Mind and Society
A Peer Reviewed Research Journal in Humanities and Social Sciences

EMPIRICAL ARTICLE
ISSN:2277-6907
doi: 10.56011/mind-mri-133-202411

Psychometric Properties and Factor Structure Validation of a Hindi Version of Twenty-One Items Depression Anxiety Stress Scale

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Abstract

The twenty-one-item depression anxiety stress scale (DASS-21) is a well-validated and widely used measure for assessing depression, anxiety, and stress in both clinical and non-clinical settings. In India, existing Hindi versions of the DASS-21 have translation and transliteral equivalence-related issues and their factor structures remain unexplored. This study developed a new Hindi version of the DASS-21 (DASS-21-H), examined its psychometric properties and validated its three-factor first-order and second-order factor models using confirmatory factor analysis (CFA) among Hindi-speaking Indian adults (N = 323). The DASS-21-H demonstrated satisfactory item and scale-level reliability and convergent validity. Both factor models showed excellent fit, indicating the DASS-21-H can reliably measure the three mental health dimensions and general psychological distress. Configural and metric invariance, along with partial scalar non-invariance across genders, further supported the validity of the said measurement models. Our findings suggest that the DASS-21-H is a reliable and valid tool for measuring depression, anxiety, stress, and overall psychological distress in Hindi-speaking populations. Further validation with larger, diverse clinical and non-clinical samples is warranted.

ARTICLE INFO

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Dates:
Received: 05-08-2024
Accepted: 13-08-2024
Published: 15-10-2024

Keywords:
DASS-21, Factor structure, Confirmatory factor analysis, India, Hindi.

How to Cite:
Tripathi, V., Pandey, A., Pandey, R. (2024). Psychometric Properties and Factor Structure Validation of a Hindi Version of Twenty-One Items Depression Anxiety Stress Scale. Mind and Society, 13(3): 84-94.
doi: 10.56011/mind-mri-133-202411

Introduction

The twenty-one-item depression anxiety stress scale (DASS-21; Lovibond & Lovibond, 1995) is a widely used tool to assess depression, anxiety, and stress (Scholten *et al.*, 2017; Zanon *et al.*, 2021). This scale is based on the tripartite model of psychopathology (Clark & Watson, 1991), which posits that the symptoms of depression, anxiety, and stress have both shared and unique characteristics (Lovibond & Lovibond, 1995). The depression scale measures levels of dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia, and inertia. The anxiety scale assesses autonomic arousal, skeletal muscle effects, situational anxiety, and the subjective experience of anxious affect. The stress scale evaluates specific and non-specific arousal, difficulty in relaxing, nervous arousal, and tendencies of being easily upset/agitated, irritable/over-reactive, and impatient (Lovibond & Lovibond, 1995).

The popularity of the DASS-21 in psychological and clinical research and its wide applicability is evident from the fact that it has been translated into 58 languages (seehttps://www2.psy.unsw.edu.au/Groups/Dass/translations.htm). It has been validated across clinical (Antony *et al*., 1998; Clara *et al*., 2001) and non-clinical samples (Lovibond & Lovibond, 1995; Sinclair *et al*., 2012) in various countries (Scholten *et al*., 2017; Zanon *et al*., 2021) and cultures (Bibi *et al*., 2020). The three-dimensional structure of DASS-21 consisting of depression, anxiety, and stress has gained substantial empirical support across different languages, nations, and cultures (Crawford & Henry, 2003; Mellor *et al*., 2015; Oei *et al*., 2013; Patias *et al*., 2016; Scholten *et al*., 2017). However, alternative factor structure models of DASS-21 have also been proposed. These include a unidimensional (Daza *et al*., 2002; Sinclair *et al*., 2012) model linking all the 21 items to one latent factor as well as a second-order model in which the three dimensions are considered to measure a higher-order latent factor of psychological distress (Daza *et al*., 2002; Makara-Studzinska *et al*., 2022). Additionally, the bifactor models have also gained support in the literature in which all items are allowed to load on their specific latent factors as well as a single general factor (Osman *et al*., 2012; Zanon *et al*., 2021). Among these alternatives, the unidimensional model lacks strong empirical support (Crawford & Henry, 2003; Daza *et al*., 2002; Sinclair *et al*., 2012), whereas second-order models and the bifactor model have gained sufficient empirical support (Shaw *et al*., 2017; Zanon *et al*., 2021) and they also accommodate the issue of moderate to high correlations among the three factors of DASS-21.

