Scandinavian Journal of
Caring Sciences
METHODS AND METHODOLOGIES
doi: 10.1111/scs.12131

Korean versions of the Perceived Stress Scale (PSS-14, 10 and 4): psychometric evaluation in patients with chronic disease

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Scand J Caring Sci; 2015; 29; 183–192

Korean versions of the Perceived Stress Scale (PSS-14, 10 and 4): psychometric evaluation in patients with chronic disease

Background: The Perceived Stress Scale (PSS) is a representative instrument used to measure stress. The original PSS comprises 14 items (PSS-14) in two subscales, but 10- and 4-item versions are also available (PSS-10 and 4, respectively). The target populations of psychometric studies using the PSS have far mainly comprised college students, and the underlying constructs of the PSS versions are controversial: one factor vs. two factors and first order vs. second order.
Objective: The aim of this study was to evaluate the psychometric properties of the Korean versions of the PSS-14, 10 and 4 (designated KPSS-14, 10 and -4, respectively) in patients with chronic disease.
Methods: The PSS-14, 10 and 4 were translated into Korean using forward and backward translation. Factorial construct validity was tested using both exploratory and confirmatory factor analyses. Item convergent validity and item discriminant validity were tested. Concurrent validity was examined using the Center for Epidemiologic Studies–Depression scale. Known-groups validity was analysed using *t*-test and effect size. Reliability was tested using Cronbach's alpha and the intraclass correlation coefficient.
Results: Exploratory factor analysis supported a two-factor model for all Korean versions of the PSS, and confirmatory factor analysis indicated that the model fit the KPSS-10 well and the KPSS-4 only marginally. The testing of item convergent and discriminant validity revealed a 100% scaling success. As expected, all scores in the KPSS-14, 10 and 4 were moderately correlated with depression scores and differed significantly according to gender. The Cronbach's alpha for the KPSS-14 and 10 exceeded the criterion of 0.70. The intraclass correlation coefficient values of all three Korean versions were satisfied.
Conclusions: The KPSS-10 exhibited a first-order, two-factor construct, and excellent reliability and validity were established for Korean patients with chronic disease. The psychometric properties of the shortest version, KPSS-4, were only marginally acceptable.

Keywords: stress, psychometrics, reliability, validity, translation, Korean.

Submitted 14 February 2014, Accepted 25 February 2014

Introduction

The Perceived Stress Scale (PSS) is a representative instrument used to assess psychological stress (1). The PSS was designed to determine "the degree to which situations in one's life are appraised as stressful" (1). On the basis of the transactional model of stress and coping, the PSS was designed to measure the degree to which an individual believes his/her life has been unpredictable, uncontrollable and overloaded during the past month (2). The original PSS, which was developed in English for a population in the USA, comprises 14 items (PSS-14) with two (negative and positive) subscales; shorter versions comprising 10 items (PSS-10) and four items (PSS-4) are also available. The items in the shorter versions were selected from the 14 items of the PSS-14.

The PSS has been translated into various languages, such as Spanish (3), Portuguese (4), Greek (5), French (6), Chinese (7), Turkish (8), Japanese (9), Thai (10) and Arabic (11), and the psychometric properties of these versions have been reported for several cultures and

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countries. However, there was a lack of consensus in these previous studies with regard to the underlying construct of the PSS. As mentioned above, the PSS-14 and 10 originally comprised two subscales: negative and positive (2). Some research supports this two-factor construct (4, 10, 11); however, a one-factor construct has also been reported (12). In addition, some researchers have insisted that the PSS-10 has a hierarchical construct with second-order factors (4, 13). For the shortest version, the PSS-4, some studies demonstrated a one-factor construct using exploratory factor analysis (EFA) (2, 6, 12), while others demonstrated a two-factor construct using confirmatory factor analysis (CFA) (5, 14). The underlying construct of the various versions of the PSS need to be clarified using a cross-validation approach including both EFA and CFA.

A recent systematic review of the PSS pointed out that the target populations used for psychometric studies on the PSS have mainly been college students or workers (15). Therefore, the generalisability of the PSS for use with other populations is limited. Given that psychological stress has been linked to various chronic illnesses over the last three decades (16), psychometric evaluation of the PSS for diverse clinical populations with a wide age range is necessary to expand its use to diverse clinical settings.

The three versions of the PSS (PSS-14, 10 and 4) have never been evaluated for Korean patients with chronic disease. The reliability and validity of the PSS-14 for a Korean population were tested recently, but only with college students (17). The Korean version used in that study involved the transcription of some English words into Korean spelling based on how the words are pronounced in English. Even though the college students appeared to experience no problems understanding those words, the words may be troublesome for individuals with lower educational levels. Therefore, before the PSS-14 can be applied to Korean patients with chronic disease, it must be translated into Korean and the psychometric properties of the translated version must be empirically assessed in that clinical population.

