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PSYCHOMETRIC PROPERTIES OF THE BANGLA VERSION OF PSS-10: IS IT A SINGLE-FACTOR MEASURE OR NOT?

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Abstract: The Bangla version of the Perceived Stress Scale(PSS-B) is a popular and widely used measure in Bangladesh. Despite its popularity, it has never been validated among non-clinical samples in the country.The present study examined the psychometric properties of the PSS-B in a sample of 300 respondents. A two-factor structure was found in EFA performed on half of the sample (Sample 1, $n = 150$), explaining 53.41% of the total variance. The CFA performed on the second half of the sample (Sample 2, $n = 150$), showed that the two-factor model had acceptable fit. A one-factor and a bifactor model were also tested. Good Cronbach's alphas and significant test-retest reliability were observed in the scale. Concurrent validity of the scale was established through the correlation PSS-B with PSQ-B. Convergent and discriminant validities were established through inter-factor correlations as well as the scores of composite reliability, average variance extraction, average shared variance, and maximum shared variance. The results support the use of PSS-B with a two-factor structure as a reliable and valid measure to assess perceived stress of Bangladeshi people.

Key words: Perceived Stress Scale, Psychometric properties of PSS-B, Reliability of PSS-B, Validity of PSS-B

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INTRODUCTION

Stress has been widely studied in research in abnormal, clinical, and health psychology. It depicts the person's feelings when an individual perceives that the demands of a situation exceed their personal and social resources (Folkman, 2013). Stress may arise from various sources such as job loss, failure to achieve something aspired, marital conflict, family crisis, retirement, loss of a spouse, medical problems, physical disabilities, financial crisis, loneliness or living alone, etc. The term "stress" was introduced by Selye (1976) to denote physiological reactions to adversity. In psychology, it is regarded as a relational concept in which a transaction occurs between an individual and the environment (Lazarus, 1991). In terms of conservation of resource theory (Hobfoll, 1989), stress occurs when people experience loss of resources, when they experience a lower level of resources, when their resources are threatened, and when they feel that they invest resources without a perceived future gain (Hobfoll, 1989; Hobfoll, Freedy, Green, & Solomon, 1996). Because stress is a physiological condition associated with feelings and thoughts people experience, its measurement depends on one's perception of stress rather than actual stress. Perceived stress is an individual's thoughts or feelings about how much stress they are under at a given point in time or over a specific time period (Phillips, 2013). For example, if a person's perception of a stressful event is associated with negative thoughts, it is likely that it will be perceived as more stressful than when it is associated with positive thoughts (Folkman, 2013).

Though the terms 'stress' and 'perceived stress' refer to the same underlying condition, they nevertheless differ between them. Stress is a physiological and psychological response when one detects a difference between what one had expected and what is actually happening. Perceived stress, on the other hand, is a multidimensional concept, comprising medical, physical, psychological, and psychosocial aspects. It is also associated with both the social and cultural context (Moore & Kooper, 1996). Perceived stress can be viewed as an outcome variable, measures the experienced level of stress as a function of stressful events, coping resources, personality factors, etc. (Cohen, Kamarck, & Mermelstein, 1983). It depicts not the types of stressful events happening to a person but how the individual feels about the general stresses of their life and how they handle such stresses. Folkman (2013) claimed that an individual experiences stress when they do not believe that their resources for coping are enough for what the circumstances demand. When they think that the demands being placed on them exceed their ability to cope, then they perceive themselves as experiencing stress. Perceived stress is not identical to the actual stress experienced and can be more health-destructive than the actual stress.

The Perceived Stress Scale-10

The original Perceived Stress Scale (PSS) was developed in 1983 by Cohen and his colleagues (Cohen et al., 1983). It was developed to measure how stressful an individual perceives their situations to be. Despite of other scales measuring perceived stress such as the Standard Stress Scale (SSS) by Gross and Seebaß (2014), the Perceived Stress Questionnaire (PSQ) by Levenstein et al. (1993), the Stress Overload Scale (SOS) by Amirkhan (2012), the Perceived Stress Reactivity Scale (PSRS) by Schlotz, Yim, Zoccola, Jansen, and Schulz (2011), the PSS-10 is one of the most widely used psychological instruments for measuring perceived stress over the world. Because it assesses general predisposition to the experience of stress (Morgan, Umberson, & Hertzog, 2014), includes a number of direct inquiries about current levels of stress (Cohen et al., 1983), used both as an outcome measure (Lin, 2009) and as a predictor variable (Potter, Hartman, & Ward, 2009).