In the Indian context, two studies report the development and validation of the DASS-21 in Hindi (Kumar *et al*., 2019; Singh *et al*., 2013), one on a non-clinical sample (Singh *et al*., 2013) and the other on a clinical sample of head and neck cancer patients (Kumar *et al*., 2019). A thorough review of these studies along with the Hindi versions of the DASS-21, revealed several issues that remain unaddressed. First, the Hindi translation of a few items, especially a few phrases like “feeling blue,” “wind down,” or the word “touchy,” was not found adequate as they did not convey the intended psychological meaning in Hindi. Further, the grammatical structure of various items was also found inadequate. Additionally, both studies used exploratory factor analysis to examine the factor structure of the scale, which was marked by some additional issues. For example, Singh *et al*. (2013) reported a three-factor model but did not provide details of the factor loadings for the items of the depression scale. They displayed the factor loadings of two factors (anxiety and stress) in tabular form and mentioned the range of factor loading (.39 to .88) for depression (Singh *et al*., 2013). Thus, it is difficult to evaluate the nature of the factor structure as some items may have significant cross-loadings on different factors and thus may undermine the factorial purity. We speculate this because the two factors for which the said authors have displayed the factor loadings, two items showed cross-loadings on both factors (see Singh et al., 2013). Similarly, the study of Kumar *et al*. (2019) reported a four-factor solution in which several items showed significant cross-factor loadings, undermining the factorial purity of the reported structure.

The aforementioned observations revealed shortcomings in the translation of the available Hindi versions of the DASS-21 as well as a lack of strong empirical support for its three-factor model. Further, no attempt has been made to test the second-order factor structure of any Hindi version of the DASS-21. Further, to the best of our knowledge, no attempt has been made to validate either the three-factor or second-order factor models of available Hindi versions of the DASS-21 using a confirmatory factor analytic approach. Taking these gaps into account, the present study aims to develop a better Hindi translation of the DASS-21 (hereafter referred as DASS-21-H) and evaluate its psychometric properties along with validation of the three-factor structure and second-order measurement models using a confirmatory factor analytic approach. Additionally, we also aim to test the measurement invariance (configural, metric and scalar invariance) of the said lower and higher-order factor models.

Method

Participants

To test the suitability of the newly developed Hindi

version of the DASS-21, ten participants in the age range of 18 to 27 years were recruited. For psychometric evaluation and validation of the factor structure of the DASS-21-H, 323 adults were recruited in the age range of 18 to 59 years (Mean = 24.34 ± 5.53 years). Only those participants were recruited for the present study who volunteered themselves and were having proficiency in the Hindi language. The sample included 130 females (Mean age ± SD = 22.83 ± 4.04 years) and 193 males (Mean age ± SD = 25.36 ± 6.15 years). None of the participants reported any past or present history of physical or mental illness at the time of assessment.

Tools

The twenty-one items depression anxiety stress scale (DASS-21; Lovibond & Lovibond, 1995) was used in the present study. It consists of twenty-one items related to depression, anxiety and stress, each comprising seven items. Each item is rated on a four-point scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time) based on the past week's experiences.

Development and evaluation of the Hindi version of DASS-21 (DASS-21-H)

The new Hindi version of the DASS-21 (DASS-21-H) was developed following the cross-cultural methodology of establishing transliteral equivalence, i.e., translation-back translation (International Test Commission 2010). Initially, three independent researchers in the field of psychology having fluency in Hindi and English were requested to translate items of the original English version of twenty-one items (DASS-21; Lovibond & Lovibond, 1995), while retaining the original psychological content and meaning as well as grammatical structure of each item. Two bilingual experts from the department of psychology, B.H.U. Synthesized and edited the obtained Hindi translations from the three experts. The Hindi translation finalized by the said review committee was then evaluated by a psychology professor having expertise in psychometrics as well as in Hindi translation/adaptation of psychological measures. Based on the input of the said expert, the translation of a few items was further modified. This final Hindi version of the DASS-21 (DASS-21-H) was then back translated to English by another psychology faculty having fluency in both Hindi and English. To establish the cross-language transliteral equivalence of the DASS-21-H with the original DASS-21, the original and the back-translated English versions were compared and evaluated and none of the items were found inadequate.

After establishing the psycholinguistic equivalence, a pilot testing was conducted by administering DASS-21-H on small group 10 participants. The aim of this pilot testing was to ascertain the adequacy of each item in terms of comprehension and communication of the intended meaning as conveyed by the original scale. The findings of this pilot testing revealed that none of the participants reported any difficulty in comprehending either the instruction or the item content of the DASS-21-H.

Procedure

After taking the informed written consent, the DASS-21-H was administered on the second sample of 323 participants, either individually or in a group of 3 to 4 participants. Participants were requested to go through the standard instructions for completing the survey and provide demographic information before responding to the items of the DASS-21-H. The obtained responses were scored as per the standard scoring procedure of DASS-21.