The selection of a questionnaire for use by health professionals in clinical practice requires consideration of its length, since longer questionnaires may represent a greater burden to patients. Therefore, it is practically important to identify whether or not the psychometric properties of the shorter versions are appropriate for Korean patients with chronic disease.

Aims

The overall aims of this study were to translate and elucidate the psychometric properties of the Korean versions of the PSS-14, 10 and 4 (designated KPSS-14, 10 and 4, respectively) in Korean patients with chronic disease.

Methods

Study design

A methodological study design was used to assess the following properties: cultural translation, factorial construct validity, item convergent and discriminant validity, concurrent validity, known-groups validity, internal consistency reliability and test–retest reliability.

Participants and procedures

Participants in this study were recruited from two university hospitals and one health centre in South Korea. The following eligibility criteria for participation were applied: aged at least 20 years, articulate in the Korean language and diagnosed with a chronic disease that is common in Korea (diabetes, cardiovascular disease, rheumatoid arthritis, chronic liver disease or asthma) and which had been present for at least 1 year. Potential participants were selected at outpatient clinics by health professionals and briefly informed about this study. Research assistants met the potential participants who agreed to participate and asked them to sign the informed consent form and to complete a package of questionnaires. Of the participants, patients with rheumatoid arthritis were given a return envelope (complete with a returning address and a stamp) to enclose the KPSS-14 for the assessment of test–retest reliability, after completing the package of questionnaires. They were asked to take the envelope home and complete the KPSS-14 after 1 week. They were then asked to post the return envelope near their home.

Ethical issues

Ethical approval for this study was obtained from medical ethics committees in South Korea prior to commencing data collection, which was performed from September 2012 to February 2013. Written consent was obtained, and all participants were assured of their confidentiality.

Measures

Cultural translation and the KPSS. The PSS was originally developed in English. It comprises 14 items that cluster into two subscales: the negative subscale (items 1, 2, 3, 8, 11, 12 and 14) and the positive subscale (items 4, 5, 6, 7, 9, 10 and 13). The items are rated on a 5-point Likert-type scale, ranging from 0 to 4, with those on the positive subscale scored in reverse. The scores for the 14 items are summed to obtain the total score of the PSS, with a higher score indicating higher perceived stress. The internal consistency reliability, test–retest reliability, criterion validity, concurrent validity and factorial

validity of the PSS-14 have been established (1, 2). Two shortened versions of the PSS were subsequently produced: the PSS-10 (negative subscale: items 1, 2, 3, 8, 11 and 14; positive subscale: items 6, 7, 9 and 10) and the PSS-4 (single subscale: items 2, 6, 7 and 14) (2).

The English versions of the PSS were translated into Korean in this study using forward and backward translation (18). The original versions of the PSS in the source language (English) were independently translated by two bilinguals into the target language (Korean). A consensus about the use of the target language in these two forward-translated versions was reached by a panel of three bilinguals. Another two bilinguals then translated the Korean versions back into English. These forward and backward translation processes were performed with a focus on semantic equivalence rather than word-to-word translation. The panel unified the backward-translated versions and finalised the potential Korean versions. A professor majoring in Korean literature finally reviewed the reading level of the words and grammar in the Korean versions. Permission to translate the PSS into Korean was obtained from its original developer.

Center for Epidemiologic Studies–Depression (CES-D). For the concurrent validity, the KPSS was hypothesised to be moderately related to depression in this study, based on previous studies (1, 3, 19). Depression was measured using the CES-D scale (20). This scale comprises 20 items, each of which is scored on a 4-point Likert scale, with the total score ranging from 0 to 60. The internal consistency reliability, test–retest reliability, concurrent validity and discriminant validity of the CES-D scale have been established in a Korean population (21).

General characteristics. Data on demographic characteristics (age, gender, education level, marital status and income) and medical characteristics (diagnosis and duration of disease) were collected. Gender was used to test the known-groups validity since women reportedly have higher scores on the PSS-14, 10 and 4 (5, 6, 14). It was therefore hypothesised that scores on the KPSS would also be higher for women than for men.

Statistical analysis

The PASW Statistics (version 18) program was used to analyse the data. The factorial construct validity of the KPSS versions was assessed using cross-validation (involving both EFA and CFA). EFA was conducted to determine an underlying construct of the items, and CFA was used to assess the fit of this underlying construct to observed data (22). The 402 patients included in the present study were randomly split into two subsamples using random sampling of 50% of all cases in PASW Statistics: one subsample was used for EFA, and the other was used for CFA. The sample size for each subsample satisfied the requirements that at least seven times the total number of items or a total of 100 cases is required for EFA (23) and that at least 200 cases are required for CFA (24).