The original PSS was a unidimensional scale of perceived stress, consisting of 14 items (Cohen et al., 1983). Four of the 14 items loaded poorly on the underlying factor in exploratory factor analysis (Cohen & Williamson, 1988). As a result, the PSS is now commonly used with a 10-item form (PSS-10). Further more, a two-dimensional structure was found both for the PSS-10 and PSS-14 (Cohen & Williamson, 1988; Taylor, 2015). Specifically, the negatively phrased items loaded on to one factor and the positively phrased items loaded on to the other factor (Cohen & Williamson, 1988). PSS-10 represents an individual's present state of perceived stress. The items of the PSS-10 scale are easy to comprehend and have very simple response alternatives (e.g., 0 for 'never', 1 for 'almost never', 2 for 'sometimes', 3 for 'fairly often', 4 for 'very often'). Although Cohen et al. (1983) designed this scale to use in junior high school students, the scale is not content-specific and can be used to any population group. The items of the PSS-10 ask about an individual's feelings and thoughts during the past month. In each question, the person is asked how often they felt or thought in a certain way. Since there are subtle differences between items the person is requested to treat each of them as a separate question. Reverse scoring (4 to 0) is applied to four of the items (4, 5, 7, and 8). The sum score of all the items represents the total score of the PSS, with higher scores indicating more perceived stress.

Cohen et al. (1983) showed correlations of PSS with other stress measures such as self-report health-service measures and health-related behavior measures. Psychometric properties of the PSS-10 were found to be good among US adults (Taylor, 2015). The PSS has been used in different contexts for various purposes, for example, to assess the stressful situations of an individual (Leon, Hyre, Ompad,

DeSalvo, & Muntner, 2007), to measure the effectiveness of stress-reducing intervention (Holzel et al., 2010), and to identify the associations between stress and psychiatric disorders (Culhane et al., 2001). Further, high PSS scores were observed among people who failed, for example, to quit smoking or control blood sugar levels, or were at risk for developing depressive symptoms (Cohen et al., 1983). Satisfactory internal consistency, reliability, factorial structure, and construct validity of the PSS-10 were reported in a review of 19 studies by Lee (2012). More over, the psychometric properties of PSS-10 were superior to those of PSS-14 (Lee, 2012).

The PSS-10 has been translated and adapted in various languages, as for example, French (Lesage, Berjot, & Deschamps, 2012), Chinese (Wang et al., 2011), Greek (Andreou et al., 2011), Japanese (Mimura & Griffiths, 2004). In the original PSS, Cronbach's alpha ranged from .84 to .86, and there was high test-retest reliability, r = .85. Correlations with other stress-related measures ranged from r = .52 to .76 (e.g., Cohen & Janicki-Deverts, 2012; Cohen & Williamson, 1988). Satisfactory Cronbach's alpha reliabilities (.85 and .82) were found for the two subscales of PSS-10, namely the 'perceived helplessness' and the 'perceived self-efficacy' subscales (Roberti, Harrington, & Storch, 2006). Similar findings were reported in a sample of middle-aged adults (Taylor, 2015). Further, a norm table was developed for the scale considering Harris Poll data on 2387 respondents in the United States (Cohen & Janicki-Deverts, 2012).

To sum up, PSS-10 has been widely used in many countries and has satisfactory reliability and validity. Studies conducted in various countries revealed a two-factor structure of the PSS-10 (Cohen & Williamson, 1988; Hewitt, Flett, & Mosher, 1992; Martin, Kazarian, & Breiter, 1995; Otto et al., 2004; Roberti et al., 2006). The two-factor structure of the scale was also found in different language versions such as Turkish (Orucu & Demir, 2009), Chinese (Ng, 2013; Wang et al., 2011), Bangla (Mozumder, 2017), Thai (Wongpakaran &Wongpakaran, 2010), Swedish (Eskin & Parr, 1996), Portuguese (Reis, Hino, & Anez, 2010), Japanese (Mimura & Griffiths, 2004), German (Klein et al., 2016), and Arabic (Ben Loubir, Serhier, Battas, Agoub, & Bennani-Othmani, 2014). Since the two-factor structure of PSS-10 has been found in different languages, one of the aims of the present study was to investigate the two-factor structure of the Bangla version of PSS-10.

