METHODS AND METHODOLOGIES

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

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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 Þrst 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 conÞrmatory 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 CronbachÕs alpha and the intraclass correlation coefÞcient.

Results:Exploratory factor analysis supported a two-factor

countries. However, there was a lack of consensus in

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 (χ^2 = 0.09, p = 0.760), marital status (χ^2 = 0.401, p = 0.982), education level (χ^2 = 4.90, p = 0.298), monthly income (χ^2 = 5.18, p = 0.159), disease diagnosis (χ^2 = 2.07, p = 0.839) and duration of disease (t = 0.115, p = 0.908).

issing 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 ßoor 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 BartlettÕs tests of sphericity for KPSS-14, 10 and 4 were signiÞcant, 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 sufÞcient 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

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 signiÞcantly to 72.06 ($\Delta\chi^2 = 11.62$, $p < 0.001$), and the modiÞed model Þt 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 modiÞed model Þtted the data well. All of the model parameters were signiÞcant, 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 signiÞcant difference in the χ^2 value ($\Delta\chi^2 = 0.02$, $p > 0.05$).

Most of the Þt indices were satisÞed 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	DifÞculties 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	ConÞdent 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 signiÞcant loadings.
KMO index for the KPSS-14: 0.85, BartlettÕs sphericity for the KPSS-14: $\chi^2 = 1223.65$, $p < 0.001$.
KMO index for the KPPS-10: 0.82, BartlettÕs sphericity for the KPPS-10: $\chi^2 = 741.27$, $p < 0.001$.
KMO index for the KPPS-4: 0.50, BartlettÕs sphericity for the KPPS-4: $\chi^2 = 124.05$, $p < 0.001$.

Table 3 Goodness-of-Þt 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
ModiÞed 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-Þt index; SRMR, standardised root mean square residual; RMSEA (90% CI), root mean square error of approximation with 90% of conÞdence interval; CFI, comparative Þt index; NFI, normed Þt 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.

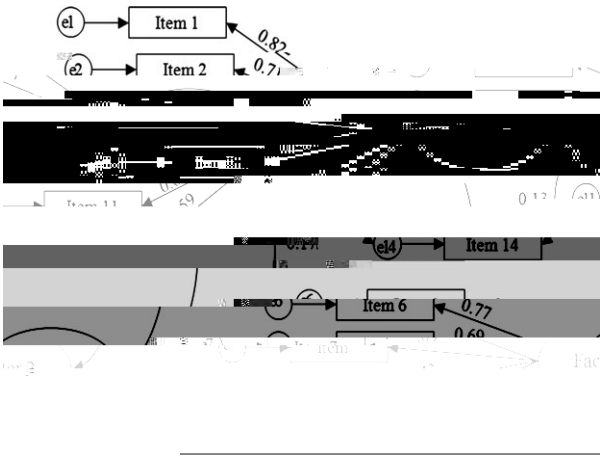

Figure 1 Modiþed two-factor model of the KPSS-10. Factor 1, negative subscale; Factor 2, positive subscale; e, error term.

Item convergent validity and item discriminant validity of the total sample

Item convergent validity is established if the correlation coefÞcient for an item and its own scale (after correcting for overlap) is ≥0.40, while item discriminant validity is established if the correlation coefÞcient between an item and its own scale is higher—by more than two standard errors—than the correlation coefÞcients between that item and the other scales (29). All of the items in the present study satisÞed 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 signiÞcantly 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 satisÞed 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 signiÞcantly 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), conÞrming the presence of known-groups validity.

Internal consistency reliability of the total sample

The overall CronbachÕs 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, conÞrming the presence of internal consistency reliability. The overall CronbachÕs 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 satisÞed.

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 Þrst 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 Þt 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.

In the present study, the two-factor model of the KPSS-14 was not conÞrmed well by CFA. In a similar vein, recent studies using CFA found that a two-factor model of the PSS-14 only marginally Þtted the observed data (5, 6). These Þndings 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 conÞrmed by CFA. These Þndings 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 difÞculty 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 (Òhow often have you found that you could not cope with all things that you had to do?Ó) and item 14 (Òhow often have you felt difÞculties were piling up so high that you could not overcome them?Ó) as being very similar, in terms of Ònot dealing well with things or difÞculties.Ó 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 Þrst-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 Þrst to assess the construct of this shortest version of the PSS using both EFA and CFA, with this revealing the marginal Þtness 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.

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 coefÞcient; 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.

Furthermore, no item was strongly correlated with both

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