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Psychometric Properties of Korean Version of Modified Leeds Sleep Evaluation Questionnaire (KMLSEQ)

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Purpose: The Leeds Sleep Evaluation Questionnaire (LSEQ) translated into Korean was modified to easily apply and reduce respondents' confusion and was evaluated for psychometric properties and discriminant ability. **Methods:** A total of 960 Korean adults aged 45 years and older participated in this cross-sectional survey. To test reliability, validity and discriminant ability, Cronbach's alpha, correlation analysis, confirmatory factor analysis, simple regression analysis and receiver operating characteristics (ROC) curve analysis were used. **Results:** Item-total correlations ranged between .62~.85 and Cronbach's alpha was .95. Area under ROC was .86 (95% CI: .83~.90) and the optimal cutoff score was identified as ≤ 66 (sensitivity, .77; specificity, .84; positive/negative predictive values, .49/.95). Using this cutoff score, the prevalence of insomnia in the study sample was 25.8% and tended to be more common in female and older groups. **Conclusion:** The data supported the psychometric properties of Korean Modified Leeds Sleep Evaluation Questionnaire (KMLSEQ) as an acceptable sleep measurement. In addition, KMLSEQ is likely to be a useful screening tool for insomnia.

Key Words: Sleep, Self-report, Questionnaire, Psychometrics

INTRODUCTION

Sleep disturbance is a common and distressing symptom in modern society (Okun et al., 2009). According to the sleep data of the Korean Sleep Research Society, the prevalence of sleep disorders was more than 20%, and 5% of the population experienced chronic insomnia. Health related specialists have given much effort to evaluating and promoting sleep quality, because sleep is an essential human need that affects everyday life, health, and quality of life (Berman, Snyder, Kozier, & Erb, 2008).

Reliable and valid measurement of sleep is necessary to evaluate and promote sleep quality. Polysomnography has been the gold standard for measuring the quality and quantity of sleep. However, it is difficult, expensive, and sometimes impossible to undertake, particularly in patients with critical illness and participants of health screening (Bourne, Minelli, Mills, & Kandler, 2007; Tarrasch, Laudon, & Zisapel, 2003). Therefore, self-administered sleep questionnaires have been used to screen sleep problems among various populations and to test the effect of sleep intervention in clinical and research fields.

The Insomnia Severity Index (ISI), Medical Outcomes Study (MOS) Sleep Scale, Pittsburgh Sleep Quality Index (PSQI), and Leeds Sleep Evaluation Questionnaire (LSEQ), which were developed and tested in western countries, have been widely used because of their sound psychometric properties, easy administration, and no need of training. Each of these measurements has its own particular characteristics in the aspects of time frame for the

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responses, cutoff score, and structure of sub-dimensions. Therefore, clinicians and researchers should choose the most appropriate measurement for the purpose of assessing sleep (Smith & Wegener, 2003).

The MOS Sleep Scale measures six sleep dimensions without a total sleep score and cutoff score. The PSQI has a slightly more complex scoring system than other tools. In addition, the PSQI and MOS-Sleep Scale may be less sensitive to estimating significant changes over time or with brief intervention periods because these refer to ratings of sleep for the previous one month period (Smith & Wegener, 2003). The LSEQ is another clinically useful tool for measuring the effect of hypnotic drugs, has shown high reliability and validity in a variety of research settings, and has been commonly used in western countries (Parrott & Hindmarch, 1980; Tarrasch et al., 2003) but not in Korea.

Measurements assessing sleep which were developed in English and tested in western cultures have to be translated and sometimes culturally modified to be used in Korea. In addition, translated versions of measurements should be tested for their psychometric properties. However, many Korean researchers skipped some steps in the translation process or in testing psychometric properties (Choi, Kim, Kim, & Kim, 2012). Recently, the reliability and validity of the Korean version of the MOS Sleep Scale (Kim, You, Lee, & Lee, 2011) and the Korean version of the PSQI (Shon, Kim, Lee, & Cho, 2012) were tested and published. In addition, the Korean Sleep Research Society posted the Korean version of ISI on its website.