The present study

The original English 10-item version of PSS (Cohen & Williamson, 1988) has been translated into Bangla by different researchers (e.g., Chakraborti et al., 2013; Fahim, 2001; Islam, 2013). In the present study, we used the Bangla version of PSS-10 (PSS-10-B) that was translated and adapted by Fahim (2001). A significant

correlation, $r = .90$, $p < .01$, was found between the PSS-10-B with the original English version of PSS-10 (Cohen & Williamson, 1988). Test-retest reliability of the Bangla adaptation was high over a period of two weeks, $r = .94$, $p < .01$. Two coefficient values, .96 and .94, respectively for the first testing session and second re-testing session, indicated that the reliability of the Bangla PSS-10 scale was satisfactorily good.

Chakraborti et al. (2013) tested the psychometric properties of their Bangla version of PSS-10. The internal consistency reliability for the English and Bangla version of the PSS-10 were $\alpha = .79$ and $\alpha = .80$, respectively. Joarder and Khan (2015) also investigated the psychometric properties of the Bangla version of PSS-10, which was translated by Fahim (2001). Though they performed two reliability analyses, namely, split-half, $r = .70$, $p < .01$, and test-retest, $r = .83$, $p < .01$, nevertheless, they did not perform any factorial analysis (either EFA or CFA) for this scale.

An extensive validation study of PSS-10-B among the LGBT population (Lesbian, Gay, Bisexual, and Transgender) in Bangladesh was conducted by Mozumder (2017). This is the only extensive study on the structure of PSS-10-B. As in the original PSS-10 (Cohen & Williamson, 1988) the items of PSS-10-B were structured into two factors, in which the negatively phrased items were loaded to one factor (perceived helplessness / Factor 1) and the positively phrased items were loaded to the other factor (perceived self-efficacy / Factor 2). With respect to the four groups (LGBT), this two-factor structure explained 43.55%-51.45% of the total variance in the various groups and was supported through CFA, $\chi^2/df = .07\text{-}1.80$, $p = .02\text{-}.44$; CFI = .927-.994; RMSEA = .01-.06. Internal consistency reliabilities varied in the four groups with respect to the full scale: L = .71, G = .62, B = .71, and T = .49; however, they were acceptable with respect to Factor 1, L = .83, G = .77, B = .71, T = .73, but not with respect to Factor 2, L = .54, G = .67, B = .58, T = .54. Significant correlations between the Self-Reporting Questionnaire (SRQ; WHO, 1994) and the full scale of PSS-10-B, $r = .519\text{-}.833$, were found, supporting the convergent validity (unidimensional form) of the scale. There were also significant correlations between SRQ and Factor 1, $r = .467\text{-}.818$, and Factor 2, $r = .122\text{-}.315$, supporting the convergent validity of the two-dimensional form of the scale.

Hypotheses of the study

The following hypotheses were formulated:

1. The two-factor structure of PSS-10-B will be confirmed in the sample of general population of the present study.
2. The PSS-10-B will have satisfactory Cronbach's alpha and test-retest reliability.
3. The PSS-10-B will show convergent and discriminant validity.
4. There will be gender invariance of the structure of the scale.

METHOD

Participants

The sample comprised 300 adults of both genders, aged 21 to 60 years (M = 31.34, SD = 8.59) from the Chittagong district, Bangladesh. A convenience sampling method was used. All participants were in good health and had no physical or clinical symptoms. Participants who reported having any physical or clinical symptoms were excluded from the study sample.The demographic characteristics of the sample are presented in Table 1.

Table 1. Socio-demographic characteristics of the sample

Variable	Participants (N = 300)
Gender (%)	
Male	150 (50)
Female	150 (50)
Residence (%)	
Urban	100 (33.33)
Suburban	100 (33.33)
Rural	100 (33.33)
Educational background (%)	
Elementary	10 (3.33)
Junior high school	25 (8.33)
SSC	35 (11.67)
HSC	87 (29)
Graduation	122 (40.67)
Post graduation	21 (7)
Age	
M (SD)	31.34 (8.59)

Note: SSC = Secondary school certificate, HSC = Higher secondary school certificate

Measures

Bangla Perceived Stress Scale (PSS-10-B)

The PSS-10-B version used in this study had gone through a standardized translation procedure by Fahim (2001). At first, the author had given the original English scale to two experts to translate the items to Bangla (forward translation). An expert panel (the author, psychologists, forward translators, linguists), then, reviewed (in some cases they modified items) the translated items of the scale. After reviewing the scale

items, the panel finalized a preliminary version of the scale. This preliminary version was then given to two other experts to translate it from Bangla to English (backward translation). After completing the backward translation process, the expert panel again reviewed the backward translated items. After a careful revision of the items, the final Bangla version of the PSS-10 was finalized.

