Validation of a Korean Version of the Insomnia Severity Index

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Background and Purpose The purposes of this study were to standardize and validate a Korean version of the Insomnia Severity Index (ISI-K), and to evaluate its clinical usefulness.

Methods We translated the ISI into Korean and then translated it back into English to check its accuracy. The 614 patients with sleep disorders who were enrolled in this study comprised 169 with primary insomnia, 133 with comorbid insomnia, and 312 with obstructive sleep apnea. All subjects underwent one night of polysomnography (PSG) and completed the Korean versions of both the Pittsburgh Sleep Quality Index (PSQI-K) and the Epworth Sleepiness Scale, as well as the ISI-K. The ISI-K was compared to these sleep scales and various PSG sleep parameters.

Results The internal consistency the ISI-K total score was confirmed by a Cronbach’s alpha of 0.92, and the item-to-total-score correlations (item-total correlations) ranged from 0.65 to 0.84, suggesting adequate reliability. The correlation between the ISI-K total score and PSQI-K was 0.84, which suggested adequate convergent validity. Low-to-moderate correlations were obtained between the ISI-K total score and PSG-defined sleep parameters: 0.22 for sleep onset latency, 0.38 for wake after sleep onset, and 0.46 for sleep efficiency. A cutoff score of 15.5 on the ISI-K was optimal for discriminating patients with insomnia. The test-retest scores over a 4-week interval with 34 subjects yielded a correlation coefficient of 0.86, suggesting excellent temporal stability.

Conclusions The findings of this study show that the ISI-K is a reliable and valid instrument for assessing the severity of insomnia in a Korean population.

Key Words sleep, insomnia, reliability, validity.

Introduction

Insomnia is one of the most common sleep disorders, with prevalence rates in general populations reportedly ranging from 12.8% to 38.3%, including 22.8% in Koreans. Insomnia can cause impairment of several daytime cognitive functions (e.g., attention, concentration, and memory) that can lower efficiency at work and increase the risks of injuries and traffic collisions and of falls in older adults. Insomnia is also a prevalent complaint in clinical practice that can present with several other medical or psychiatric disorders. When left untreated, insomnia may aggravate or increase other conditions or delay recovery. It is therefore necessary to recognize insomnia early and initiate the appropriate treatment.

Polysomnography (PSG) is regarded as a reliable method for obtaining objective information on several sleep parameters. However, it is expensive and is not recommended for routine screening for insomnia. On the other hand, the Korean version of the Pittsburgh Sleep Quality Index (PSQI-K) and the Korean version of the Epworth Sleepiness Scale (KESS) are reliable and valid instruments for subjectively assessing sleep quality, sleep disturbances, and daytime sleepiness, but neither of these instruments is specifically designed for assessing insomnia.

The Insomnia Severity Index (ISI) is a brief self-report ques-
mania, the primary complaint of which is difficulty initiating or maintaining sleep, or nonrestorative sleep, for at least 1 month. Comorbid insomniacs meet the criteria of primary insomniacs, but are also diagnosed as simultaneously having another disease, such as a psychiatric disorder or medical disorder. Such comorbid disorders were diagnosed through an interview using sleep questionnaires. OSA was diagnosed for those with a Respiratory Disturbance Index greater than 5, based on the second edition of the International Classification of Sleep Disorders.

All subjects completed the ISI-K, KESS, second edition of the Beck Depression Inventory, and PSQI-K, and submitted to overnight PSG. In order to examine test-retest reliability, 34 subjects were randomly selected to undergo a retest at a 4-week interval without treatment. The required sample size was calculated using the G-power 3.1.3 program based on an effect size of $dz=0.5$, an error probability of 0.05, and a statistical power of 0.80.

The PSQI-K and PSG were used as a subjective and an objective gold standard, respectively. The PSQI is a widely used measure of sleep quality and has been used in previous studies as a convergent measure with ISI in other language versions. PSG was used as the primary diagnosis tool for other sleep disorders, and as a complementary instrument for the evaluation of insomnia, although it is not indicated for the routine evaluation of this condition.

The study and all procedures were approved by the institutional review board of a regional university hospital in Korea.

