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ORIGINAL RESEARCH

Psychometric Analysis of the Perceived Stress Scale Among Healthy University Students

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Background: There is a gradual increase in the prevalence of stress during professional courses. Previous studies reported a high incidence of stress among university students. The psychometric properties of the perceived stress scale-10 (PSS-10) have been established in different populations. The current study aimed to assess psychometric properties of the PSS-10 in Saudi university students.

Methods: Healthy university students (n= 192) participated in this cross-sectional study. All the participants were explained about the aim and procedures of the study. Participants were requested to complete the English version of the PSS, the generalized anxiety disorder-7 (GAD-7), the sleep hygiene index (SHI), and demographic details.

Results: The range of the PSS-10 total score was 0–35; 1% reported minimum score of 0, but none reported maximum score of 40. Therefore, there was no issue of ceiling or floor effect in the PSS-10 total score. Positive and significant correlations of the PSS total and the PSS Factor-1 (distress perception) with the GAD-7 total score, SHI item-8 and SHI item-13 score support its convergent validity. Negative or no correlation of the PSS Factor-2 score (coping perception) with the GAD-7 total score, SHI item-8 and SHI item-13 scores demonstrate its divergent validity. The internal homogeneity test indicated moderate to strong positive correlations (r=0.60–0.82) between the PSS Factors and the items loading on them. The internal consistency test showed a good agreement for the PSS Factor-1 and the PSS Factor-2 scores (Cronbach's alpha 0.78 and 0.71, respectively), suggesting an acceptable level of consistency. Factor analysis favored a 2-Factor model of the PSS in the Saudi students.

Conclusion: The current study supported the use of the PSS-10 to assess the perceived stress among Saudi university students.

Keywords: PSS, stress, university students, validity, reliability

Introduction

Psychological stress results from an imbalance between the external environmental demands and an individual's perception of meeting them. Studies have suggested that mental stress is often associated with depression, anxiety, and physical conditions including cancer and cardiovascular diseases.[1–4] People often experience stress if they realize that their assets are inadequate to handle a situation.[5]

There is a gradual rise in the prevalence of stress during professional courses.[6,7] Previous studies reported a high incidence of stress among university students,[8,9] resulting in an increased tendency of the suicidal act.[10,11] Emotional stress and other related disorders significantly affect the academic performance as well as professional practice.[12,13] Students who perceive medical stress can present with mental distress and further health problems.[14,15]

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University students irrespective of courses often meet various sources of stress for instance lifestyle changes, variable environment, interpersonal relationships, and academic burdens, all of which result in a significant psychological impairment. High risk of perceived stress is present among residents in Saudi Arabia.[16] Moreover, medical students in the Arab countries have frequent problems of stress, depression and anxiety.[17] Besides, medical students demonstrated a high level of stress in Saudi university.[18]

The perceived stress scale-10 (PSS-10) is a commonly used scale to assess stress.[19] The PSS evaluate the degree to which external demands appear to be higher than individual's perceived capability to handle the situation.[19] The original PSS-10 was considered as a single construct due to the irrelevant distinction between the two different dimensions.[20] However, a confirmatory factor analysis (CFA) by Golden-Kreutz suggested that the PSS-10 had predominantly two-dimensional structure.[21] Besides, Andreou et al[22] indicated that the two-dimensional model of the PSS-10 and the PSS-14 appears to be a better fit. Furthermore, a principal component analysis (PCA) approved the presence of two dimensions of the PSS-10.[21]

It is widely accepted that gender influences stress and females reported higher levels of daily stressors as compared to males.[22,23] McDonough and Walters[24] reported approximately 23% higher distress scores in the females than males. Similarly, another study also reported higher stress levels in females as compared to males.[25] A recent study also found significantly increased levels of anxiety, depression, and frustration in female than male university students.[26] Since the influence of gender on stress is well known, the current study includes only male participant to minimize gender's effect.

The psychometric properties of the PSS-10 have been established in different populations.[27–30] Several past studies have examined the validity of PSS-10 to assess perceived stress among university students.[31–37] For example, a previous study examined confirmatory factor analysis (CFA) of PSS-10 and they found the 2-factor model is most suitable to assess perceived stress among the Ethiopian university students.[31] Similarly, another study evaluated the principal components factor analysis of PSS-10 and they reported an adequate reliability and validity of PSS-10 to measure perceived stress among Turkish university students.[32] Additionally, Lu et al[34] conducted construct validity analysis of PSS-10 and they reported that the 2-factor model of the principal component analysis indicated positive (Factor 1) and negative (Factor 2) perception of stress among Chinese university students. Although many studies have been published on the psychometric properties of PSS-10 among university students in different countries, no previous study evaluated the psychometric properties of the PSS-10 in the Saudi population. Therefore, the current study aimed to assess the psychometric properties of the PSS-10 in Saudi university students.