The PSS-10 consists of two types of items: negatively phrased items (1, 2, 3, 6, 9, and 10) and positively phrased items (4, 5, 7, and 8). The negatively phrased items in the scale reflect the helplessness behavior of an individual, in which an individual endures repeated painful stimuli which is unable to escape or to avoid. The positively phrased items, on the other hand, reflect an individual's self-efficacy beliefs about their capabilities to influence the stressful events that affect their lives. Thus, on the basis of an item's content, researchers labelled the negatively phrased items as 'perceived helplessness' or 'perceived distress' and the positively phrased items as 'perceived self-efficacy' or 'perceived coping' (Hewitt et al., 1992; Martin et al., 1995; Mozumder, 2017; Orucu & Demir, 2009; Roberti et al., 2006). Example items for Factor 1 are: In the last month, how often have you been upset because of something that happened unexpectedly? (Item 1); In the last month, how often have you been angered because of things that were outside of your control? (Item 9). Example items for Factor 2 are: In the last month, how often have you felt confident about your ability to handle your personal problems? (Item 4); In the last month, how often have you been able to control irritations in your life? (Item 7).

Bangla Perceived Stress Questionnaire (PSQ-B)

A culturally appropriate measure of perceived stress in Bangla, namely the Perceived Stress Questionnaire (PSQ-B), was developed by Keya (2006). It consists of 20 items, with the response given on a 5-point Likert-type scale, ranging from 0 = Not at all, 1 = A little, 2 = Moderate, 3 = Quite a lot, and 4 = A great deal. Higher scores indicate high perceived stress. Reverse scoring is used in five items (items 7, 9, 10, 11, and 12). For the full scale of PSQ-B, the internal consistency reliability was $\alpha = .77$ (Keya, 2006). Temporal stability of the PSQ-B, $r = .73$, was established using the test-retest method over a two-week period. The PSQ-B scores were found to be much higher for respondents who were evicted from their shelter than respondents who were non-evicted, indicating the predictive validity of the scale. Thus, the PSQ-B (Keya, 2006) was shown to be psychometrically sound and is a valid and reliable questionnaire for measuring perceived stress of Bangladeshi people.

Procedure

Data were collected purposefully from different districts at Chittagong division, Bangladesh. After getting informed consent by the participants and their briefing on the aim of the study, respondents were assured that the highest confidentiality would be maintained throughout the whole research process. The questionnaires were administered along with a demographic information form individually. The participants were instructed to give the answer for each question attentively. Respondents who did not understand the questions properly were given necessary explanations. They were requested to read each statement carefully and express their feelings by putting a tick mark (✓) on the appropriate response scale. They were also told that there was no right or wrong answer, so give their response truthfully. The respondents were also provided with a return envelope to ensure anonymity. The envelope was returned to the researcher upon completion of the questionnaires.

RESULTS

Exploratory factor analysis

The Kaiser-Meyer-Olkin (KMO) test, a sampling adequacy test, was firstly performed to the data. The KMO index was .823, above the recommended value of .60 (Tabachnick & Fidell, 2013). Bartlett's test of sphericity was also performed and indicated suitability of the data for factor analysis, $\chi^2(45) = 653.165$, $p < .01$. Shared variance by commonalities also indicated that factor analysis can be carried out; the commonalities for the scale items were above 0.30, except Item 4 (.125).

An exploratory factor analysis (EFA) was performed using the Principal Axis Factor (PAF) extraction method and direct oblimin rotation method with Kaiser Normalization. Sample 1 ($n = 150$) was used in the EFA. Based on the eigen values (>1) and screeplot, a two-factor model was opted. The two factors explained 53.41% of the variance. Table 2 displays the pattern matrix from the EFA. Six items loaded Factor 1 (Items 1, 2, 3, 6, 9, and 10) and accounted for 41.10% of the variance; four items loaded Factor 2 (Items 4, 5, 7, and 8) and accounted for 12.31% of the variance. Factor loadings ranged from .368 to .943. The two factors were significantly and positively correlated with each other, $r = .491$, $p < .01$ (Table 2).