Statistical analysis
The data analyses were performed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA). The data are presented as mean±SD values, and $p<0.05$ was considered indicative of statistical significance. Descriptive statistics were used for examining the demographic data, test-retest reliability was examined with a paired-samples $t$-test, and internal consistency was examined with Cronbach’s alpha coefficient. The correlations between ISI-K, KESS, and PSQI-K scores and various sleep parameters from PSG [sleep onset latency (SOL), wake after sleep onset (WASO), and sleep efficiency] were examined using Pearson’s correlation coefficient. In addition, the receiver operating characteristic (ROC) curve was used to determine the optimal cutoff score based on its sensitivity and specificity; a perfect medical test would have 100% sensitivity and 100% specificity, corresponding to the upper left-hand corner (0, 1) on the ROC curve. The discriminative ability of the test across the full range of cutoffs was reflected by the area under the curve (AUC). A perfect test would have an AUC of 1.0; a commonly applied rule of thumb is that a test with an AUC greater than 0.9 has high accuracy, while 0.7–0.9 indicates moderate accuracy, 0.5–0.7 indicates low accuracy, and 0.5 is considered a chance result.
Validation of Korean ISI

| Table 1. Demographic and clinical characteristics of the subjects |
|---------------------------------------------------------------|
| **Primary** | **Comorbid** | **OSA** | **Total** |
| (n=169) | (n=133) | (n=312) | (n=614) |
| Age (years) | 53.5±11.6 | 52.3±13.5 | 45.5±13.5 | 49.8±13.7 |
| Female, n (%) | 104 (61.2) | 86 (64.7) | 44 (14.1) | 234 (38.0) |
| BMI (kg/m²) | 23.3±2.8 | 23.0±4.0 | 26.0±5.3 | 24.6±4.7 |
| PSG | | | | |
| SOL [min] | 34.0±48.7 | 34.2±51.4 | 12.0±22.0 | 22.9±39.8 |
| WASO [min] | 147.8±75.4 | 112.0±76.5 | 68.1±59.2 | 99.6±76.0 |
| SE [%] | 59.3±20.6 | 68.3±21.9 | 82.3±13.9 | 72.9±20.5 |
| N1 (%TST) | 18.2±11.9 | 16.4±12.3 | 10.7±6.3 | 14.7±10.7 |
| N2 (%TST) | 46.5±12.0 | 51.8±35.5 | 42.8±10.2 | 46.5±21.0 |
| N3 (%TST) | 19.2±12.3 | 17.2±14.2 | 24.3±8.7 | 20.7±12.0 |
| REM (%TST) | 15.5±9.1 | 18.9±9.8 | 13.2±11.7 | 15.1±10.9 |
| RDI | 1.7±3.2 | 1.6±3.4 | 29.6±21.8 | 15.9±21.0 |
| Arousal index, total | 9.9±6.2 | 10.4±5.8 | 28.5±19.9 | 19.5±17.4 |
| O₂ saturation | 96.4±1.2 | 96.6±1.2 | 94.9±2.4 | 95.7±2.1 |
| KESS score | 3.3±3.9 | 5.0±4.6 | 8.2±4.0 | 6.2±4.6 |
| PSQI-K score | 15.4±2.8 | 14.5±3.4 | 7.4±3.3 | 11.1±4.9 |
| ISI-K score | 22.8±4.3 | 22.2±4.9 | 10.4±5.6 | 16.4±7.9 |

Data are mean±SD or n [%] values.
BMI: body mass index, ISI-K: Korean version of the Insomnia Severity Index, KESS: Korean version of the Epworth Sleepiness Scale, N1: stage 1, N2: stage 2, N3: slow-wave sleep, PSG: polysomnography, PSQI-K: Korean version of the Pittsburg Sleep Quality Index, RDI: Respiratory Disturbance Index, REM: rapid eye movement, SE: sleep efficiency, SOL: sleep onset latency, TST: total sleep time, WASO: wake after sleep onset.

Results

Demographic characteristics
The entire sample comprised 614 patients with sleep disorders, including 169 with primary insomnia, 133 with comorbid insomnia, and 312 with OSA. The age was 49.8±13.7 years. The gender ratios (i.e., percentage of women) in the primary insomnia, comorbid insomnia, and OSA groups were 61.2%, 64.7%, and 14.1%, respectively. The sleep efficiency, SOL, WASO, and KESS, PSQI-K, and ISI-K scores were 72.9±20.5%, 22.9±39.8 min, 99.6±76.0 min, 6.2±4.6, 11.1±4.9, and 16.4±7.9, respectively. The other demographic and clinical characteristics of the subjects are listed in Table 1.

