Open Access

OBM Neurobiology

Research Article

Validation of the Insomnia Severity Index among University Students in Korea

Boram Lee [1], Yang Eun Kim [2,*]

1. Department of Early Childhood Education, Woosong University, 171 Dongdaejeon-ro, Dong-gu, Daejeon, 34606, South Korea; E-Mail: blee@wsu.ac.kr
2. Department of Global Child Education, Woosong University, 171 Dongdaejeon-ro, Dong-gu, Daejoen, 34606, South Korea; E-Mail: yekim@wsu.ac.kr

* **Correspondence:** Yang Eun Kim; E-Mail: yekim@wsu.ac.kr

Academic Editor: María Jose Hernández Serrano

Special Issue: Implications of Technologies on the Brain Development in Younger Students

OBM Neurobiology
2023, volume 7, issue 4
doi:10.21926/obm.neurobiol.2304196

Received: July 12, 2023
Accepted: November 14, 2023
Published: November 21, 2023

Abstract

Insomnia is the most common sleep complaint in clinical practice, affecting both the physical and mental health of patients as well as many aspects of their life quality. Young adults, especially university students, are prone to a high prevalence of poor sleep quality or insomnia. Accurate assessment of insomnia severity among university students has become an important issue. One promising screening tool to identify clinically significant insomnia in the campus setting is the Insomnia Severity Index (ISI), a seven-item self-report measure designed to assess the nature and severity of one's insomnia. Although the ISI has been validated in primary care settings in Korea, no studies have examined its factor structure for university students. This study aimed to analyze the psychometric properties of the Korean version of the ISI. A convenience sample of 252 undergraduate students aged 18-64 attending a four-year university in South Korea was recruited for the study. The collected data underwent exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), which tested alternative models to determine the factorial structure of the ISI. Internal consistency and convergent and discriminant validity were examined. CFA findings showed that a two-factor model best fit the data. The ISI was found to be significantly correlated with higher depressive symptoms and possess adequate internal consistency. Our study confirmed that the ISI had insufficient reliability and good convergent and discriminant validity. This study generally supports the validity and factor structure of the ISI. Its two-factor structure is a psychometrically robust measure for evaluating the prevalence of insomnia.

Keywords
Factor structure; insomnia; sleep; university students; validity

1. Introduction

Sleep is a well-documented biological necessity vital for good health and overall quality of life [1, 2]. Recent decades have seen an exponential growth in international interest in sleep disorders and well-being because of their significant effects on young adults' health, education, and functioning [3]. Research has demonstrated the critical role of sleep in developing essential cognitive functions linked to academic success in higher education, including learning, memory consolidation, and critical thinking [4]. Young adults, especially university students, have an increased risk of impaired sleep or developing sleep problems mainly because of their high levels of perceived stress [5, 6]. As emerging adults seeking success in their academic endeavors, university students confront many new challenges, such as managing academic demands, living independently, handling finances, preparing for their careers, and pursuing future life goals [6]. With increased freedom and independence, university students often have irregular lifestyles or everyday routines because of their self-organized schedules. Evidence has shown that college students often suffer from irregular sleep–wake cycles, with short sleep durations on weekdays and later wake-up times on weekends [5]. This, in turn, triggers a vicious cycle associated with an adverse effect on sleep quality and mental health [7, 8]. Studies worldwide have shown that poor sleep quality diminishes students' learning capacity and academic performance and is linked to a higher prevalence of depressive symptoms in university students [9-11].

Sleep problems have been further aggravated by the outbreak of the coronavirus disease 2019 (COVID-19). Although containment strategies such as lockdowns, quarantines, mobility restrictions, and stay-at-home requests have prevented the spread of COVID-19, they have also resulted in unintended and unexpected detrimental effects [12, 13]. School and workplace closures and reduced physical activity due to stay-at-home requirements affected the need for sleep and led to challenges in falling and staying asleep. Under confinement measures or social distancing, the lack of regular social interactions increased boredom, isolation, and loneliness, resulting in improved sleep disturbances [13].

Compared with the overall population, university students have perhaps been significantly burdened by COVID-19 regarding their sleep quality and mental health as they have engaged in the most significant variation of activities before and after the pandemic [12, 14, 15]. A recent study in Korea revealed that sleep quality among university students has severely deteriorated since the start of the COVID-19 pandemic [14]. Generally, the transition from high school to college is a critical risk period commonly associated with the initiation and escalation of substance use [16, 17].