The item and scale level psychometric properties of the DASS-21-H were examined using the classical test theory as well as the confirmatory factor analytic approach. Based on classical test theory, the corrected item-to-total correlation and alpha if – item deleted were computed to evaluate the item-level psychometric properties. For scale-level psychometric properties, Cronbach's alpha coefficients as well as McDonald's omega, were computed. The intercorrelation among the three dimensions of DASS-21-H was also computed, which provides preliminary support for the convergent validity, indicating that all the dimensions measure the same construct.

The factor structure models of the DASS-21-H (the three-factor lower-order and second-order factor model) were validated using the maximum-likelihood confirmatory factor analysis (CFA) approach with the help of the SPSS AMOS (version 24). The

goodness of fit of the said two models was assessed based on the following cut-offs of model fit indices: the ratio of chi-square to the degrees of freedom (χ^2/df<5), the goodness of fit index (GFI>.95), Bentler's comparative fit index (CFI>.95), root-mean-square error of approximation (RMSEA<.08), standardised root mean square residual (SRMR<.08), Tucker and Lewis non-normed fit index (TLI>.95) (Hooper *et al*., 2008). To determine the better-fitting model, we calculated the differences in chi-square, CFI and RMSEA between the competing nested-models. A statistically-significant difference in these indices ($\Delta\chi^2$ with p <.05, ΔCFI>.005, and ΔRMSEA>.01; Yuan & Chan, 2016) suggested significant improvement in the model fit. Further, the measurement invariance of the tested factor models across sexes (male and female) this included configural, metric and scalar invariance. To evaluate the invariance the three-factor and second-order factor models, the statistical tests used for judging improvement in the model fit were used but the criteria differed. Thus, a non-significant difference between chi-square, CFI and RMSEA between the model parameters across the two sexes ($\Delta\chi^2$ with p>.05, ΔCFI≤.005, and ΔRMSEA≤.01) supports the invariance of the model. Configural invariance was inferred if the given factor model was found to show an equally good fit across groups of males and females. While a statistically non-significant difference between the unconstrained and measurement weight-constrained models was considered supportive evidence for metric invariance, a statistically non-significant difference between the measurement weight-constrained model and measurement intercept-constrained model was considered to support scalar invariance.

Results

Item and scale level psychometric properties DASS-21-H

Findings of the corrected item- to-total correlation analysis revealed that all the items showed adequate item level reliability (item-total correlation ranged from 0.450–0.739, except item 2 having item-total correlation = 0.137) for the full scale as well as for the subscales viz., depression (item total correlation ranging from 0.448–0.696), anxiety (item total correlation ranging from 0.460–0.539; except item 2- r = 0.163) and stress (item total correlation ranging from 0.505–0.707). Further, alpha-if-item deleted analysis also substantiated the item level reliability of the DASS-21-H as none of the values exceeded the scale level Cronbach's alpha coefficient either at full-scale level analysis or at subscale level analysis, except item 2 for which the Cronbach alpha coefficient increased from .916 to .923 at full-scale level and from 0.727–0.768 at subscale level. However, this item was not dropped at this level because we have not seen how it behaves in the CFA model.

The DASS-21-H also showed satisfactory internal consistency for three subscales viz., depression, anxiety and stress (Cronbach alpha coefficients were 0.835, 0.727 and 0.824, respectively) as well as for the full scale (Cronbach alpha coefficients = .916). The satisfactory internal consistency of the various subscales of the DASS-21-H is further supported by satisfactory levels of the McDonald's omega coefficient (ω 0.838 for depression, ω = 0.732 for anxiety, and ω = 0.825 for stress. The full-scale and full-scale McDonald's omega coefficient (ω = 0.917) were highly satisfactory. Further, the inter-scale correlation revealed that depression, anxiety and stress scores were significantly and positively correlated with each other, which provide some support for the convergent validity of the scale as well as the homogeneity of the subscales (See Table 1).

It is important to note that both measures of the internal consistency (alpha and omega coefficients) for full scales were substantially higher than any of the subscales, suggesting the possibility that the DASS-21-H items may better represent a higher-order factor of psychological distress. This possibility has been tested and findings are presented in the following section.

Table 1: Correlation between depression, anxiety and stress

	Depression	*Anxiety*	*Stress*
Depression	1	.713**	.776**
Anxiety	.713**	1	.728**
Stress	.776**	.728**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Factor Structure of DASS-21-H

As proposed, we tested two measurement models of DASS-21-H - first three correlated factor model proposed by the original authors and subsequently well supported in the existing literature, and secondly, the three-factor model representing a second- order model in which three subscales were hypothesized to reflect the second-order latent factor of "psychological distress".