Reliability of the ISI-K
Cronbach’s alpha of the ISI-K was 0.92, which indicated a high internal consistency, and did not change substantially even after deleting any of the items on the scale. The item-total correlations ranged from 0.65 to 0.84, suggesting good homogeneity of the items for measuring the severity of insomnia (Table 2). The test-retest correlation was 0.86 for the total score (p<0.001), and ranged from 0.43 to 0.85 (Table 3) for the seven components.

Validity of the ISI-K
There was a strong positive correlation between the total ISI-K score and other subjective sleep assessment tools, and the PSQI-K score (r=0.84, p<0.01), suggesting that patients with more severe perceived insomnia also reported worse sleep quality; and a weak negative correlation with the KESS score (r=0.29, p<0.01), indicating that those with more severe insomnia reported less daytime sleepiness (Table 4).

The correlations between ISI-K and PSG parameters were as follows: there was a weak positive correlation between item 1 of the ISI-K (difficulty falling asleep) and SOL (r=0.22, p<0.01), a moderate positive correlation between item 2 of the...
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Table 3. Item-total correlations and Cronbach’s alpha for the test-retest reliability of the ISI-K (n=34)

| Item     | Test score | Retest score | r     | p     |
|----------|------------|--------------|-------|-------|
| Initial  | 1.6±1.3    | 1.4±1.3      | 0.77  | <0.001|
| Middle   | 1.8±1.3    | 1.6±1.3      | 0.68  | <0.001|
| Terminal | 1.4±1.3    | 1.3±1.3      | 0.73  | <0.001|
| Distress | 2.7±1.0    | 2.5±1.1      | 0.77  | <0.001|
| Interference | 1.9±1.2 | 1.5±0.9      | 0.51  | 0.002 |
| Noticeability | 1.9±1.4 | 1.7±1.1      | 0.43  | 0.010 |
| Satisfaction | 2.0±1.5 | 1.8±1.4      | 0.85  | <0.001|
| Total score | 13.6±7.7 | 12.1±6.7    | 0.86  | <0.001|

Data are mean±SD values.

Table 4. Correlations between ISI-K, PSQI-K, and KESS scores, and PSG data (n=614)

| ISI-K | PSQI-K | KESS | SOL | WASO | SE |
|-------|--------|------|-----|------|----|
| Initial | 0.29*  |      |     |      |    |
| Middle  |        | 0.38*|     |      |    |
| Total score | 0.84*  | -0.29*| 0.22*| 0.40*| -0.46*|

*Correlation is significant at the 0.01 level (two-tailed).

ISI-K: Korean version of the Insomnia Severity Index, KESS: Korean version of the Epworth Sleepiness Scale, PSG: polysomnography, PSQI-K: Korean version of the Pittsburg Sleep Quality Index, SE: sleep efficiency, SOL: sleep onset latency, WASO: wake after sleep onset.

Discussion

The findings of this study show that the ISI-K measures the severity of insomnia similarly to the original ISI.16 There was a high degree of internal consistency, with the Cronbach’s alpha of 0.92 exceeding the usually accepted value of 0.70.40 The item-total correlations ranged from 0.65 to 0.84, thus also exceeding the usual accepted value of 0.30.41 The value of Cronbach’s alpha was higher than 0.74, which was first established for examining the validation of clinical tests,16 and similar to those achieved by the Arabic27 and Hindi25 versions of the ISI (0.92 and 0.91, respectively). However, the item-total correlations of the current research were more stable than those of the Arabic27 and Hindi25 versions (0.49–0.92 and 0.56–0.87, respectively). For the test-retest reliability, the total score changed from 13.6±7.7 to 12.1±6.7 over the 4-week interval. The correlation coefficient for the test-retest total scores was high, at 0.86.

The present results suggest that the ISI-K exhibits good convergent/discriminant validity with other subjective sleep-related instruments measuring sleep quality (PSQI-K) and sleepiness (KESS). The ESS has been used widely to assess the propensity for daytime sleepiness, especially among patients with OSA.15,42 Daytime sleepiness may be a consequence of inadequate sleep, but it is not a common complaint of patients with insomnia. There have been reports of patients with insomnia tending to have slightly elevated ESS scores (mostly among patients with comorbid OSA), but such elevations are not necessarily predictive of insomnia.10 The present study found a correlation between the ISI-K and KESS, which may be due to some of the insomnia patients also having OSA. OSA patients achieved higher scores on the KESS and lower scores on the ISI-K, while insomnia patients tended to exhibit-
Table 5. Sensitivity and specificity for various cutoff scores of the ISI-K