Prior to performing EFA, the Kaiser–Meyer–Olkin (KMO) and Bartlett's sphericity tests were performed to measure the sampling adequacy for factor analysis and the factorability of the correlation matrix (25). For EFA, principal axis factor analysis with varimax rotation was performed. Factors with an eigenvalue >1 were retained. The criterion for factor loading was set at ≥0.40 (22). For CFA, model parameters were estimated using a maximum-likelihood method. The adequacy of the model fit was assessed by the chi-square (χ^2) statistic and multiple fit indexes: the ratio of χ^2 to the number of degrees of freedom (CMIN/DF), goodness-of-fit index (GFI), standardised root mean square residual (SRMR), root mean square error of approximation (RMSEA) with 90% confidence interval (CI), comparative fit index (CFI) and normed fit index (NFI). The following indicators were used to confirm that a model was an acceptable fit: relative $\chi^2 < 3$, RMSEA < 0.08, SRMR < 0.08, GFI > 0.9, CFI > 0.9 and NFI > 0.9 (26–28).

The item convergent validity and item discriminant validity of the KPPS versions were tested using a multitrait item scale correlation matrix (29). The correlation of each item with its own scale (corrected for overlap) and the item's correlations with other scales were computed for this matrix. Pearson's correlation was used to test concurrent validity. Known-groups validity was assessed using the *t*-test, and the effect size was assessed using Cohen's *d*.

Internal consistency reliability was examined using Cronbach's alpha. A reasonable acceptability criterion for Cronbach's alpha is ≥0.70 (30). Test–retest reliability was tested using the intraclass correlation coefficient (ICC), with a criterion of ≥0.70 (23).

General characteristics, percentages of missing value, and ceiling and floor responses were computed using descriptive statistics. Comparisons of general characteristics between subsamples were analysed using the *t*-test and χ^2 test.

Results

General characteristics

Women comprised 60.4% (n = 243) of the 402 participants (Table 1). The participants were aged 58.56 ± 12.91 (mean ± SD) years, most of them were married or cohabitating (76.9%), about half had graduated from high school or a higher education establishment, and about half had a monthly income of <2 million KRW (about 1818 USD). The duration of disease was

Table 1 General characteristics of the participants

Variable	*Total sample* (*N* = 402) *n (%)*	*Subsample 1* (*n* = 201) *n (%)*	*Subsample 2* (*n* = 201) *n (%)*
Gender			
Male	159 (39.6)	80 (39.8)	79 (39.3)
Female	243 (60.4)	121 (60.2)	122 (60.7)
Age (years)			
20–29	3 (0.7)	2 (1.0)	1 (0.5)
30–39	24 (6.0)	15 (7.5)	9 (4.5)
40–49	75 (18.7)	31 (15.4)	44 (21.9)
50–59	111 (27.6)	55 (27.3)	56 (27.8)
60–69	99 (24.6)	53 (26.4)	46 (22.9)
≥70	90 (22.4)	45 (22.4)	45 (22.4)
Marital status			
Married/cohabitating	309 (76.9)	150 (74.6)	159 (79.1)
Divorced/widow(er)	62 (15.4)	32 (15.9)	30 (14.9)
Unmarried	23 (5.7)	14 (7.0)	9 (4.5)
Other	4 (1.0)	2 (1.0)	2 (1.0)
Missing data	4 (1.0)	3 (1.5)	1 (0.5)
Education level			
Elementary school	72 (17.9)	34 (16.9)	38 (18.9)
Middle school	84 (20.9)	39 (19.4)	45 (22.4)
High school	133 (33.1)	70 (34.8)	63 (31.3)
College and above	97 (24.1)	51 (25.4)	46 (22.9)
Other	11 (2.7)	6 (3.0)	5 (2.5)
Missing data	5 (1.2)	1 (0.5)	4 (2.0)
Monthly income (KRW)			
<2 000 000	206 (51.2)	105 (52.2)	101 (50.2)
2 000 000–2 999 999	64 (15.9)	32 (15.9)	32 (15.9)
3 000 000–3 999 999	48 (11.9)	19 (9.5)	29 (14.4)
≥4 000 000	59 (14.7)	32 (15.9)	27 (13.4)
Missing data	25 (6.2)	13 (6.5)	12 (6.0)
Diagnosis			
Diabetes	90 (22.4)	38 (18.9)	52 (25.9)
Hypertension or cardiovascular disease	91 (22.6)	49 (24.4)	42 (20.9)
Asthma	24 (6.0)	14 (7.0)	10 (5.0)
Rheumatoid arthritis	145 (36.1)	74 (36.8)	71 (35.3)
Chronic liver disease	52 (12.9)	26 (12.9)	26 (12.9)
Duration of disease (years)			
≤5	190 (47.3)	88 (43.9)	102 (50.7)
6–10	118 (29.3)	61 (30.3)	57 (28.4)
11–15	39 (9.7)	20 (9.9)	19 (9.5)
16–20	35 (8.7)	20 (9.9)	15 (7.4)
21–25	4 (1.0)	3 (1.5)	1 (0.5)
26–30	14 (3.5)	9 (4.5)	5 (2.5)
≥30	2 (0.5)	0 (0)	2 (1.0)