Significant evidence suggests that addictive substance abuse (e.g., alcohol, nicotine use) among university students is associated with sleep disorders, including insomnia [16, 17]. Furthermore, excessive smartphone and internet use among university students has been linked to unhealthy sleeping habits and insomnia, significantly affecting sleep quality during COVID-19 [12, 18]. The transition to university and its associated stressors, along with the outbreak of the pandemic, may explain university students' predisposition to sleep problems; hence, most students are chronically sleep-deprived.

Insomnia, defined as a persistent difficulty with sleep initiation, maintenance, or consolidation, is a common sleep disorder that has become a significant healthcare concern worldwide [19]. It can cause functional impairment in various cognitive domains (e.g., memory, concentration, and attention) [20] and can also be comorbid with medical and psychiatric disorders [21]. Left untreated, it can worsen into chronic conditions and increase the risk of psychiatric and medical diseases, especially depression and anxiety [22, 23]. The prevalence of insomnia among university students ranges from 7.7% to 70% across various countries using different time frames, measurements, and sampling methods [24]. A meta-analysis of 14 studies found a 48.9% overall pooled prevalence of sleep disturbance in Korean university students [25]. Because of the high prevalence of insomnia in students and the significant mental health risks associated with it, suitable screening tools could be handy. Polysomnography is considered the gold standard for diagnosing sleep disorders [26]. It is time-consuming, expensive, and not recommended for routine use in evaluating insomnia. The Epworth Sleepiness Scale [27] and the Pittsburgh Sleep Quality Index [28] are reliable, valid instruments for assessing specific sleep characteristics or quality (e.g., excessive daytime sleepiness, sleep apnea). Still, they are not designed to identify insomnia per se. One promising insomnia screening instrument is the Insomnia Severity Index (ISI) [29], a seven-item self-report measure designed to map onto the Diagnostic and Statistical Manual of Mental Disorders [30] and the International Classification of Sleep Disorders [31] symptom criteria for insomnia. Since its introduction in 1993, the ISI has been widely used for clinical purposes and research and translated into several languages, with these language versions exhibiting adequate psychometric properties as evidenced by good reliability and construct validity [32-39]. However, while the ISI showed sound psychometric properties, studies examining its factor structure have yielded mixed results. Some suggest that the ISI is a unidimensional measure of insomnia [32, 35, 36]. In contrast, others supported a two- or three-factor structure [33, 34, 37, 39], suggesting that the measure may not possess a universally consistent dimensionality. The ISI has also been translated and validated with a Korean sample, and evidence suggests that the Korean version of the ISI has good psychometric properties [26].

Nevertheless, this study involved patients with chronic and severe sleep disorders selected from those who visited a regional sleep center. Thus, in nonclinical samples, the psychometric properties of the ISI are not well understood; most studies that examined the ISI have focused on clinical models [26, 29, 35, 38-41]. Although a few studies have used the ISI to screen for insomnia in the general population [32-34, 36, 37], its utility in campus settings has not been well established. The lack of consensus on the factor structure of ISI in different contexts further warrants a validation study involving Korean university students.

Several gaps in the existing literature must be addressed when considering the available research on the factor structures of the ISI, which, as noted above, has provided mixed results. Therefore, the factor structure of the ISI must be verified. Validated sleep-related measurements for students are required to screen and investigate the effects of interventions. Selecting the most appropriate measures for a specific application depends on many factors. These could include characteristics of the study sample, practical issues such as the burden on respondents, the original intent, the need for validated language translations, and the instrument's psychometric properties [42]. A measurement tool's psychometric properties can vary between different populations and cultural groups; hence, these properties must be systematically assessed before the instrument is widely employed on a specific population. Moreover, it is essential in practical terms to identify whether the psychometric properties of the Korean version of the ISI are appropriate for use in the university, which considers it necessary to locate efficient measures for sleep health.

Given this background, this study's main objective was to test competing ISI models suggested by the literature to determine which structural model best fits the data using a range of fit measures, including exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). An additional aim was to provide preliminary evidence of the convergent and discriminate validity of the ISI.

2. Materials and Methods

2.1 Participants

To determine the requisite sample size of the study, we conducted an a priori power analysis using G Power 3.1. The current sample of 252 participants resulted in a power of 0.995 to detect a medium effect size of f^2 = 0.16, and the minimum required sample size was 200 (Cohen's effect for R^2) [43]. Therefore, this study's total sample size of 252 has sufficient power.