| Cutoff score | Sensitivity | Specificity |
|--------------|-------------|-------------|
| 5.50         | 0.99        | 0.19        |
| 6.50         | 0.99        | 0.25        |
| 7.50         | 0.99        | 0.31        |
| 8.50         | 0.99        | 0.39        |
| 9.50         | 0.99        | 0.45        |
| 10.50        | 0.99        | 0.55        |
| 11.50        | 0.98        | 0.63        |
| 12.50        | 0.97        | 0.67        |
| 13.50        | 0.95        | 0.73        |
| 14.50        | 0.93        | 0.78        |
| 15.50        | 0.92        | 0.82        |
| 16.50        | 0.87        | 0.86        |
| 17.50        | 0.84        | 0.88        |
| 18.50        | 0.81        | 0.90        |
| 19.50        | 0.76        | 0.91        |
| 20.50        | 0.69        | 0.93        |
| 21.50        | 0.63        | 0.95        |
| 22.50        | 0.56        | 0.96        |
| 23.50        | 0.50        | 0.97        |
| 24.50        | 0.42        | 0.98        |
| 25.50        | 0.32        | 0.99        |
| 26.50        | 0.25        | 0.99        |
| 27.50        | 0.16        | 0.99        |

The analysis showed that a cutoff score of 15.5 had a sensitivity and specificity of 0.92 and 0.81, respectively, and is similar to the optimal cutoff score found in the original study (15.0). Thus, the ISI-K can be considered as a first-line tool for screening insomnia patients in Korean.

Our study was subject to some limitations. First, it was conducted at a regional sleep center in Korea and so was limited to community patients; however, since the questions of the ISI-K did not have local characteristics, there were no regional differences and hence the ISI-K did not need to be changed. Second, we did not include any healthy controls without sleep problems, and additional studies that include such participants are needed. Third, we did not strictly assess for the presence of comorbid disorders, such as psychiatric disorders.

In conclusion, within the limitations of this study, the ISI-K can be considered a valid and reliable tool for assessing the severity of insomnia in Koreans. In addition, it is useful as a simple screening tool to identify patients who suffer from insomnia.

Conflicts of Interest

The authors have no financial conflicts of interest.

REFERENCES

1. Morphy H, Dunn KM, Lewis M, Boardman HF, Croft PR. Epidemiology of insomnia: a longitudinal study in a UK population. Sleep 2007;30:274-280.
2. Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn. Sleep Med Rev 2002;6:97-111.
3. Zallainawati A, Ariff K, Nurjahan M, Teng C. Epidemiology of insomnia in Malaysian adults: a community-based survey in 4 urban areas. Asia Pac J Public Health 2008;20:224-233.
4. Cho YW, Shin WC, Yun CH, Hong SB, Kim J, Earley CJ. Epidemiology of insomnia in Korean adults: prevalence and associated factors. J Clin Neurol 2009;5:20-23.
5. Fortier-Brochu E, Beauleau-Bonneau S, Ivers H, Morin CM. Insomnia and daytime cognitive performance: a meta-analysis. Sleep Med Rev 2012;16:83-94.
6. Laraqui S, Hossini OL, Tripodi D, Manar N, Aoudi YE, Cauvet A, et al. [Prevalence and risk factors of attention disorders of professional drivers in Morocco]. Sante Publique 2011;23:89-100.
7. Fernandez-Mendoza J, Calhoun S, Bixler EO, Pejovic S, Karataraki M, Liao D, et al. Insomnia with objective short sleep duration is associated with deficits in neuropsychological performance: a general population study. Sleep 2010;33:459-465.
8. Chen YY, Wu KC. Sleep habits and excessive daytime sleepiness correlate with injury risks in the general population in Taiwan. Inj Prev 2010;16:172-177.
9. Mahgoub N, Majdak P, Friedman DB, Klimstra S. Insomnia and risk of falling in older adults. J Neuropsychiatry Clin Neurosci 2012;24:E5-E6.
10. Morin CM, Benca R. Chronic insomnia. Lancet 2012;379:1129-1141.
11. Osorio RS, Pirraglia E, Agüera-Ortiz LF, During EH, Sacks H, Ayappa J, et al. Greater risk of Alzheimer’s disease in older adults with insomnia. J Am Geriatr Soc 2011;59:559-562.
12. Sofi F, Cesari F, Casini A, Macchi C, Abbate R, Gensini GF. Insomnia and risk of cardiovascular disease: a meta-analysis. Eur J Prev Cardiol 2014;21:57-64.
13. Haack M, Scott-Sutherland J, Santangelo G, Simpson NS, Sethna N, Mullington JM. Pain sensitivity and modulation in primary insomnia.