The three correlated factor model achieved an acceptable fit as all the goodness of fit indices were above the minimum recommended cut-off except GFI and AGFI[$\chi2(186) = 396.040$, $p = 0.000$, $\chi2/df = 2.129$, GFI = 0.891, AGFI = 0.864, TLI = 0.909, CFI = 0.920, RMSEA = 0.059, and SRMR = 0.0491]. An examination of modification indices suggested that allowing a few error terms to covary may improve the model fit. Thus, we allowed the said error terms to correlate one by one, and the final model [see Figure 1(a)] was found to be a good model fit as all the goodness of fit indices were in acceptable range ($\chi2(175) = 282.3$, $p = .000$, $\chi2/df = 1.613$, GFI = .923, AGFI = .899, TLI = .951, CFI = .959, RMSEA = .044, and SRMR = .0403). Further, the said three-factor measurement model of the DASS-21-H was also found to have satisfactory local fit as all the standardized estimates (factor loadings) were around .5 or above except item 2 of anxiety subscale having a loading of 0.116 (Figure 1 and Table 2) that was having a trend level significance ($p = .061$). It is worth mentioning that three subscales of the DASS-21-H had a very high positive correlation with each (correlation

Table 2: The standardized factor loadings for the correlated three-factor model of the DASS-21-H

Item No.	*Items*	*Depression*	*Anxiety*	*Stress*
3	मुझे किसी भी तरह की सकारात्मक भावना का बिलकुल अनुभव नहीं होता था।	.502**		
5	किसी भी कार्य की शुरुआत करने के लिए कदम बढ़ाने में मुझे कठिनाई होती थी।	.559**		
10	मुझे महसूस होता था कि भविष्य में मेरे लिए कोई उम्मीद नहीं है।	.682**		
13	मैं निराश व उदास महसूस करता था/करती थी।	.698**		
16	मैं किसी भी चीज़ के प्रति उत्साहित होने में असमर्थ था / थी।	.601**		
17	मुझे लगता था मैं योग्य व्यक्ति नहीं हूँ।	.681**		
21	मुझे जीवन निरर्थक लगा।	.688**		
2	मुझे अपने मुंह के सूखने का अहसास हुआ ।		.116#	
4	मुझे साँस लेने में कठिनाई का अनुभव होता था (जैसे, अत्यधिक तेजी से साँस चलना, शारीरिक मेहनत के बिना साँस का फूलना / हांफना)।		.498**	
7	मुझे कम्पन का अनुभव होता था (जैसे हाँथो में)।		.593**	
9	मैं उन परिस्थितियों के बारे में चिंतित रहता / रहती था / थी, जिनमे मैं संभवतः घबरा जाता / जाती और खुद का मजाक बनवा लेता / लेती।		.698**	
15	मुझे लगता था कि मैं जल्द ही घबराने वाला / वाली हूँ।		.688**	
19	शारीरिक मेहनत के बिना भी मैं अपने हृदय की गतिविधियों (जैसे, धड़कन तेज होने का अहसास, धड़कन का लापता होना / रुक जाना) से परिचित था / थी।		.448**	
20	मुझे बिना किसी उचित कारण के डर लगा।		.643**	
01	मुझे तनाव मुक्त होने में कठिनाई हुई।			.590**
06	मेरी परिस्थितियों के प्रति जरुरत से ज्यादा प्रतिक्रिया देने की प्रवृत्ति हो गई थी।			.573**
08	मुझे लगता था कि मैं अत्यधिक नकारात्मक ऊर्जा का प्रयोग करता/करतीहूँ।			.744**
11	मैंने खुद को चिड़चिड़ा/व्याकुल पाया।			.772**
12	मुझे विश्राम करने में कठिनाई होती थी।			.616**
14	मैं अपने काम में किसी तरह की रूकावट को सहन नहीं कर पाता था/पाती थी।			.554**
18	मैंने महसूस किया की मैं जल्द ही नाराज हो जाता था/जाती थी।			.571**