Table 2. Pattern matrix from the exploratory factor analysis of the PSS-10-B

Item	Factor loadings	
	Factor 1 (Perceived helplessness)	Factor 2 (Perceived self-efficacy)
Item 10	.943	-.019
Item 2	.760	.114
Item 1	.756	-.023
Item 3	.742	.045
Item 9	.637	.031
Item 6	.462	.033
Item 5	-.093	.811
Item 8	.152	.635
Item 7	.084	.551
Item 4	.205	.368
KMO	.823	
Bartlett test of sphericity (χ^2)	653.165**	
Eigen values	4.110	1.232
% of variance explained	41.095	12.316
Total % variance explained	53.411	
Inter-factor Pearson correlation (2-tailed)	.491	

Extraction method: Principal Axis Factor; Rotation method: Direct Oblimin with Kaiser Normalization

Note: KMO = Kaiser-Meyer-Olkin; $^{**}p < .01$

A Horn's parallel analysis was also performed for the accurate estimation of the number of factors of the scale. For this analysis, a data set was simulated through a syntax written in SPSS besides the actual data. The actual and simulated data were then run with the following specifications: iteration number of 1000, principal axis factoring extraction, and random normal data generation method. The results of the parallel analysis supported the two-factor solution (Table 3). The eigen values of the first two factors in the actual data were higher than that of the eigen values of the first two factors in the simulative data, confirming the two factors of the scale.

Table 3. Eigen values of the actual and simulated data

Factor	Eigen values of the actual data	Eigen values of the simulated data
1	4.109528	1.296809
2	1.231589	1.204036
3	.938026	1.135443
4	.834598	1.074154
5	.726271	1.019192
6	.673061	.964987
7	.446632	.912692
8	.433423	.859509
9	.357821	.800533
10	.249051	.732645

Confirmatory factor analysis

A confirmatory factor analysis (CFA) was performed to test the goodness of fit of the two-factor structure of the PSS-10-B using AMOS 20. Before performing the CFA, a test of normality and a Mahalanobis Distance test were performed to evaluate whether the basic assumptions of univariate and multivariate normality are met. The normality test showed that the error variances of the scale's items were equal across different groups. The Mahalanobis Distance test was used to measure whether there were any outliers in the study sample. This test allows us to know the multivariate normality assumption of a particular test. There was no multivariate outlier in the study sample. Sample 2 (n = 150) was used. A path model (i.e., a diagrammatic model formation in the AMOS) was defined initially based on the factor structure extracted by EFA. The maximum likelihood method was used. Standardized regression estimates (β), correlation between latent variables (r), and squared multiple correlations of standardized regression estimates (R) were considered for the CFA solution. Standardized regression estimates for all items of the PSS-10-B were significant at .01 and .05 levels, respectively (see Figure 1). The squared multiple correlations of standardized regression estimates ranged from .11 to .67. A significant correlation, r = .470, p < .01, between two latent variables (perceived helplessness and perceived self-efficacy) of the scale was observed in the model (Figure 1), suggesting that the two factors were not independent.