However, the LSEQ was not commonly used in Korea even though it can be applied easily to assess sleep comprehensively. Most Korean researchers who tested medication effect using the LSEQ translated and modified it for their own studies by changing the time frame, or response type from VAS (visual analogue scale) to Likert type scale or omitting some items (Kim et al., 2008; Lee et al., 2005). The translation and validation study of the LSEQ would be helpful to many Korean sleep researchers, because the LSEQ has a different time frame for the response from other sleep questionnaires and has been identified as a very effective instrument to evaluate sleep in other countries.

The purpose of this study was to culturally modify the translated LSEQ and test its psychometric properties. The discriminant ability of this Korean version of the modified LSEQ as an insomnia screening instrument was also identified.

METHODS

1. Translation and Modification of the LSEQ

The LSEQ comprises ten self-rating 100 mm lines of visual analogue scale (VAS) containing four dimensions that pertained to the ease of getting to sleep (GTS), the perceived quality of sleep (QOS), the ease of awakening from sleep (AFS), and the integrity of behavior following wakefulness (BFW) (Parrott & Hindmarch, 1980).

After getting permission to use the LSEQ, the original English version was translated and modified according to guidelines for the process of cross-cultural adaptation of self-report measures (Beaton, Bombardier, Guillemin, & Ferraz, 2000) and decentering method (Brislin, 1970). The process of translation was described in detail in another article (Choi et al., 2012).

The final Korean version of the LSEQ was modified from the original in terms of language. That is, the phrase 'than usual' was eliminated from the original questions because that phrase made respondents confused, especially during screening in the pilot study. The response format was also changed into a graphic and numeric rating scale showing the left end of the line with negative wording (0), nine anchors from 10 to 90, and the right end with positive wording (100) from VAS. The reason for this modification was the difficulty in comparing current condition to past condition with the VAS response format (Choi et al., 2012). VAS, having no anchor and number on the graphic response line, is more difficult to understand and answer than other types of response formats in Korea (Won, Yang, Kim, Kim, & Choi, 2001), and the graphic and numeric rating scale is more preferable than VAS (Lee, 2002).

KMLSEQ has a total score (all item scores were summated and then divided by the number of items) and scores of four sub-dimensions (GTS, QOS, AFS, and BFW). All scores have the range of 0 to 100, and a higher score indicates better sleep.

2. Other Measurements

Role limitation due to emotional problems which are theoretically related to sleep was measured because sleep disturbance can cause difficulty in functioning in everyday life (Shekleton, Rogers, & Rajaratnam, 2010). Therefore, the concept of role limitation due to emotional problems was used to test concurrent validity and discriminant validity. It is one of the dimensions of the Medical Outcome Study (MOS) Health Survey Question-

naire (Ware, Kosinski, Turner- Bowker, & Gandek, 2002). The score ranges from 0 to 100. A higher score shows a better health condition. The Cronbach's alpha in this study was .91.

The Insomnia Severity Index (ISI) was chosen to test convergent validity and also used as a gold standard for assessing discriminant ability. It has been translated into Korean and presented as a sleep disturbance self-monitoring tool on the Korean Sleep Research Society website. It has seven items with a 5-point Likert scale (0=not at all, 4=extremely), therefore, scores range from 0 to 28. A higher score shows severe sleep disturbance and the cutoff score of insomnia is above 7 (Bastien, Vallieres, & Morin, 2001). Cronbach's alpha of this study was .80.

3. Participants and Data Collection Method

The participants were 45 years and older adults who lived in the Seoul metropolitan area. A total of 960 adults were selected using a quota sampling method with three age groups (45 to 54 years, 55 to 64 years, and 65 years and older) and by gender. Each age-gender group selected had an equal number of subjects (n=160). The mean age of the 959 subjects excluding one night shift worker was 59.8±9.13. Data were collected online from September 15th to 30th, 2011 after getting informed consent to participate in this study.

4. Statistical Analysis

To test internal consistency reliability, item-total correlation, Cronbach's alpha and composite reliability were used. In addition, floor and ceiling effects were analyzed.

Confirmatory factor analysis on four dimensions with the measurement model was evaluated using AMOS 19.0. Convergent and discriminant validity was also assessed by comparisons of correlation coefficients and values of average variance extracted (AVE). We also compared the correlation coefficient between the KMLSEQ and ISI with that of the KMLSEQ and role limitation due to emotional problems. Concurrent validity, one of the criterion-related validities, was assessed through regression analysis with role limitation due to emotional problems as a dependent variable.