*p<.05; **p<.01; #p=.061

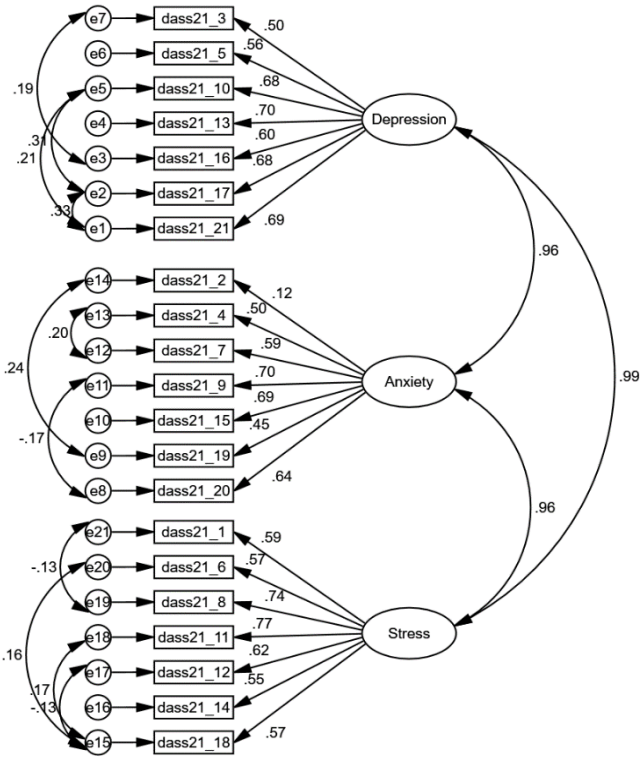

Figure 1a: Three factor model

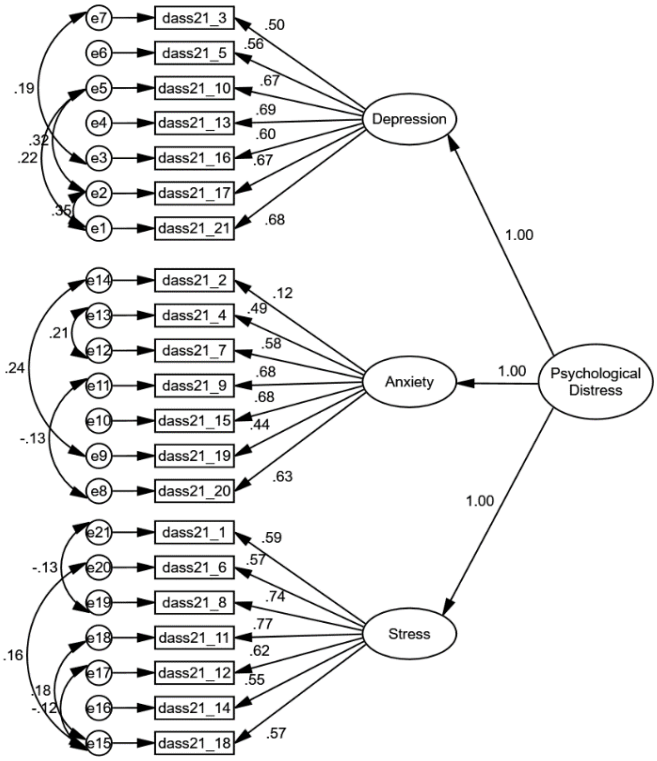

Figure 1b: Second order model

ranged from .96 to .99, which further supports our speculation that these three apparently distinct subscales of depression, anxiety, and stress may represent a higher-order factor of psychological distress.

In view of the above, we tested the second-order model in which the three first-order factors of depression, anxiety, and stress were treated as indicators of the second-order latent construct of psychological distress. Similar to the correlated three-factor model of the DASS-21-H (Figure 1a), few error terms within a subscale were allowed to correlate, one – by -one, based on modification indices. The final model (Figure 1b) demonstrated a good fit to the data as the various goodness of fit indices were in the acceptable range ($\chi2(178) = 286.289$, p = .000, $\chi2/df = 1.608$, GFI = .922, AGFI = .899, TLI = .951, CFI = .958, RMSEA = .043, and SRMR = .0406). The second-order factor structure model of the DASS-21-H was found to have a comparable fit ($\Delta\chi2$ (3) = 3.989; p=.263; ΔCFI = .001; ΔRMSEA=.001).

The standardized estimates (factor loadings) of the three subscales of the DASS-21-H have been presented in Table 2.

Factor structure invariance

The three-factor model of the DASS-21-H showed a configural invariance (no difference in the number of factors and its constituent items) across sexes($\chi^2(350) = 500.508$, $p = .000$, $\chi^2/df = 1.430$, GFI = .873, AGFI = .832, TLI = .933, CFI = .944, RMSEA = .037, SRMR = .0509) as well as a metric invariance (no significant difference in the magnitude of factor loadings of various items of given factors) as evident from non-significant difference between unconstrained and measurement weight constrained models [$\Delta\chi^2(18) = 12.274$, $p = .833$, ΔCFI = .002, ΔRMSEA = .002]. In terms of scalar invariance (i.e., equality of the intercepts), findings revealed a significant difference in chi-square and CFI values of the measurement weight-constrained and intercept-constrained models [$\Delta\chi^2(21) = 53.236$, $p = .000$, ΔCFI = 0.012] suggesting that intercept of one or more items are not comparable across male and female participants. However, a non-significant difference in RMSEA (ΔRMSEA=.003) as well as an overlap of the confidence interval of RMSEA of measurement weight-constrained model (RMSEA

0.027–0.042) and intercept-constrained model (RMSEA 0.031–0.044) suggested scalar invariance.