A total of 252 undergraduate students (80 male, 172 female) were recruited via convenience sampling from a four-year university in the central region of Korea. The participants' mean age was 20.6 years (SD = 4.68), ranging from 18 to 64. The mean age for males was 20.2 (SD = 2.31, range 18-31), and the mean age for females was 20.8 (SD = 5.44, range 18-64). The participants' courses included beauty design management, education, public health, and social work.

2.2 Procedures

After obtaining ethical approval (Protocol Code: 1041549-230117-SB-155), data were collected anonymously during the 2023 academic year via an online survey administered by Google platforms. A link to the survey was e-mailed to instructors in different faculties at the university, who then forwarded it to their students using the university's mailing lists. The survey forms explained the study objectives and the voluntary and confidential nature of the study, and e-informed consent was obtained from all eligible participants before data collection. The survey was accessible for four weeks, and after that, it was automatically deactivated. During this time, two reminders were e-mailed to potential participants.

2.3 Measures

2.3.1 The Insomnia Severity Index (ISI)

The ISI is a self-report instrument designed to identify the perceived severity of one's insomnia over the past two weeks [29]. It consists of seven items: magnitude of sleep onset difficulties, maintenance difficulties, early morning awakening, satisfaction with current sleep, interference of sleep difficulties with daily functioning, apparency of impairment due to sleep complaints, and concerns or distress caused by sleep problems. Each item is rated on a five-point Likert scale ranging from 0 (not at all) to 4 (very much). These items are summed to obtain a total score ranging from 0 to 28, with higher scores indicating a more excellent perception of insomnia severity. The full ISI scores are further divided into four subcategories: 0-7 (absence of insomnia), 8-14 (subthreshold insomnia), 15-21 (moderate insomnia), and 22-28 (severe insomnia). A cutoff score 15 has been used to indicate clinically significant insomnia [44]. This study used the Korean version of the ISI (ISI-K), verified and validated by Cho et al. [26].

2.3.2 The Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 was used to measure participants' depressive symptoms [45].

It consists of nine items scored on a four-point Likert scale from 0 to 3, resulting in a total score from 0 to 27, with higher scores indicating more severe symptoms of depression. This study used the Korean version translated and validated by Park et al. [46]. The Cronbach's alpha coefficient for the overall PHQ-9 was 0.87.

2.4 Statistical Analyses

The data were analyzed using IBM SPSS version 25 and IBM SPSS Amos version 23. The normality of the distributions was assessed at both the univariate and multivariate levels. At the item level, all items yielded skewness and kurtosis values within the ±1.5 range, indicating normal distribution. Multivariate normality was evaluated using Kolmogorov–Smirnov tests, which suggested that the distributions of all variables significantly differed from normality ($p < 0.001$). EFA and CFA were simultaneously performed to examine the construct validity and factor structure of the ISI. EFA was first conducted using principal component analysis with varimax rotation. The Kaiser–Meyer–Olkin measure of sampling adequacy and Bartlett's test of sphericity were used to determine the suitability of the data for EFA. Several criteria were employed to determine the final factor structure: eigenvalues >1, exclusion of items with factor loadings less than 0.40, exclusion of items with loadings greater than 0.40 on more than one factor, visual inspection of the scree plot on the reduced correlation matrix, and elements with at least three items per factor. Next, CFA was conducted to determine the factor structure of the ISI. Because of the unconditional nature of the items, maximum likelihood estimation was employed using a covariance matrix. Three competing models based on the literature were tested. Model 1 posited all seven ISI items loading onto a single factor. Model 2 is a correlated two-factor model where the two latent variables are represented by the severity of sleep (items 1-4) and the impact of sleep (items 5-7).

Model 3 is a correlated three-factor model where the three latent variables are represented by the severity of sleep (items 1-3), sleep satisfaction (item 4), and impact of sleep (items 5-7). The following fit indices and their criteria were used to evaluate model fit in the CFA: chi-square (χ^2) and its related degrees of freedom ($\chi^2/df < 5$) [47], comparative fit index (CFI ≥ 0.95) [47, 48], goodness-of-fit index (GFI ≥ 0.95) [35, 36], root mean square error of approximation (RMSEA < 0.080) [49, 50] and its 90% confidence interval (90% CI), and standardized root mean square residual (SRMR < 0.080) [49, 50]. In addition, chi-square difference tests determined whether the models were significantly different.