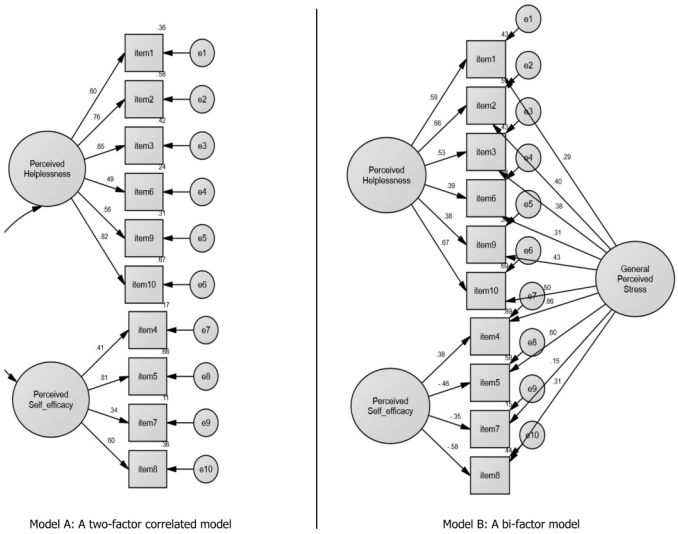

Figure 1: Two CFA models of the PSS-10-B

The model fit was assessed by multiple fit indices, including chi-squared (χ^2), ratio of chi-square and *DF* (χ^2/DF), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), comparative fit index (CFI), Tucker-Lewis index (TLI), standard root mean residuals (SRMR), and root mean square error of approximation (RMSEA). The following cut off values of model fit indices were applied: χ^2 with $p \geq .01$, $\chi^2/DF \leq 3$, GFI $\geq .95$, AGFI $\geq .90$, CFI $\geq .90$, TLI $\geq .95$, and SRMR and RMSEA $\leq .08$ (Hu & Bentler, 1999).The CFA showed an excellent model fit for the two-factor structure of PSS-10-B (see Table 4). A bi-factor model, a model with a latent structure where each items of a scale loads on a general factor, was also performed to evaluate the plausibility of the subscales, the degree to which sum scores reflect a single factor, and to evaluate the feasibility of applying a single model structure with heterogeneous indicators. The bi-factor model allowed us to retain the idea of a single common construct (perceived stress) while also recognizing two uncorrelated factors. The CFA indicated that the bi-factor model had very good fit to the perceived stress data (see Table 4).

Table 4. CFA models of the PSS-10-B and their corresponding fit indices

Model	χ^2	*DF*	*p*	χ^2/DF	GFI	AGFI	CFI	TLI	SRMR	RMSEA
One-factor	111.682	35	.000	3.191	.884	.818	.802	.746	.077	.121
Two-factor	78.674	34	.000	2.314	.918	.867	.905	.880	.073	.067
Bi-factor	52.424	26	.002	2.016	.942	.877	.932	.882	.070	.083

Since the development of the original PSS-10 scale had suggested that it is a single-factor measure, a one-factor model of the scale was also performed to compare it with the bi-factor model. Though the one-factor model showed significant standardized regression weights for the 10 items of the scale, it did not show good and acceptable fit indices, except the SRMR (see Table 4). Thus, the CFA confirmed a 10-item PSS-10-B scale with two correlated factors (Figure 1). For the comparison of the two CFA models a chi-squared difference test was calculated ($\Delta\chi^2$). Further, no invariance result was found between the one-factor and the two-factor model by a chi-square difference test, indicating that they are different models (see Table 5).

Table 5. Chi-square difference test between two nested models

Model	χ^2	χ^2 Difference	*DF*	*p*
One-factor	111.682	33.008	35	< .001
Two-factor	78.674		34	

Reliability analysis

Both internal consistency and test-retest reliability were carried out on the general and narrow factors ($N = 300$). Cronbach's alpha was .691 for the general factor, .869 for Factor 1, and .608 for Factor 2.

Test-retest reliability was also performed. The first testing was conducted on the original 300 participants. Of them, 50 respondents were selected for the second testing (retest) over a two-week period. Pearson product moment correlation was performed on the scores of the two testing sessions. A significant test-retest reliability, $r = .478$, $p < .001$, was found. Test-retest reliability was also confirmed by using the intra-class correlation coefficient (ICC) based on the initial sample scores ($N = 300$). A one-way random effects model was tested to obtain ICC. The ICC value was .770 (Table 6), higher than the recommended value of .70.

Table 6. Reliability indices and validity of the PSS-10-B (N = 300)

Reliability of the scale								Validity of the scale		
Cronbach's alpha reliability			Composite reliability			Test-retest reliability	Intra class corr.	Convergent validity (Corr. with PSQ)		
FS	F1	F2	FS	F1	F2	*r*	ICC	FS	F1	F2
.853	.876	.608	.894	.869	.691	.478**	.770	.683**	.660**	.471**

Note: FS = Full scale, F1 = Factor 1, F2 = Factor 2 ; PSQ = Perceived Stress Questionnaire; $^{**}p < .01$

Validity analysis

Two types of validity, namely convergent and discriminant, were tested in the study. To test the convergent validity of the scale, the PSS-10-B was administered along with the other standard Bangla stress measurement scale, namely the Perceived Stress Questionnaire (PSQ-B, Keya, 2006). A significant correlation, $r = .683$, $p < .01$, was found between the total score of PSQ-B and the total score of PSS-10-B. The total score of PSQ-B were also significantly correlated with the Factor 1 score of PSS-10-B, $r = .66$, $p < .01$, and the Factor 2 score of PSS-10-B, $r = .471$, $p < .01$. These correlations established the convergent validity of the scale (Table 6).