8.12 ± 7.16 years. The proportions of patients with rheumatoid arthritis, hypertension/cardiovascular disease, diabetes, chronic liver disease and asthma were 36.1%, 22.6%, 22.4%, 12.9% and 6.0%, respectively. Table 1 also presents the general characteristics of subsamples 1 and 2. The subsamples did not differ statistically with regard to age ($t = 1.37$, $p = 0.171$), gender ($\chi^2 = 0.09$, $p = 0.760$), marital status ($\chi^2 = 0.401$, $p = 0.982$), education level ($\chi^2 = 4.90$, $p = 0.298$), monthly income ($\chi^2 = 5.18$, $p = 0.159$), disease diagnosis ($\chi^2 = 2.07$, $p = 0.839$) and duration of disease ($t = 0.115$, $p = 0.908$).

Missing data and ceiling/floor responses in the total sample

The percentage of missing values for each item ranged from 0% to 1.5%. Percentages of floor responses for individual items ranged from 1.2% to 20.1%, and those of ceiling responses ranged from 1.0% to 7.0%.

Factorial construct validity

EFA with subsample 1. For subsample 1, the Bartlett's tests of sphericity for KPSS-14, 10 and 4 were significant, indicating that the correlation matrixes were suitable for a factor analysis. The KMO index of sampling adequacy for factor analysis was 0.85 for the KPSS-14, 0.82 for the KPSS-10 and 0.50 for the KPSS-4. KMO indices of >0.9, 0.8–0.9, 0.7–0.8 and 0.5–0.7 are considered superb, great, good and mediocre, respectively (31). Consideration of these criteria indicated that there was sufficient covariance in the KPSS-14 and 10 items for factor analysis; however, the KMO index for the KPSS-4 was borderline.

Exploratory factor analysis extracted a two-factor solution for all KPSS versions (Table 2), which explained 50.86%, 51.11% and 52.61% for the total variance in the KPSS-14, 10 and 4, respectively. The first factor (negative subscale) of the KPSS-14 included seven items with factor loadings from 0.47 to 0.79, and the second factor (positive subscale) included seven items with factor loadings from 0.54 to 0.75. There was no cross-loaded item. The first factor (negative subscale) of the KPSS-10 included six items with factor loadings from 0.48 to 0.79, and the second factor (positive subscale) included four items with factor loadings from 0.52 to 0.80. That is, all items of the KPSS-14 and 10 meaningfully loaded (at a criterion of ≥0.40) on their own factors, as for the original versions of the PSS-14 and 10 (2). A two-factor solution was extracted for the KPSS-4, in contrast to the single factor of the original version of the PSS-4 (2).

CFA with subsample 2. To cross-validate the two-factor models extracted by EFA, CFA was performed with subsample 2. Missing data were replaced with item means. Table 3 presents the goodness-of-fit indexes. The two-factor model of the KPSS-14 did not adequately fit the data. The χ^2 statistic was significant for the KPSS-10; however, the traditional χ^2 is sensitive to sample size and considered overly stringent in fitness assessments (32). One of the fit statistics that can be used to address this problem is the CMIN/DF; with this parameter, all of the indexes except the NFI were satisfied or at the cut-off point. Therefore, the modification indices were inspected to identify potential points of model misspecification, and

their values were used to subsequently connect the covariance between two error terms with two-headed curved arrows (Fig. 1). This model was re-estimated, which showed that χ^2 had decreased significantly to 72.06 ($\Delta\chi^2 = 11.62$, $p < 0.001$), and the modified model fit indices were CMIN/DF = 2.18, GFI = 0.95, SRMR = 0.07, RMSEA = 0.07 (with 90% CI of 0.05–0.09), CFI = 0.94 and NFI = 0.91, indicating that the modified model fitted the data well. All of the model parameters were significant, and the standardised loadings ranged from 0.30 to 0.88 (Fig. 1).

As an ancillary analysis of the constructs of the KPSS-10, CFA with a second-order two-factor model was conducted. A Heywood case (negative estimation of variance) occurred for the residual error variance associated with a factor (negative subscale), which was resolved by constraining the negative error variance to near zero (=0.005) (33). The re-estimated second-order model revealed no significant difference in the χ^2 value ($\Delta\chi^2 = 0.02$, $p > 0.05$).