To test discriminant ability, Receiver Operating Characteristic (ROC) curve analysis (Rao, 2003) was performed with the score of ISI as a gold standard. Area Under Receiver Operating Characteristic (AUROC) was extracted to estimate sensitivity which refers to the ability of the test to correctly identify those patients with insomnia, specificity which refers to the ability of the test to correctly identify those patients without insomnia, negative predictive value (NPV) and positive predictive value (PPV) Youden's Index (sensitivity + specificity - 1) was used to find the optimal cutoff score of insomnia.

RESULTS

1. Reliability

Cronbach's alpha of ten items was .95 and four dimensions ranged .84~.93; and alpha coefficients of KMLSEQ among the three age groups were all over .94 (Table 1). Item-total correlations ranged .62~.85 exceeding .40 of minimum level of summated scale (Ware, Jr. & Gandek, 1998). Composite reliability of four underlying const-

Table 1. Item Analysis and Reliability of Modified Leeds Sleep Evaluation Questionnaire (LSEQ)

Variables	Items	Item-total correlation	Floor effect (%)	Ceiling effect (%)	Cronbach's α			
					Total	45~54 yr	55~64 yr	≥65 yr
GTS	Item 1	.77	0.1	0.2	.95	.94	.95	.95
	Item 2	.76						
	Item 3	.62						
QOS	Item 4	.84						
	Item 5	.72						
AFS	Item 6	.82						
	Item 7	.78						
BFW	Item 8	.85						
	Item 9	.80						
	Item 10	.80						

GTS=Getting to sleep; QOS=Quality of sleep; AFS=Awake following sleep; BFW=Behavior following wakening.

ructs of sleep exceeded the threshold level of .70 ranging from .75 to .82 (Table 2) indicating high internal consistency of the constructs (Bagozzi & Yi, 1988; Hair, Anderson, Tatham, & Black, 1995). Floor and ceiling effects were 0.1% and 0.2%, respectively (Table 1), below the maximum level of 15% (McHorney & Tarlov, 1995).

2. Validity

Confirmatory factor analysis was undertaken for assessing the construct validity. Though the chi-square goodness of fit of measurement model was significant (x^2=127.79, df=29, p<.001), all indices indicated sound goodness of fit such as GFI=.97, AGFI=.95, NFI=.98, RFI =.97, IFI=.98, TLI=.98, CFI=.98, RMSEA=.06.

All items loaded significantly on their pre-specified latent constructs and standardized factor loadings of 10 items ranged from .71 to .92 (Table 2), exceeding the critical value of .50 (Bagozzi & Yi, 1988). T-values of all factor loadings were statistically significant (t-value > 1.96) ranging from 26.46 to 43.36. Finally, the average variance extracted (AVE) score for all sub-dimensions exceeded the recommended level of .50, ranging from .86 to .90, indicating that a higher amount of variance in the items was captured by the construct compared to that accounted for by measurement error (Hair et al., 1995). These results all supported convergent validity of the constructs (Bollen, 1989).

To verify discriminant validity between constructs, the values of AVE should be greater than the squared correlation between constructs in the model. In Table 3, the AVE was presented at the diagonal of the correlation matrix and squared correlation between constructs was shown below and left to the diagonal of the matrix. Adequate discriminant validity was evident because all AVEs were greater than the squared correlations in the corresponding rows and columns (Green, Barclay, & Ryans, 1995), and 95% CI of correlations between dimensions did not include 1 (Anderson & Gerbing, 1988).

To assess the concurrent validity of KMLSEQ, role limitation due to emotional problems was adopted as a dependent variable of regression analysis. The result showed statistically significant coefficients; r=.48 (p<.001), R^2=.23 (F=280.96, p<.001), regression coefficient β=.48 (t=16.76, p<.001).