Convergent and discriminant validities were evaluated by using CFA data ($N = 150$). Composite reliability (CR), average variance extracted (AVE), average shared variance (ASV), and maximum shared variance (MSV) were performed to test the convergent and discriminant validity of the scale. Based on validity determination criteria (e.g., Fornell & Larcker, 1981; Hair, Black, Babin, & Anderson, 2010; Hair, Hult, Ringle, & Sarstedt, 2014), for convergent validity, CR for the construct should

be ≥ .70 and AVE ≥ .50, and for discriminant validity, AVE > MSV, AVE > ASV, the AVE of a latent variable should be higher than the squared correlations between the latent variable and all other variables. Though the convergent validity of the PSS-10-B with the PSQ-B was good (Table 6), it was not satisfactory by CR and AVE values, except the CR (.814) for Factor 1 (see Table 7). Table 7 shows that the AVE value of each factor was greater than the corresponding factor's ASV and MSV values (Fornell & Larcker, 1981; Hair et al., 2010; Hair et al., 2014). Hence, the discriminant.

Table 7. Convergent and discriminant validity of the PSS-10-B using CFA data (N = 150)

	F1 (Perceived Helplessness)	F2 (Perceived Self-efficacy)
Number of items	6	4
Total factor loadings	3.874	2.159
Average factor loading	.646	.540
Composite Reliability (CR)	.814	.633
Average Variance Extracted (AVE)	.430	.340
Average Shared Variance (ASV)	.034	.192
Maximum Shared Variance (MSV)	.202	.139

Invariance testing

A set of multi-group CFA tests was conducted to examine the equivalence of the scale across gender. The PSS 10 has been widely administered to men and women under the assumption that it is measuring perceived stress equally for these two different population groups. However, measurement invariance across gender has not been tested. Several researchers claim that it is necessary to compare different groups on a latent construct, like PSS-10 (e.g., Brown, 2006; Cheung & Rensvold, 2002; Vandenberg & Lance, 2000). Gender invariance was tested with five comparison models (e.g., configural, measurement weights, measurement intercepts, measurement residuals, and structural covariances). The following fit indices (e.g., chi-square, CFI, RMSEA) were used for the comparison of the models along with the invariance values of ΔCFI ≥ -.01 and ΔRMSEA ≥ .015 (Chen, 2007), which indicate lack of invariance (see Table 8). The configural model (M1) had adequate fit indices, suggesting the same PSS-10-B factor structure in the two genders. Taking all the findings into consideration (except the ΔCFI value for the comparison of model M3-M2), the four models (M2 through M4) demonstrated no meaningful decreases in model fit indices. Thus, the two-factor structure of PSS-10-B was invariant across genders. Not only the two-factor structure of PSS-10 was invariant across gender but the bi-factor model of PSS-10 was also invariant across gender (see Table 8).

Table 8. Test of measurement invariance of PSS-10-B by gender

Comparison models	Model	Model fit					Model comparison		
		χ^2	*DF*	χ^2/DF	CFI	RMSEA (90% CI)	Models	ΔCFI	ΔRMSEA
Configural (M1)	Two-factor	179.80	68	2.64	.900	.074 (.061-.088)			
	Bi-factor	78.28	50	1.57	.900	.044 (.023-.061)			
Measurements weights (M2)	Two-factor	184.16	76	2.42	.891	.076 (.065-.088)	M2-M1	-.009	.002
	Bi-factor	134.02	67	2.00	.891	.058 (.044-.072)		-.009	.014
Measurements intercepts (M3)	Two-factor	234.92	86	2.73	.852	.069 (.060-.083)	M3-M2	-.039	-.007
	Bi-factor	184.84	77	2.40	.852	.069 (.056-.081)		-.039	.011
Measurements residuals (M4)	Two-factor	241.49	96	2.52	.849	.071 (.056-.082)	M4-M3	-.003	.002
	Bi-factor	200.08	87	2.30	.849	.066 (.054-.078)		-.003	-.003
Structural covariances (M5)	Two-factor	243.92	98	2.49	.848	.071 (.056-.082)	M5-M4	-.001	.000
	Bi-factor	203.18	90	2.26	.848	.065 (.053-.077)		-.001	-.001

DISCUSSION

Although the Bangla version of PSS-10-B (Fahim, 2001) has been available since its translation in 2001, few studies have extensively examined its psychometric properties considering non-clinical Bangladeshi people. To our best understanding, the present study is the first study to measure the psychometric properties of the PSS-10-B among Bangladeshi non-clinical samples.