Thus, to address this inconsistency, we tested the pair-wise difference in intercepts across male and female groups and the intercept of item 9 was found to be significantly higher in males (.938) compared to females (.738) of the anxiety subscale (critical ratio = -2.027, p <.05). Similarly, the intercept of items 6 and 8 of the stress subscales of the DASS-21-H was found to be significantly higher (Critical ratio -2.582, p <.05; -2.259, p <.05, respectively) in males (1.057 and .777, respectively) than females (.792 and .569), respectively. Thus, these findings suggest that the three-factor model is partially non-invariant (or almost invariant) in terms of the intercept of one item of anxiety and two items of stress subscales, as only three intercepts differed out of 21. The observed partial non-invariant suggests that item 9 contributed more to the latent factor score of anxiety and item 6 & 8 to a latent score of stress among males compared to females.

The measurement invariance of the second-order measurement model of DASS-21-H was also tested and the findings revealed configural invariance (χ^2(356) = 523.730, p = .000, χ^2/df = 1.471, GFI = .867, AGFI = .828, TLI = .927, CFI = .938, RMSEA = .038, SRMR = .0513) as well as metric invariance ($\Delta\chi^2$(18) = 12.468, p = .822, ΔCFI = .002, ΔRMSEA = .001) across the two sexes. However, in terms of scalar invariance the model showed partial non-invariance like the three-factor model first-order model. The difference between the measurement weight-constrained and intercept-constrained model was significant in terms of chi-square and CFI ($\Delta\chi^2$(21) = 52.723, p = .000, ΔCFI = .012) but not in terms of change in RMSEA (ΔRMSEA = .002). The scalar invariance test results of the second-order factor model were found to be same as for the three-factor first-order model because of the same standardized estimates of each item of the respective factors. Accordingly, this model was also found to have partial scalar non-invariance and the intercepts of items 6, 8, and 9 were found to be significantly higher in males compared to females (p <.05; see the previous paragraph for intercept values and critical ratios).

Discussion

In the present study, we developed a new Hindi version of the twenty-one-item depression anxiety stress scale (DASS-21) that can be considered a refinement of the earlier available Hindi versions of the DASS-21 (Kumar *et al*. 2019; Singh *et al*. 2013). As discussed in the introduction, the review of the item content of the said earlier versions by present authors and other experts revealed that Hindi translations of several items of DASS-21 in both versions (Kumar *et al*. 2019; Singh *et al*. 2013) either failed to convey the intended psychological content or lacked in the clarity. Our new Hindi version of the DASS-21 (referred to as DASS-21-H to distinguish it from earlier Hindi versions) was found to have satisfactory linguistic and transliteral equivalence, as evident from the comparability of the original English version and the back-translated English version. The adequacy of the item translation of the newly developed DASS-21-H was not only supported by the comparability of the original English and back-translated English version but it is also evident from the findings of our pilot testing. The findings of pilot testing of the DASS-21-H revealed that none of the participants reported any difficulty in comprehending the meaning of the item content which lends further support for the adequacy of the Hindi translation of the DASS-21-H.

The findings support the psychometric adequacy of the DASS-21-H to assess the symptom severity of depression, anxiety, and stress as well as the overall level of general psychological distress (using the aggregate score of the three symptom categories) among Hindi-speaking Indians. The findings of the confirmatory factor analysis provide support for the original three-factor model as well as the second-order factor model of the DASS-21-H. The validity of the factor structure can be considered as evidence for the construct (factorial) validity of the scale. Further, the observed high positive correlation among the three factors (subscales) may be considered as preliminary evidence of the convergent validity of the DASS-21-H.

The item level as well as scale level psychometric properties of the DASS-21-H were found to be highly satisfactory. All the items (except item number 2) of the DASS-21-H were found to be psychometrically adequate, as evidenced by the acceptable level of item-total correlation and alpha–if–item deleted, both at the subscale level as well as full-scale level. Item 2 of the DASS-21-H (an item of the anxiety

subscale) was found to be psychometrically inadequate in our study, as evidenced by its low item-total correlation (.137), increase in the reliability of the full scale after deleting this item (alpha increased from .916–.923), as well as poor factor loading in the CFA model. The consistently poor psychometric property of this item across different methods and parameters, though it provides ample support for its psychometric inadequacy, we recommend that this item be dropped in subsequent studies only after re-examining the item level psychometric properties of the DASS-21-H in general and the item-2, in particular. The reason for such a recommendation is that even after removing the said items, we noted that the model fit did not show significant improvement. Further, with the present data and analyses, it is difficult to infer whether the observed poor psychometric property of this item is because of the inadequate translation or due to some other reasons.