Most of the fit indices were satisfied by the two-factor model of the KPSS-4 (Table 3). However, the RMSEA value needs to be carefully considered. RMSEA has recently been recognised as one of the most informative criteria in covariance structural modelling, and the advantage of RMSEA shows its CI (34). The value of RMSEA in the present study was >0.1, which corresponds to the level for model rejection (35). Moreover, the 90% CI was very wide (0.00–0.25), indicating unreliability of the estimated value (28).

Table 2 Factor loadings for exploratory factor analyses

		KPPS-14		*KPPS-10*		*KPPS-4*	
	Abbreviated item description	*Factor 1 NS*	*Factor 2 PS*	*Factor 1 NS*	*Factor 2 PS*	*Factor 1 PS*	*Factor 2 NS*
1	Upset because of something that happened unexpectedly	**0.79**	−0.06	**0.79**	−0.03		
2	Unable to control the important things in your life	**0.76**	0.05	**0.78**	0.05	0.06	**0.68**
3	Nervous or stressed	**0.77**	−0.11	**0.78**	−0.08		
8	Not coping with all the things you have to do	**0.47**	−0.11	**0.48**	−0.14		
11	Anger because of things that happened that are outside of your control	**0.75**	−0.01	**0.75**	0.01		
12	Thinking about things that you have to accomplish	**0.74**	−0.20				
14	Difficulties are piling up so high that you cannot overcome them	**0.73**	−0.06	**0.70**	−0.01	0.02	**0.76**
4	Dealing successfully with day-to-day problems and annoyances	−0.12	**0.75**				
5	Effectively coping with important changes that are occurring in your life	−0.14	**0.70**				
6	Confident about your ability to handle your personal problems	0.10	**0.75**	0.08	**0.76**	**0.71**	0.08
7	Things are going your way	0.05	**0.68**	0.02	**0.65**	**0.74**	0.01
9	Able to control irritations in your life	−0.19	**0.54**	−0.22	**0.52**		
10	You are on top of things	−0.04	**0.72**	−0.05	**0.80**		
13	Able to control the way you spend your time	−0.15	**0.63**				
	Eigenvalue	4.24	2.88	3.20	1.91	1.06	1.05
	Percentage of variance explained	30.28	20.58	32.04	19.07	26.42	26.19

KPPS-14, Korean version of the Perceived Stress Scale-14; KPPS-10, Korean version of the Perceived Stress Scale-10; KPPS-4, Korean version of the Perceived Stress Scale-4; NS, negative subscale; PS, positive subscale. Boldface values represent significant loadings.
KMO index for the KPSS-14: 0.85, Bartlett's sphericity for the KPSS-14: $\chi^2 = 1223.65$, $p < 0.001$.
KMO index for the KPPS-10: 0.82, Bartlett's sphericity for the KPPS-10: $\chi^2 = 741.27$, $p < 0.001$.
KMO index for the KPPS-4: 0.50, Bartlett's sphericity for the KPPS-4: $\chi^2 = 124.05$, $p < 0.001$.

Table 3 Goodness-of-fit indexes for the two-factor KPSS models

	χ^2 (p)	*df*	*CMIN/DF*	*GFI*	*SRMR*	*RMSEA (90% CI)*	*CFI*	*NFI*
KPSS-14	221.70 ($p < 0.001$)	76	2.92	0.86	0.09	0.10 (0.08–0.11)	0.86	0.80
KPSS-10	83.68 ($p < 0.001$)	34	2.46	0.92	0.08	0.08 (0.06–0.10)	0.93	0.88
Modified KPSS-10	72.06 ($p < 0.001$)	33	2.18	0.95	0.07	0.07 (0.05–0.09)	0.94	0.91
KPSS-4	3.37 ($p = 0.06$)	1	3.37	0.98	0.02	0.11 (0.00–0.25)	0.98	0.97

df, degrees of freedom; CMIN/DF, ratio of chi-square value to the degrees of freedom; GFI, goodness-of-fit index; SRMR, standardised root mean square residual; RMSEA (90% CI), root mean square error of approximation with 90% of confidence interval; CFI, comparative fit index; NFI, normed fit index; KPPS-14, Korean version of the Perceived Stress Scale-14; KPPS-10, Korean version of the Perceived Stress Scale-10; KPPS-4, Korean version of the Perceived Stress Scale-4.

