s recommendation of 10–20 cases per parameter\cite{5} demonstrated that for the 15 parameters the sample size required was minimum 150, and we were short on sample by 26 participants. However, as there are alternative fit indices, such as CFI and RMSEA, which adjust for the effect of sample size and degrees of freedom and are better than the Chi-square-based model of fit index, we used these two indices.\cite{6} Thus, we are justified in choosing the alternative fit indices and using the standard 2-index fit strategy to evaluate the various model fits.

### CONCLUSION

Although the original factor structure of BIDS\cite{1} was not confirmed in this study, one of the alternative theoretical models we hypothesized for the construct validity of BIDS is correct. Therefore, the BIDS factor structure has been revised, refined, and trimmed to the final 2-factor, 7-item shorter version. Further documentation of the diagnostic accuracy, validity, and reliability of this shorter version of BD1 is recommended.

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### Conflicts of interest

There are no conflicts of interest.

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