The internal consistency of all three subscales as well as for the full scale, was found satisfactory as both alpha and omega coefficient values were found to be greater than the minimum recommended value of 0.7. The reliability of our DASS-21-H was comparable to a previous validation study of the Hindi version of the DASS-21 conducted on a non-clinical sample (Singh *et al*., 2013). The reliability of DASS-21-H obtained in the present study was also comparable to the reliability obtained with non-clinical samples across several countries and cultures using English, Chinese, Turkish and German (Bibi *et al*., 2020; Osman *et al*., 2012; Zanon *et al*., 2020), and Polish (Makara-Studzinska *et al*., 2022) versions of DASS-21. However, the reliability estimate obtained in our study was lower than another validation study of the Hindi version of DASS-21 conducted on a clinical sample of head and neck cancer patients (Kumar *et al*., 2019). Based on the said observations, it can be safely concluded that the newly developed Hindi version of the DASS-21 (DASS-21-H) is psychometrically adequate and can be used to reliably assess the symptoms of depression, anxiety and stress.

It is important to note that the full-scale level reliability of the DASS-21-H was much higher than the individual subscales which suggests two possibilities. First, the DASS-21-H might be measuring a unidimensional construct (e.g., psychological distress), and secondly, the scale length might be a factor underlying the observed higher reliability of the full scale as an increase in scale length has been found to increase the reliability estimate (DeVellis, 2017, p.137). Further, the observed strong correlations among the raw score of the three subscales (depression, anxiety, and stress) as well as the latent factor score of the said subscales support the former possibility of the existence of either first-order or the second-order unitary construct such as mental health or psychological distress. Both the possibilities (i.e., first-order unidimensional construct and second-order latent construct of psychological distress have received some empirical support in earlier studies (Daza *et al*., 2002; Makara-Studzinska *et al*., 2022; Sinclair *et al*., 2012).

The present findings of the confirmatory factor analysis provide support for the original three-dimensional model. The three-factor model of the DASS-21-H gets support from earlier studies validating different language versions of the DASS-21 such as Spanish (Daza *et al*., 2002) and Polish (Makara-Studzinska *et al*., 2022)language versions. The observed configural and metric invariance and partial scalar non-invariance of the three-factor model of the DASS-21-H across sexes provide additional support for the validity of the three-dimensional models of DASS-21. Moreover, the partial scalar non-invariance across genders (limited to one item of anxiety and two items of stress) suggests that the scores of depression are comparable across males and females, but due care is needed while comparing the scores of anxiety and stress subscales. Lack of scalar invariance has been found in a cross-cultural study that compared the factor model of DASS-21 across participants of two countries viz., Pakistan (assessed using the English version) and Germany (assessed using the German version) (Bibi *et al*., 2020). The said authors noted that the model failed to achieve metric invariance because of significant differences in factor loadings of five items (item number 6, 8, 9, 12 and 14) as well as scalar invariance because of significant differences in the intercept of item number 6, 9, and 12. Similarly, in a multinational study examining the factor structure of DASS-21 using the local languages of the coun-

tries, Zanon *et al*. (2020) found scalar invariance for the three-factor model across Canada, Hong Kong, Romania, Taiwan, and the United States but not across Turkey, Brazil, and UAE.

The observed significant differences in intercepts (scalar non-invariance) were limited to only three items in the present study, which suggests that users of this Hindi version of the DASS-21 should be cautious while comparing and interpreting scale level differences between males and females. These significant differences in intercepts imply that latent means across these groups may be biased, and group differences in indicator mean (or estimated factor scores) may not correspond to factor means (Kline, 2015). This finding implies that the scores may reflect not only differences in the underlying constructs but also disparities in how males and females perceive and respond to these three items. Specifically, males reported a higher tendency to overreact (item 6), panic (item 9), and use nervous energy (item 8) at the same levels of the latent constructs of anxiety and stress compared to females. This indicates that these items contribute more significantly to males' anxiety and stress levels. Therefore, caution should be exercised when generalizing the results across genders.

The observation of a good-fitting second-order factor structure model of the DASS-21-H is another notable finding of the present study. The model fit of this second-order factor structure was though comparable to the first-order three-factor model, the existence of a higher-order single factor of 'psychological distress' supports the possibility of computing a global score (by adding the scores of the three subscales) to index overall psychological distress or mental health problems. The existence of a second-order latent factor of 'psychological distress' has also been reported by other researchers across different cultures and countries (Daza *et al*., 2002; Makara-Studzinska *et al*., 2022; Zanon *et al*., 2020). The speculation that three subscales of the DASS-21-H may also gauge the overall mental health problems has also been advocated in a recent study in which the three psychopathological symptoms of depression, anxiety and stress were modeled to represent higher-order latent factors of mental health (Chauhan *et al*., 2024).