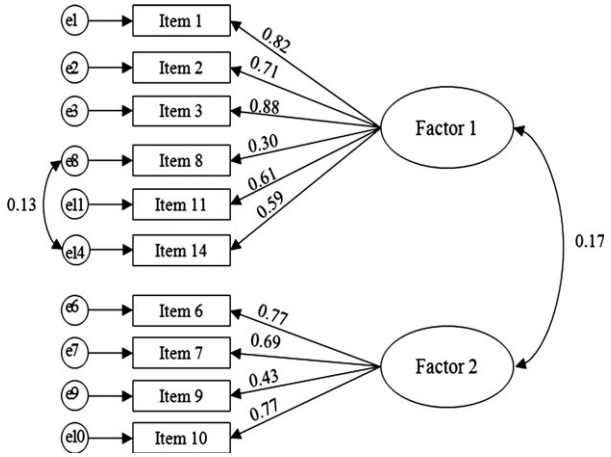

Figure 1 Modified two-factor model of the KPSS-10. Factor 1, negative subscale; Factor 2, positive subscale; e, error term.

Item convergent validity and item discriminant validity of the total sample

Item convergent validity is established if the correlation coefficient for an item and its own scale (after correcting for overlap) is ≥0.40, while item discriminant validity is established if the correlation coefficient between an item and its own scale is higher—by more than two standard errors—than the correlation coefficients between that item and the other scales (29). All of the items in the present study satisfied both item convergent validity and item discriminant validity for the KPSS-14, 10 and 4, so that the scaling success rates for all versions were 100% (Table 4).

Concurrent validity of the total sample

As hypothesised, the KPSS-14, 10 and 4 scores were significantly correlated with the CES-D scale: $r = 0.63$ ($p < 0.001$), $r = 0.66$ ($p < 0.001$) and $r = 0.59$ ($p < 0.001$), respectively. The concurrent validity was satisfied for all three KPSS versions.

Known-groups validity of the total sample

Table 5 shows the mean scores for men and women on the KPSS-14, 10 and 4. As hypothesised, the KPSS-14, 10 and 4 scores were significantly higher for women than for men ($t = -4.76$, $p < 0.001$, $d = 0.49$; $t = -5.00$, $p < 0.001$, $d = 0.51$; and $t = -4.05$, $p < 0.001$, $d = 0.41$; respectively), confirming the presence of known-groups validity.

Internal consistency reliability of the total sample

The overall Cronbach's alpha was 0.75 (0.87 and 0.85 for the negative and positive subscales, respectively) for the KPSS-14 and 0.74 (0.86 and 0.78 for the negative and positive subscales, respectively) for the KPSS-10, confirming the presence of internal consistency reliability. The overall Cronbach's alpha was 0.55 (0.67 and 0.70 for the negative and positive subscales, respectively) for the KPSS-4, indicating that internal consistency reliability was not satisfied.

Table 4 Item convergent and item discriminant validity: Correlations between each item and subscales of the KPSS-14, 10 and 4 corrected for overlap

	KPSS-14		*KPSS-10*		*KPSS-4*	
Item no.	*Negative subscale*	*Positive subscale*	*Negative subscale*	*Positive subscale*	*Negative subscale*	*Positive subscale*
1	0.72	−0.11	0.72	−0.07		
2	0.62	−0.08	0.70	−0.02	0.51	0.09
3	0.74	−0.14	0.73	−0.08		
8	0.44	−0.16	0.42	−0.14		
11	0.67	−0.02	0.65	0.04		
12	0.64	−0.25				
14	0.65	−0.10	0.63	−0.05	0.51	0.10
4	−0.18	0.67				
5	−0.16	0.61				
6	0.03	0.68	0.06	0.65	0.10	0.55
7	0.08	0.61	0.10	0.58	0.11	0.55
9	−0.28	0.49	−0.28	0.43		
10	−0.08	0.67	−0.05	0.68		
13	−0.19	0.58				

KPPS-14, Korean version of the Perceived Stress Scale-14; KPPS-10, Korean version of the Perceived Stress Scale-10; KPPS-4, Korean version of the Perceived Stress Scale-4.

Table 5 Known-groups validity: Mean differences by gender and effect sizes

	Men (n = 159) *Mean ± SD*	*Women (n = 243)* *Mean ± SD*	*t*	*d*
KPSS-14	23.73 ± 5.95	26.58 ± 5.84	−4.76[a]	0.49
KPSS-10	16.13 ± 4.58	18.53 ± 4.79	−5.00[a]	0.51
KPSS-4	6.27 ± 2.13	7.22 ± 2.41	−4.05[a]	0.41

KPPS-14, Korean version of the Perceived Stress Scale-14; KPPS-10, Korean version of the Perceived Stress Scale-10; KPPS-4, Korean version of the Perceived Stress Scale-4.
[a]p value <0.001 (two-tailed).