Methods
Participants and Study Design
Healthy university students participated in this cross-sectional study. This study failed to include any female participants because the study was conducted in the male campuses. All the participants were explained about the aim and procedures of the study. Participants were excluded if they had a history of stress-related disorders. Participants were requested to complete the English version of the PSS, the generalized anxiety disorder-7 (GAD-7), the sleep hygiene index (SHI), and demographic details. The participants were requested to provide a written informed consent. The study was approved by the institutional Ethical committee, Rehabilitation Research chair, King Saud University, Saudi Arabia. All the procedures were followed the Declaration of Helsinki.

Measures
PSS-10
The PSS is a 10-item questionnaire designed to evaluate the self-reported amount of stress in the participants by assessing thoughts and feelings in the previous month. Each question is scored from 0 (never) to 5 (very often) with a total possible score range of 0 to 40. A higher score indicates a high level of stress.[19]

GAD-7
The GAD-7 scale is a 7-item questionnaire designed to assess the self-reported level of anxiety in the participants in the last two weeks. Each question is scored from 0 (not at all) to 3 (nearly every day) with a total score in the range of 0 to 21. The items were constructed to assess symptoms of anxiety as per the Diagnostic and Statistical Manual of Mental Disorders-IV-TR.[27] The GAD-7 scale has been found to have psychometric validity in Saudi university students.[38]

SHI
The SHI is a 13-item questionnaire designed to assess participants' sleep hygiene behaviour. Items in the questionnaire

are dichotomous and scored 0 (no) or 1 (yes). The SHI total score (range of 0 to 13) is obtained by adding together all the item scores. A higher SHI total score signifies poor sleep hygiene. In addition, two items of the SHI (item-8 and item 13) also assess stress and worry at bedtime. Therefore, both of these items were used to assess the convergent validity of the PSS.[28] The SHI with dichotomous scoring pattern has been validated in Saudi university students.[39]

Statistical Analysis

SPSS 16.0 for Windows (SPSS Inc., Chicago, USA) along with add on module-AMOS (Analysis of Moment Structures) was used for the statistical analysis. Descriptive statistics including mean, percentage, frequency, skewness and kurtosis index were employed for demographics and item analysis. The Cronbach's alpha test was used to assess the internal consistency of the scale. The Spearman correlation test was used to evaluate the internal homogeneity and the convergent validity. Sample size adequacy and the sample suitability for the factor analysis of the PSS scores were evaluated using the anti-image matrix, Determinant, Bartlett's test of Sphericity, Inter-item Correlation, Communality, and Kaiser-Meyer-Olkin Test of Sampling Adequacy (KMO). The Confirmatory factor analysis (CFA) was conducted using Maximum likelihood extraction. CFA tested two models, i.e. 1-Factor model, and 2-Factor correlated model (found valid in previous studies).[29,31] Multiple indices from various classes of fit measurements were also employed.[30] According to standard practice, model fit was evaluated using the adjusted goodness of fit index (AGFI), chi-square statistics, Akaike information criterion (AIC), goodness of fit index (GFI), comparative fit index (CFI), parsimony normed fit index (PNFI), Tucker–Lewis index (TLI), root-mean-square error of approximation (RMSEA), and root-mean-square residual (RMR).

Results

Participants' Characteristics

Table 1 details the participant's characteristics. The average scores for the PSS-10, the GAD-7 and the SHI were 16.16, 5.27, and 6.70, respectively. Most of the participants (79%) were involved in the light physical activity.

Item Analysis and Internal Consistency

Item analysis for the PSS-10 is presented in Table 2. Item analysis indicated that data did not have issues of skewness or kurtosis. Floor and ceiling effects were calculated

Table 1 Participant Characteristics of Saudi University Students

Characteristics	Mean ± SD/Frequency
Age (year)	20.54 ± 1.93
PSS	16.16 ± 5.98
SHI	6.70 ± 2.29
GAD-7 scale	5.27 ± 4.44
Light physical activity	
No	17 (8.9%)
Yes	152 (79.1%)
Did not report	23 (12%)

Abbreviations: SD, standard deviation; BMI, body mass index; GAD-7, generalized anxiety disorder-7; PSS, perceived stress scale, SHI, sleep hygiene index.

if more than 15% of the participants reported the lowest or the highest score, respectively.[31,32] The range of the PSS-10 total score was 0–35; 1% reported minimum score of 0 but none reported the maximum score of 40. Therefore, there was no issue of the ceiling or the floor effect in the PSS-10 total score.