The present observation that the three psychopathological symptoms of anxiety, depression and stress are strongly correlated is suggestive of several possibilities. First, the said three psychopathological symptom categories may have some underlying common latent factor. This possibility is supported by the observation that they are often found as comorbid conditions (see reviews, Hammen, 2005; Saha *et al*., 2020). Further, the tripartite model of psychopathology theorizes that negative affect is a common factor underlying both depression and anxiety (Clark & Watson, 1991). The second possibility is that there may be an overlap in terms of the content of these three subscales. This possibility is supported by the fact that stress defined from a response-oriented perspective (i.e., equating it with strain) includes anxiety, depression, and worries as indicators of stress (Suzuki & Ito, 2013). Hence, all three subscales of the DASS-21 have stress as a common underlying factor and this psychological content-related overlap is supported by the observation of a second-order factor of 'psychological distress' in the present study as well as in earlier studies (Daza *et al*., 2002; Makara-Studzinska *et al*., 2022). However, if this speculation is correct, then obtaining a good-fitting three-factor model might have been a remote possibility because such content-related overlap will always lead to cross-loading of items across different factors.

The findings of the present study are encouraging and provide sufficient empirical evidence to support the psychometric adequacy of this newly developed Hindi version of the DASS-21 (DASS-21-H). The DASS-21-H was not only found to be highly reliable but also found to have construct validity as supported by the convergence of the different subscales and validity of the three-factor model. These findings suggest that the DASS-21-H can be used to reliably assess the three distinct yet related constructs of depression, anxiety, and stress among Hindi-speaking Indians. Hindi is the world's third most spoken language (Eberhard *et al*., 2023) and the official language of the Republic of India (Constitutional Provision, Government of India, Ministry of Education). The availability of a psychometrically sound measure of depression, anxiety, and stress will facilitate research in the area of health and clinical

psychology in India and other parts of the world where Hindi-speaking populations exist.

The DASS-21-H, though showed satisfactory reliability and validity, and may be recommended for further research use. Attempts should be made to revalidate its psychometric properties and obtain additional support for its reliability and validity. For instance, future research may plan to evaluate other forms of reliability (e.g., temporal reliability) and validity (e.g., concurrent validity, predictive validity). The future attempt to revalidate the DASS-21-H may also help to learn whether item number 2 is psychometrically inadequate or if there is some problem in the Hindi translation of this item. Moreover, the transliteral equivalence of the DASS-21-H with the original DASS-21 needs to be empirically validated by testing its factor structure in both Hindi and English-speaking Indians and examining the cross-language measurement invariance of the factor structure of the DASS-21. The measurement invariance of the factor structure of the DASS-21 across Hindi and English will provide stronger empirical support for its transliteral equivalence. The observed strong correlations among the three subscales of depression, anxiety, and stress put a need for future research to clarify whether it reflects an overlap of the content or some shared common factor variance (e.g., negative affect). To address this issue, the positive and negative affect, autonomic arousal (using self-report or physiological measures) and DASS-21-H may be administered on the same sample of participants, and tripartite model-based analyses may be carried out to uncover the nature of the constructs measured by DASS-21-H.

Finally, the study was conducted on a non-clinical sample of young healthy adults and thus, to generalize the findings related to factor structure of the DASS-21-H, future research may include both lower (e.g., adolescents) and higher age groups, including elderly people. To enhance the clinical utility of the DASS-21-H, there is also a need to conduct validation studies on clinical samples of Hindi speaking Indians to establish the cut-off scores of each subscale to identify people with clinically significant symptoms.

Conclusion

The present study provides a transliterally better and psychometrically sound Hindi version of DASS-21 (as evident from satisfactory reliability and validity) to assess the symptom categories of depression, anxiety, and stress among Hindi-speaking Indians. The observed validity of a three-factor model while providing support for the using the DASS-21-H for assessing the three distinct symptom categories, the observation of equally good-fitting second-order factor model suggests the use of a global index to measure overall psychological distress. Both factor-structure models were found to have configural and metric invariance across sexes, supporting the generalization of the obtained factor structure across males and females. However, the lack of complete scalar invariance across genders warrants a cautious interpretation of scores for males and females. Future research should use more diverse samples, including clinical samples, to further validate these findings and ensure the scale's applicability across different demographic groups.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

We would like to express our sincere gratitude to Professor Peter Lovibond for granting us permission to translate and validate the DASS into Hindi.

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