Test–retest reliability

Participants with rheumatoid arthritis of the total sample were asked to complete the KPSS twice with a 1-week interval in order to assess the test–retest reliability. About 70.29% of the patients completed the KPSS twice. These patients were aged 49.75 ± 7.09 years, and most of them

were women (87.3%) and married or cohabitating (81.7%). Table 5 presents the test–retest reliability data. ICC values of all three versions exceeded the criterion value of 0.70, implying the presence of temporal stability (i.e., test-retest reliability) for the three versions (Table 6).

Discussion

The current study is the first to evaluate the psychometric properties of the KPSS-14, 10 and 4 in a Korean population with chronic disease. The underlying construct of the PSS-14 based on EFA has been mainly reported as a two-factor construct (15). This is congruent with the present study. However, most previous studies did not satisfy the criterion of ≥50% of the total variance in the items explained by a two-factor solution; to our knowledge, the only exception is one study involving the Japanese version of the PSS (9). The low percentage of explained total variance in EFA might be indicative of the poor fit of the two-factor solution. In most studies—including the present study—seven items (items 1, 2, 3, 8, 11, 12 and 14) loaded on the negative subscale and the remaining seven items (items 4, 5, 6, 7, 9, 10 and 13) loaded on the positive subscale, as for the original English version of the PSS-14 (2). However, a few studies have presented somewhat different patterns of item loading. In a study involving 96 psychiatric patients in Canada, 11 of the 14 items meaningfully loaded on one of the two factors (36). However, their sample was small to allow EFA; it is therefore recommended to repeat that analysis with a larger sample. Another study involving 313 Korean college students (17) found that items 1, 2, 3, 11 and 14 loaded on the negative subscale and items 4, 5, 6, 7 and 10 loaded on the positive subscale. Those authors considered these 10 items, which constituted a subset of the 14 original items, were suitable for a Korean version of the PSS-10, although the item clustering differed from that of the original English version of the PSS-10.

Table 6 Test–retest reliability: ICC values for the KPSS-14, -10, and -4

	Test *Mean ± SD*	*Retest* *Mean ± SD*	*ICC*
KPSS-14 (Total)	25.61 ± 5.09	26.31 ± 5.71	0.80
Negative subscale	12.90 ± 4.48	12.32 ± 5.05	0.85
Positive subscale	12.70 ± 3.78	13.99 ± 3.79	0.75
KPSS-10 (Total)	18.11 ± 4.27	18.24 ± 5.06	0.81
Negative subscale	10.77 ± 3.78	10.26 ± 4.28	0.84
Positive subscale	7.34 ± 2.35	7.97 ± 2.51	0.73
KPSS-4 (Total)	6.56 ± 2.14	6.94 ± 2.43	0.77
Negative subscale	2.99 ± 1.51	2.90 ± 1.67	0.77
Positive subscale	3.58 ± 1.40	4.04 ± 1.51	0.72

ICC, intraclass correlation coefficient; KPPS-14, Korean version of the Perceived Stress Scale-14; KPPS-10, Korean version of the Perceived Stress Scale-10; KPPS-4, Korean version of the Perceived Stress Scale-4.

In the present study, the two-factor model of the KPSS-14 was not confirmed well by CFA. In a similar vein, recent studies using CFA found that a two-factor model of the PSS-14 only marginally fitted the observed data (5, 6). These findings are as expected given that the previous studies (2, 36) consistently found that <50% of the total variance was explained by a two-factor solution, as mentioned above.

Exploratory factor analysis extracted a two-factor construct for the KPSS-10, with item loadings that were the same as those for the original English version of the PSS-10 (2); furthermore, this model was confirmed by CFA. These findings are consistent with those of several studies that used EFA and/or CFA (15). However, the present study found covariance between error terms of items 8 and 14, which suggests the presence of a systematic error in the response to the affected items. The sources of the error covariance are unknown, but they may be due to the respondents misunderstanding or having difficulty interpreting the questions (37) or to a high degree of overlap in item content (34). The amount of missing data in the present study was very low, which makes respondent misunderstanding an unlikely error source. On the other hand, Koreans might perceive item 8 ("how often have you found that you could not cope with all things that you had to do?") and item 14 ("how often have you felt difficulties were piling up so high that you could not overcome them?") as being very similar, in terms of "not dealing well with things or difficulties." Future studies need to further analyse the error covariance.

Some researchers have proposed a second-order two-factor model of the PSS-10 (4, 13), but this was not supported by the present study. This is not surprising because a second-order model is feasible when there is a substantial correlation among the lower-order factors (38), whereas in the present study the first-order factors had a weak correlation, so that a second-order model of the KPSS-10 might not be adequate.