The present study aimed to assess the factor structure, reliability, and validity of PSS-10-B in Bangladeshi non-clinical population. The CFA results revealed a significant bi-factor as well as a two-factor model in the PSS-10-B. The two-factor structure of the present scale was consistent with previous studies conducted on PSS-10 in different countries (e.g., Chaaya, Osman, Naassan, & Mahfoud, 2010; Golden-Kreutz, Browne, Frierson, & Andersen, 2004; Klein et al., 2016; Mozumder, 2017; Orucu & Demir, 2009). The present study performed a correlated trait model (i.e., a model with correlated factors), a very familiar and commonly applied model among all CFA models, to confirm the two-factor structure of the PSS-10-B. This model is reasonable when a scale is composed of multiple item parcels with similar

content, assumed that the multiple factors can always be extracted depending on the degree of correlation between the factors.The argument is forming a single aggregate versus scoring factors can be made (Reise et al., 2010). As compared with the correlated trait model, a restricted bi-factor model (Gibbons & Hedeker, 1992) was also performed to test whether each item of a scale loads on a single general factor (e.g., perceived stress) as well as on additional orthogonal group factors (perceived helplessness or perceived self-efficacy). This model assumes that all items measure a common latent factor, influenced by an additional common factor (caused by parcels of items) through the variance of each item (Reise, Moore, & Haviland, 2010).

PSS-10-B was internally consistent for the Bangladeshi non-clinical population. Though moderate Cronbach's alpha and composite reliability index were observed in the second factor (perceived self-efficacy), however, internal consistency reliabilities were good and acceptable in the first factor (perceived helplessness) and the full scale (perceived stress). Inter-correlations between the standard Bangla PSQ and the PSS-10-B and its factors were high and significant, indicates a good convergent validity of the scale. Test-retest reliability over two-week period and intra-class correlation coefficient were also significant for the PSS-10-B. Multiple fit indices using CFA data indicated a good fit of the two-factor as well as the bi-factor model of PSS-10-B. Model fit was supported by the χ^2/DF criterion as well as by GFI, AGFI, CFI, and TLI indices. Though a low fit index of RMSEA ($< .05$) is considered for a highly acceptable fit index for a particular model, however, RMSEA (.067) was considered as indicative of the acceptable fit index (.05-.80) in the present model (Hu & Bentler, 1999). Since there were good fit indices for both the two-factor and the bi-factor models, no modifications were made to maintain the comparability between these two models.

Though the full scale (Perceived stress) and Factor 1 (Perceived helplessness) of the scale showed acceptable levels of internal consistency, however, Factor 2 (Perceived self-efficacy) showed moderate acceptable internal consistency reliabilities. This finding is consistent with previous findings (e.g., Ng, 2013; Wang et al., 2011) in which poor psychometric properties were found for Factor 2. The internal consistency reliability of Factor 2 was not very poor, so the factor was not discarded from the final analysis. In contrast to the two-factor CFA model, the one-factor CFA model (i.e., one general factor model) of PSS-10-B had a poor fit. This result is consistent with previous findings (e.g., Mitchell, Crane, & Kim, 2008; Ng, 2013). An additional bi-factor model and rotations (Reise et al., 2010) also showed that the multidimensional PSS-10-B is most appropriate to measure perceived stress among Bangladeshi people rather than the unidimensional PSS-10-B.

Limitations of the study

Some limitations of the present study should be addressed. The present study relied solely on self-report measures and did not consider any behavioral or physiological aspects of stress. Future studies might incorporate these issues so that the scale can further be substantiated to measure its construct validity. Further, due to the sampling procedure applied, different levels of an important demographic characteristic, namely, education, were not equally represented. Moreover, there was high variability in the participants' age. Against the above-mentioned limitations, a good sample size and a high response rate are credited for the accuracy of the findings of the study.

Conclusions

The present study demonstrated a two-factor structure of the PSS-10-B, a finding which is consistent with previous studies. However, since a bi-factor model was also confirmed, it is evident that the scale can be used to measure both general perceived stress but also aspects of it. The satisfactory reliability indices and validity of the scale allow us to recommend its use to measure perceived stress of Bangladeshi people.

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