The Pearson correlation coefficient was -.65 (p<.001)

Table 2. Confirmatory Factor Analysis of Korean Modified Leeds Sleep Evaluation Questionnaire (KMLSEQ)

Variables	Items	Standardized factor loading	Composite reliability	Cronbach's alpha	AVE
Getting to sleep	Item 1 Item 2 Item 3	0.92 0.90 0.71	0.75	0.85	0.88
Quality of sleep	Item 4 Item 5	0.92 0.79	0.76	0.84	0.86
Awake following sleep	Item 6 Item 7	0.90 0.85	0.79	0.87	0.88
Behavior following wakening	Item 8 Item 9 Item 10	0.92 0.89 0.89	0.82	0.93	0.90

AVE=Average variance extracted.

Table 3. Correlation Coefficients, Squared Correlations, and Average Variance Extracted

Variables	GTS	QOS	AFS	BFW
Getting to sleep (GTS)	.88	.70 (.026)	.67 (.027)	.65 (.026)
Quality of sleep (QOS)	.49	.86	.74 (.023)	.78 (.020)
Awake following sleep (AFS)	.45	.55	.88	.82 (.016)
Behavior following wakening (BFW)	.42	.61	.68	.90

Correlation coefficient: upper right elements; ( ): Standard error of correlation coefficient; Squared correlation: lower left elements; Average variance extracted: diagonal elements

between the total score of the KMLSEQ and ISI showing higher than that of KMLSEQ, ISI and role limitation due to emotional problems (r=.48, $p<.001$, r=-.51, $p<.001$, respectively).

3. Discriminant Ability

To test discriminant ability of the scale, ROC curve analysis was performed. In this analysis, the ISI score served as a proxy gold standard. The cutoff point of screening insomnia was greater than 7 (Smith & Wegener, 2003).

The estimated AUROC was .86 (95% CI: .83~.90). The optimal cutoff point was 66.5 which showed the greatest Youden's Index. Using an integer value cutoff score of 66, the estimated overall prevalence of insomnia was 25.8% of the participants (Table 4).

The prevalence and mean scores of those who have sleep difficulty according to different possible cutoff scores is shown in Table 5. When the cutoff score is 66, insomnia tended to be more common among females ($x^2=4.05$, $p=044$), and older people ($x^2=16.08$, $p<.001$) than males and younger respondents, respectively.

DISCUSSION

The psychometric properties of the KMLSEQ, which was translated into Korean and modified, were tested in terms of reliability, validity, and discriminant ability among Korean adults aged 45 years and older. The results of this study supported that KMLSEQ was a reliable and valid measurement to assess sleep disturbance and screen insomnia.

All results of various tests for identifying internal consistency of the KMLSEQ indicated it is a reliable tool to measure subjective sleep. Cronbach's alpha, regardless of respondents' age, was over .90. According to the suggestion that important decisions should be made on the score from the scale with its reliability in excess of .90 (Nunnally & Bernstein, 1994), the KMLSEQ could be a very reliable screening tool, even for older people.

Internal consistencies of the four domains demonstrated better than those of the French version of the LSEQ, showing .78~.92 (Tarrasch et al., 2003), and confirmatory factor analysis showed this four-factor measurement model was valid. This means that the KMLSEQ provides reliable and independent variables of sleep latency (GTS), sleep quality (QOS), ease of awakening (AFS), and daytime coordination and behavior after sleep (BFW).

Assessing the criterion-related validity, it is possible for concurrent validity and predictive validity to be used. Concurrent validity through regression and correlation was employed in this study, because a research design for collecting cross-sectional data was not suitable to apply predictive validity which requires a longitudinal study. Another reason is that subjects who show bad health status as of criterion variable could get medical treatment which can have an effect on the criterion variable during the experiment period (McDowell, 2006).

Table 4. Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and Youden's Index according to Cutoff Scores

Cutoff score	Insomnia ratio (%)	Sensitivity	Specificity	PPV	NPV	Youden's index
≤65	24.4	.739	.853	.496	.943	.592
≤66	25.8	.771	.843	.490	.949	.614
≤67	27.4	.783	.825	.468	.951	.608

Table 5. Prevalence of Insomnia according to Different Cutoff Scores of Modified Leeds Sleep Evaluation Questionnaire (LSEQ)