Several previous studies explored the construct of the PSS-4 using only EFA or CFA. The present study is the first to assess the construct of this shortest version of the PSS using both EFA and CFA, with this revealing the marginal fitness to a two-factor construct comprised of two items for each factor. However, each construct needs to be considered since at least three items per construct are recommended to test the adequacy of homogeneity of items with each latent construct (39).

The results for item convergent and item discriminant validity obtained in the present study supported the constructs of the KPSS versions. In other words, items in the subscales of the KPSS versions contributed roughly equal proportions of information to their own subscale scores.

Furthermore, no item was strongly correlated with both the negative and positive subscales.

Concurrent validity refers to the correlation between a studied scale and another scale based on a prior hypothesis (23). Previous studies found moderate correlations between the PSS and depression as measured with the CES-D scale (20), the Beck Depression Inventory (40) and the Hospital Anxiety and Depression Scale (41). Consistent with this, all of the KPSS versions in the present study demonstrated moderate correlations with the CES-D scale; the values of the correlation coefficients decreased in the order KPSS-10 > KPSS-14 > KPSS-4.

Known-groups validity is established when different groups have different scores on the same measure (30). As expected, women had higher scores than men on all three versions of the KPSS in the present study, demonstrating known-groups validity. However, the magnitudes of the difference (effect size) for the KPSS-14 and -4 were <0.5, which is the cut-off value for a moderate effect size (42); this result requires careful interpretation.

In this study, the overall Cronbach's alpha of the KPSS-4 was 0.55, which does not satisfy internal consistency reliability. Other studies have also found that Cronbach's alpha of the PSS-4 tends to be low, ranging from 0.60 to 0.68 (2, 5, 14). These low values may be due to the presence of a smaller number of items naturally reducing the value of Cronbach's alpha (43).

Test–retest reliability reflects the extent to which an instrument is free of measurement error (23). Pearson's correlation coefficient or ICC is commonly used as a reliability parameter. However, the former is not recommended because it does not take systematic differences into account, whereas the latter considers systematic differences to be part of the measurement error (44). Previous studies involving the Brazilian (4), Arabic (11) and Thai (10) versions of the PSS found that ICC values for the PSS-14 and 10 ranged from 0.72 to 0.90, which are similar to the values found in the present study. Together these results suggest that the various language versions of the PSS may exhibit temporal stability.

In the present study, the percentages of missing data for each item were very low, implying that the participants experienced little or no comprehension difficulties when completing the KPSS. However, some patients in this study considered the contents of the items to be very broad or general, which resulted in them experiencing hesitation when responding to the questions. This may be due to the PSS measuring general stress rather than situation-specific stress.

Study limitations

This study was subject to some limitations associated with psychometric properties. Responsiveness, which is the ability of an instrument to detect change when it occurs (30), was not tested in this study. A future study with a longitudinal design should assess responsiveness. Another limitation is the use of a 1-week time interval for the test–retest reliability. Other studies that have assessed the test–retest reliabilities of the various versions of the PSS have administered tests using intervals from 2 days to 6 weeks (15). Cohen et al. (1) found that test–retest reliability was not satisfied when using a 6-week time interval. Currently there is no empirical evidence available to guide the selection of the most appropriate time interval to use when assessing the test–retest reliability of the PSS. However, an empirical study found no significant differences when intervals of 2 days and 2 weeks were used for in the test–retest reliability of health status instruments (45). Further empirical studies of the optimal time interval to use for the test-retest reliability of the KPSS are required.

Conclusion

The KPSS-10 was revealed as having a first-order two-factor construct and excellent reliability and validity for Korean patients with chronic disease. The KPSS-10 can be therefore be used by healthcare professionals in practice to measure perceived stress and to evaluate programme interventions in research. The KPSS-4 demonstrated only marginally acceptable psychometric properties, indicating that careful assessment is necessary when considering its use. Nevertheless, the KPSS-4 has the advantage of being very short, which may make it feasible especially for the elderly or in telephone surveys. The present cultural validation of the KPSS versions will promote both domestic and international studies of stress.

Acknowledgements

The authors thank Professor Sheldon Cohen for providing permission to translate the Perceived Stress Scale into Korean.

Author contributions

Eun-Hyun Lee conceptualised and deigned the study, analysed and interpreted the data, and drafted the manuscript. Bok Yae Chung, Chang-Hee Suh and Ju-Yang Jung acquired the data, interpreted the results and revised the manuscript. All authors read and approved the final manuscript. All authors declare that they have no conflict of interest.

Ethical approval

Institutional Review Board of Ajou University Hospital (approval no. AJIRB-MED-SUR-12-172) and Kungbuk National University Hospital (approval no. KNUH 2012-10-006-001).

Funding

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science, and Technology (grant no. 2012R1A1B5000978). The funder did not play any role in the conduct or publication of the study.

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