Convergent and Divergent Validity

Table 3 presents the convergent and the divergent validity. Positive and significant correlations of the PSS total and the PSS Factor-1 scores (distress perception) with the GAD-7 total score, SHI item-8 and SHI item-13 scores confirm the convergent validity. Negative or no correlation of the PSS Factor-2 score (coping perception) with the GAD-7 total score, SHI item-8 and SHI item-13 scores demonstrate the divergent validity of the PSS in this population of Saudi male students. This is because the PSS Factor-2 score does not assess stress, but it measures the coping strategy to stress.

Homogeneity Test

The internal homogeneity test indicated moderate to strong positive correlations (r=0.60–0.82) between the PSS Factors and the items loading on them (Table 4). The internal consistency test indicated a good agreement for the Factor-1 and the Factor-2 of the PSS scale (Cronbach's alpha 0.78 and 0.71, respectively), suggesting an acceptable level of consistency (Table 4).

Sample Size Adequacy

Table 5 illustrates measures of sample size adequacy and the sample suitability for factor analysis of the PSS-10 scores. The anti-image (>0.5) and the Kaiser-Meyer-Olkin Test of Sampling Adequacy (KMO) (>0.5) suggests that the sample size is adequate.[33] The Bartlett's test

Table 2 Descriptive Statistics of the Perceived Stress Scale-10 (PSS-10) in Saudi University Students

Perceived Stress Scale Items	Mean ± SD	Skewness		Kurtosis		Percentage Distribution of Item Scores				
		Statistic (SE)	z	Statistic (SE)	z	0	1	2	3	4
pss 1	1.45 ± 1.18	0.49 (0.18)	2.78	−.61 (0.35)	−1.74	22.9	33.3	23.4	14.1	6.3
pss_2	1.29 ± 1.11	0.73 (0.18)	3.16	−.01 (0.35)	−.02	26.6	36.5	23.4	7.8	5.2
pss_3	1.67 ± 1.09	0.31 (0.18)	1.75	−.35 (0.35)	−.98	14.1	29.7	35.4	12.5	6.3
pss_4	2.14 ± 1.23	0.03 (0.18)	0.20	−1.00 (0.35)	−2.86	8.9	25.5	27.1	21.4	17.2
pss_5	1.32 ± 1.11	0.58 (0.18)	3.29	−.28 (0.35)	−.80	25.5	32.8	26.0	9.4	4.7
pss_6	1.29 ± 1.23	0.76 (0.18)	3.20	−.26 (0.35)	−.75	31.8	30.7	18.8	10.9	6.8
pss_7	2.34 ± 1.26	−.24 (0.18)	−1.37	−.98 (0.35)	−2.79	7.3	19.3	24.3	25.9	22.8
pss_8	2.03 ± 1.34	−.07 (0.18)	−.40	−1.19 (0.35)	−3.27	15.6	20.8	19.8	24.0	16.7
pss_9	1.49 ± 1.20	0.43 (0.18)	2.44	−.74 (0.35)	−2.12	25.5	28.6	24.5	14.6	6.3
pss_10	1.26 ± 1.20	0.63 (0.18)	3.27	−.54 (0.35)	−1.55	32.8	28.6	21.1	12.1	4.7
pss_total	16.28 ± 5.93	0.15 (0.18)	0.84	0.51 (0.35)	1.45					

Abbreviations: SD, standard deviation, SE, standard error.

(<.001) signifies that the original matrix is not an identity matrix and therefore, there is no issue of singularity in the measured variables-the PSS item scores.[33] The determinant score (>.01) indicates that there was no problem of multicollinearity in the PSS item scores.[33]

Factor Analysis

Table 6 shows that the 2-Factor model (Figure 1) had the best fit with lowest values for AIC, χ^2 and χ^2/df, and optimal values for AIC, PNFI, CFI, TLI, and RMSEA.

Discussion

The current study found the evidence for the psychometric validation of the PSS-10 in Saudi university students. There were no floor and ceiling effects for the PSS total scores indicating that even at the highest or the lowest scores of the PSS total score, the variance of the measures is not numerous.[32] This supports the construct validity as

Table 3 Convergent and Divergent Validity: Correlation of the Perceived Stress Scale-10 (PSS-10) with Related Measures in Saudi University Students

	GAD-7 Total	SHI Item-8	SHI Item-13
PSS total	0.37**	0.17*	0.19**
PSS Factor-1	0.52**	0.16*	0.22**
PSS Factor-2	−.17*	0.02	0.03

Notes: *p < 0.05, **p < 0.01. SHI-8 and SHI-13 are items of the SHI which assess self-reported measures of stress and worry at bedtime.
Abbreviations: GAD-7, generalized anxiety disorder-7 scale; SHI, sleep hygiene index.