Cutoff score	Insomnia		Gender			Age			
			Male (n=480)	Female (n=479)	x^2 (p)	45~54 yr (n=320)	55~64 yr (n=320)	≥65 yr (n=319)	x^2 (p)
	n (%)	M±SD	n (%)	n (%)		n (%)	n (%)	n (%)	
≤65	234 (24.4)	52.28±10.43	103 (19.8)	131 (27.3)	4.51 (.034)	54 (16.9)	78 (24.4)	102 (32.0)	19.75 (.003)
≤66	247 (25.8)	53.00±10.61	110 (22.9)	137 (28.6)	4.05 (.044)	60 (18.8)	83 (25.9)	104 (32.6)	16.08 (<.001)
≤67	263 (27.4)	53.86±10.81	118 (24.6)	145 (30.3)	3.90 (.048)	63 (19.7)	87 (27.2)	113 (35.4)	19.89 (<.001)

The score of the KMLSEQ could explain respondent's role limitation. In addition, the score of the KMLSEQ correlates more with the score of the ISI, another sleep questionnaire, than with the score of role limitation. These indicated that the KMLSEQ is valid to measure sleep.

Calculated AUROC was .86 (95% CI: .83~.90) indicating good discriminant ability (McDowell, 2006) at the optimal cutoff value of 66. This indicates that the person who scored 66 and lower has a high probability of having sleep problems. Originally the LSEQ was developed for assessing the effect of medication on sleep disturbance, but the KMLSEQ can serve to screen insomnia.

The overall prevalence of insomnia was 25.8% of subjects with this cutoff score, which is similar to the 22.8% of prevalence in the Korean population study (Cho et al., 2009). In addition, a higher rate of insomnia in the female adults and older age groups was also similar to other studies (Cho et al., 2009; Ohayon & Hong, 2002). The similar pattern of prevalence in various groups to other study results could indicate that the KMLSEQ is as good a screening tool as other measurements.

The limitation of this study was using a subjective self-reporting measure as a gold standard of ROC analysis. Therefore, a study using objective physiologic measures, such as polysomnography as a gold standard, is needed in the future.

CONCLUSION

The Korean version of the modified Leeds Sleep Evaluation Questionnaire, comprised of four dimensions of 10 items with graphic and numeric response format, is a valid and reliable sleep measurement. It is useful for assessing subjective sleep quality and screening sleep problems. In addition, it is easy to apply and score.

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Appendix. Korean Version of Modified Leeds Sleep Evaluation Questionnaire (KMLESQ)

KMLSEQ (Korean Modified Leeds Sleep Evaluation Questionnaire)

※ 다음은 귀하가 요즘에 느끼는 수면의 질에 대한 질문입니다. 그 정도를 0점에서 100점 사이에서 V 표시해 주세요.

잠들기가 어떠십니까?

1 잠들기가 힘들다. 0 10 20 30 40 50 60 70 80 90 100 잠들기가 쉽다.

2 더디게 잠든다. 0 10 20 30 40 50 60 70 80 90 100 빨리 잠든다.

3 잠들기 전에 졸리지 않다. 0 10 20 30 40 50 60 70 80 90 100 잠들기 전에 졸리다.

수면 상태는 어떠십니까?

4 선 잠을 잔다. 0 10 20 30 40 50 60 70 80 90 100 푹 잔다.

5 자다가 깨어있는 시간이 많다. 0 10 20 30 40 50 60 70 80 90 100 자다가 깨어있는 시간이 적다.

잠에서 어떻게 깨십니까?

6 잠에서 깨는 것이 어렵다. 0 10 20 30 40 50 60 70 80 90 100 잠에서 깨는 것이 쉽다.

7 잠에서 깨는데 시간이 많이 걸린다. 0 10 20 30 40 50 60 70 80 90 100 잠에서 깨는데 시간이 적게 걸린다.

잠에서 깰 때의 기분은 어떠십니까?

8 피곤하다. 0 10 20 30 40 50 60 70 80 90 100 정신이 맑다.

지금 현재의 기분은 어떠십니까?

9 피곤하다. 0 10 20 30 40 50 60 70 80 90 100 정신이 맑다.

잠자리에서 일어날 때 신체의 균형감과 조정능력은 어떠십니까?

10 나쁘다. 0 10 20 30 40 50 60 70 80 90 100 나쁘지 않다.