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17. Chung KF, Kim do H, Lee MY, Cho YW. The reliability and validity of the Korean version of the Pittsburgh Sleep Quality Index. Sleep Breath 2012;16:803-812.

18. Sierra JC, Guillén-Serrano V, Santos-Iglesias P. [Insomnia Severity Index: some indicators about its reliability and validity on an older adults sample]. Rev Neurol 2008;47:566-570.

19. Morin CM. Insomnia: Psychological Assessment and Management. New York: Guilford Press, 1993.

20. Morin CM, Belleville G, Bélanger L, Ivers H. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. Sleep 2011;34:601-608.

21. Savard MH, Savard J, Simard S, Ivers H. Empirical validation of the Insomnia Severity Index in cancer patients. Psychooncology 2005;14:429-441.

22. Omachi TA. Measures of sleep in rheumatologic diseases: Epworth Sleepiness Scale (ESS), Functional Outcome of Sleep Questionnaire (FOSQ), Insomnia Severity Index (ISI), and Pittsburgh Sleep Quality Index (PSQI). Arthritis Care Res (Hoboken) 2011;63 Suppl 11:S287-S296.

23. Tang NK, Wright KJ, Salkovskis PM. Prevalence and correlates of clinical insomnia co-occurring with chronic back pain. J Sleep Res 2007;16:85-95.

24. Yu DS. Insomnia Severity Index: psychometric properties with Chinese community-dwelling older people. J Adv Nurs 2011;66:2350-2359.

25. Lahan V, Gupta R. Translation and validation of the insomnia severity index in hindi language. Indian J Psychol Med 2011;33:172-176.

26. Fernandez-Mendoza J, Rodriguez-Muñoz A, Vela-Bueno A, Olavarrieta-Bernardino S, Calhoun SL, Bixler EO, et al. The Spanish version of the Insomnia Severity Index: a confirmatory factor analysis. Sleep Med 2012;13:207-210.

27. Suleiman KH, Yates BC. Translating the insomnia severity index into Arabic. J Nurs Scholarsh 2011;43:49-53.

28. Morin CM, Vallaères A, Guay B, Ivers H, Savard J, Mérette C, et al. Cognitive behavioral therapy, singly and combined with medication, for persistent insomnia: a randomized controlled trial. JAMA 2009;301:2005-2015.

29. First MB, Frances A, Pincus HA. DSM-IV-TR Handbook of Differential Diagnosis. Washington, DC: American Psychiatric Press, 2002.

30. American Academy of Sleep Medicine. The International Classification of Sleep Disorders: Diagnostic & Coding Manual. 2nd ed. Westchester: American Academy of Sleep Medicine, 2005.

31. Sung HK, Kim JB, Park YN, Bai DS, Lee SH, Ahn HJ. A study on the reliability and the validity of Korean version of the Beck Depression Inventory-II (BDI-II). J Korean Soc Biol Psychiatry 2008;14:201-212.

32. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193-213.

33. Littner M, Hirshkowitz M, Kramer M, Kupfer DJ, mosquitoes on polysomnography to evaluate Epworth Sleepiness Scale: a normative US population. Chest 2003;124:674-680.

34. Reite M, Buysse D, Reynolds C, Mendelson W. The use of polysomnography in the evaluation of insomnia. Sleep 1995;18:58-70.

35. Akobeng AK. Understanding diagnostic tests 3: Receiver operating characteristic curves. Acta Paediatr 2007;96:644-647.

36. Perkins NJ, Schisterman EF. The inconsistency of “optimal” cutpoints obtained using two criteria based on the receiver operating characteristic curve. Am J Epidemiol 2006;163:670-675.

37. Zweig MH, Campbell G. Receiver-operating characteristic (ROC) plots: a fundamental evaluation tool in clinical medicine. Clin Chem 1993;39:561-577.

38. Fischer JE, Bachmann LM, Jaeschke R. A readers’ guide to the interpretation of diagnostic test properties: clinical example of sepsis. Intensive Care Med 2003;29:1043-1051.