Table 4 Internal Consistency and Rotated Factor Matrix of the 2-Factor Model of the Perceived Stress Scale-10 (PSS-10) in Saudi University Students

Items of PSS-10	Item-Factor Score Correlation		Cronbach's Alpha if Item Deleted	
	Factor-1	Factor-2	PSS Factor-1 (0.78)	PSS Factor-2 (0.71)
pss_1	0.64**		0.76	
pss_2	0.63**		0.75	
pss_3	0.62**		0.77	
pss_4		0.73**		0.69
pss_5	0.60**		0.77	
pss_6	0.63**		0.77	
pss_7		0.82**		0.56
pss_8		0.82**		0.58
pss_9	0.72**		0.74	
pss_10	0.74**		0.74	

Note: **p < 0.01.

Table 5 Measures of Sample Size Adequacy and Sample Suitability for Factor Analysis of the Perceived Stress Scale-10 (PSS-10) Scores in Saudi University Students

Measures	Values
Anti-image matrix	0.60–0.84
Bartlett's test of Sphericity	<0.001
Communality	0.24–0.46
Determinant	0.08
Kaiser-Meyer-Olkin Test of Sampling Adequacy (KMO)	0.74

Table 6 Fit Statistics of the Perceived Stress Scale-10 (PSS-10) in Saudi University Students

Models	AIC	PNFI	CFI	TLI	RMSEA	χ^2	df	p	χ^2/df
1-Factor	233.33	0.39	0.65	0.45	0.14 (0.12–0.17)	173.33	35	0.00	4.95
2-Factor	133.42	0.52	0.91	0.85	0.08 (0.05–0.10)	71.42	34	0.00	2.10

Abbreviations: AIC, Akaike information criterion; PNFI, parsimony normed fit index; CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root-mean-square error of approximation.

well the content validity of the PSS in Saudi university students as a self-rated measure of stress. In a previous study, Wu and Amtmann did not find any major floor and/or ceiling effects in patients with Multiple Sclerosis.[40]

Stress disorders are commonly associated with anxiety[41] and impaired sleep,[42] whereas sleep impairment may be due to bedtime stress and worries.[43] Therefore, the correlation between the PSS and the measures of anxiety, i.e. the GAD-7 scale[27] and bedtime stress and worries as assessed by items of the SHI[28] were used to confirm the convergent validity of the PSS. The results of the current study indicated that the correlation between the PSS total and the PSS Factor-1 scores with the GAD-7 total, SHI item-8 and SHI item-13 scores confirm the convergent validity of the PSS in Saudi university students. Past studies have also confirmed the convergent validity of PSS-10 in various populations by evaluating its associations with measures of anxiety.[44–46] The studies assessed the convergent validity of the PSS by evaluating its associations with the measures of anxiety. Perera et al[46] used the Spielberger Trait Anxiety Inventory in community-dwelling adults to establish the convergent validity of the PSS. Similarly, the Hospital Anxiety and Depression Scale was used to assess convergent validity of the PSS in patients with the systemic lupus erythematosus,[47] while the GAD-7 was employed in community-dwelling adults.[48] Maroufizadeh et al[49] reported a moderate association between the PSS-10 and anxiety sub-item of the Depression Anxiety Stress-21 scale in adults with asthma.[49]
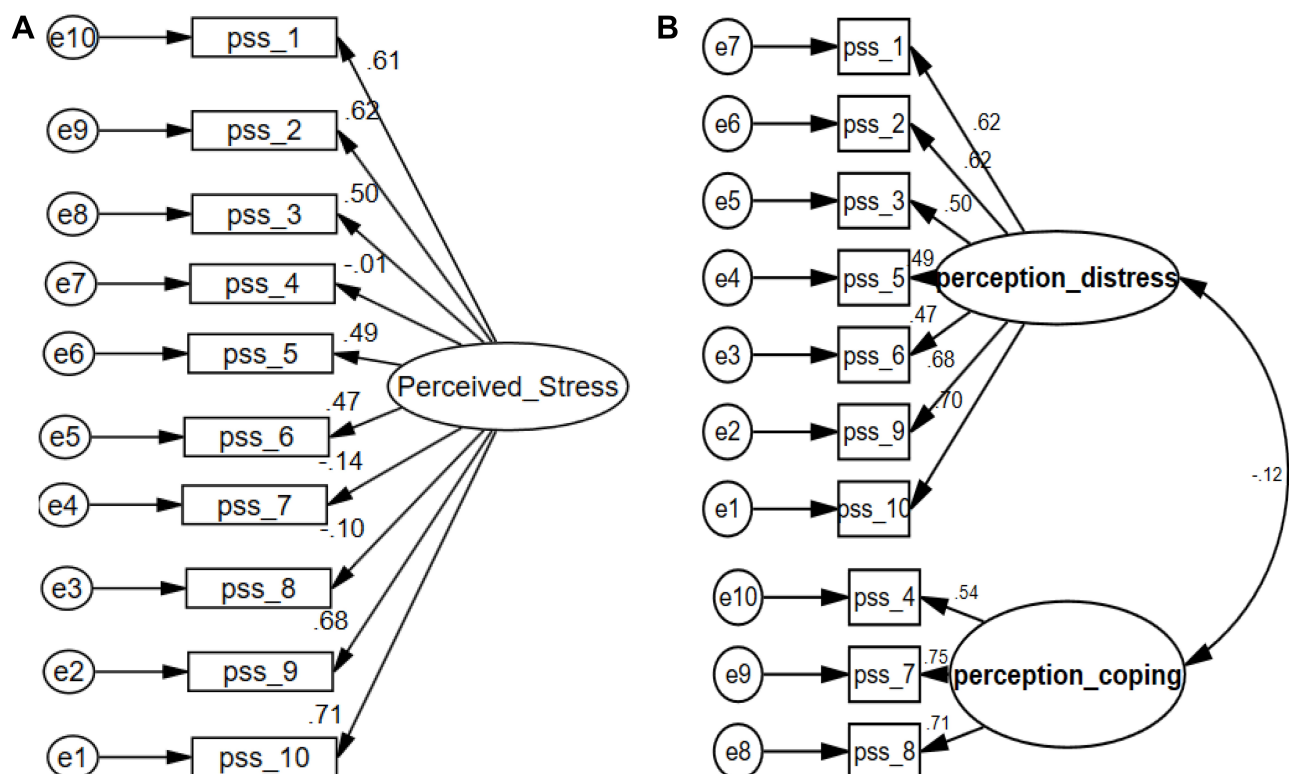
Figure 1 Confirmatory factor analysis models of the perceived stress scale-10 (PSS-10) in Saudi university students ((**A**) 1-Factor model, (**B**) 2-Factor model). All coefficients are standardized. Ovals latent variables, rectangles measured variables, circles error terms, single-headed arrows between ovals and rectangles factor loadings, single-headed arrows between circles and rectangles error terms.

The Cronbach's alpha value for the two factors in the current study found an acceptable consistency with little higher values for the Factor-1, which is a measure of distress. However, in a systematic review, Lee[50] reported higher values, i.e. 0.74 to 0.91 in diverse populations. The internal homogeneity as demonstrated by the moderate to strong correlations between the PSS factors and their respective items, further validate the PSS-10 in this population of Saudi university students. Possibly no previous study had reported the internal homogeneity, as most of the earlier studies had depended on the evaluation of the internal consistency using the Cronbach's alpha.

The 2-Factor model indicated the best fit. Similarly, previous studies have also supported the 2-factor model of PSS-10.[31,50,51] Moreover, Nielsen et al[52] also indicated better statistical fit for a two-dimensional model than a one-dimensional model of the PSS-10 among Danish nationals. Another study reported acceptable statistical fit for a two-dimensional PSS-10 among Greeks.[22] Furthermore, Golden-Kreutz[21] reported a "poor fit" for the one-dimensional model, although the statistics for the two-dimensional model suggested "close fit". In contrast, some studies supported the 1-factor[47,48,53] model, while some favored a bi-factor[50,51] model of PSS-10. Future studies involving multi-center designs with socio-culturally distinct populations are recommended to assess inconsistencies in the factorial validity.

The current study had potential limitations. First, the result of the present study is only limited to male students. Second, the current study did not assess the concurrent validity. Therefore, future studies using the diagnostic clinical interview to determine the concurrent validity of the PSS-10 in Saudi students are warranted. Third, the current study used the original English version of questionnaire; however, the participants were not the native speakers that might result poor understanding of verbal descriptors and thus affect the validity of responses. Therefore, future studies may be conducted using an Arabic translated version of the questionnaire to validate these results.

Conclusion

The current study reports adequate item analysis, internal consistency, convergent and divergent validity, and factorial validity that supports the use of PSS-10 to assess the perceived stress among Saudi university students. Further research is recommended to determine the diagnostic validity of PSS-10 for measuring perceived stress in these population.

Disclosure

The authors report no conflicts of interest for this work.

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