To evaluate convergent validity, we used Pearson's *r* to test the associations between ISI scores and depressive symptoms derived from the PHQ-9. We also assessed convergent validity via item factor loadings, composite reliability (CR), and average variance extracted (AVE). To confirm convergent validity, the item factor loading and AVE should equal or exceed 0.50. CR values between 0.60 and 0.70 are deemed satisfactory [51]. Discriminant validity was assessed by following the procedures suggested by Fornell and Larcker [52]. To ensure discriminant validity, the square root of the AVE of each construct should be greater than its correlations with any other composite construct in the assessed model. Internal consistency was evaluated using McDonald's omega (ω) and its 95% Confidence interval (CI), Cronbach's alpha coefficients (α), corrected item-total correlations, and alpha if an item was deleted.

3. Results

3.1 Descriptive Statistics

Table 1 presents the mean scores and standard deviations for total and individual ISI item scores, showing an overall mean score of 10.5 (SD = 3.61) for the entire sample. Total scores varied between 0 and 25. Using Bastien et al.'s cutoff criteria for the ISI [36], 58 (23%) did not reach the level of clinical significance on the ISI, 143 (57%) went subthreshold insomnia, 38 (15%) had moderate insomnia, and 13 (5%) had severe clinical insomnia.

Table 1 Descriptive statistics for ISI-7 items.

Item	*M*	*SD*
1. Difficulty falling asleep	1.53	0.72
2. Difficulty staying asleep	1.28	0.86
3. Early morning awakenings	1.29	0.83
4. Sleep dissatisfaction	2.07	0.77
5. Interference of sleep problems with daytime functioning	1.79	1.15
6. Perception of sleep difficulties by others	1.45	0.94
7. Preoccupation and distress caused by sleep difficulties	1.11	0.86
Total score	10.5	3.16

3.2 Exploratory Factor Analysis (EFA)

The Kaiser–Meyer–Olkin measure of sampling adequacy (0.728) and Bartlett's test of sphericity (χ^2 = 543.6, $p < 0.001$) confirmed that the data and sample size were adequate for factor analysis. EFA produced two factors with eigenvalues >1.0, which explained 66.3% of the total variance. Factor 1, which consisted of four items with loadings ranging from 0.44 to 0.78, appeared to capture the severity of sleep disturbance. Factor 2, which seemed to catch the daytime impact of insomnia, consisted of three items with loadings ranging from 0.41 to 0.72. Therefore, as revealed in Table 2, all 7 items were loaded onto one of the two factors, with loadings of >0.40. After two factors, the scree plot also indicated a distinct decline in explained variance.

Table 2 Factor loadings of ISI-7 items in the EFA.

ISI-7 items	Factor 1	Factor 2
1. Difficulty falling asleep	0.54	
2. Difficulty staying asleep	0.48	
3. Early morning awakenings	0.44	
4. Sleep dissatisfaction	0.78	
5. Interference of sleep problems with daytime functioning		0.72
6. Perception of sleep difficulties by others		0.50
7. Preoccupation and distress caused by sleep difficulties		0.41
Eigenvalues	1.12	1.87
% Variance explained	42.9	23.4

3.3 Confirmatory Factor Analysis (CFA)

Table 3 summarizes the fit indices for the three competing models within CFA. Models 1 and 3, representing one- and three-factor models, respectively, were found to have poor absolute fit. The two-factor model (model 2) demonstrated the best data fit (χ^2 = 23.9, df = 9; χ^2/df = 2.7; CFI = 0.97; GFI = 0.99; RMSEA = 0.048 (90% CI = 0.041-0.066); SRMR = 0.036; Figure 1) compared with the one-factor ($\Delta\chi^2(5)$ = 127.5, $p < 0.001$) and three-factor models ($\Delta\chi^2(2)$ = 26.1, $p < 0.001$). All items are loaded on their respective specified factors. The estimated correlation between the elements in this model was 0.61.

Table 3 Goodness-of-fit indices of models for the ISI (N = 252).

Model	k	χ^2	df	χ^2/df	CFI	GFI	RMSEA (90% CI)	SUMMER
Model 1	7	151.4	14	10.8	0.74	0.86	0.198 (0.170-0.227)	0.104
Model 2	7	23.9	9	2.7	0.97	0.99	0.048 (0.041-0.066)	0.036
Model 3	7	50.0	11	4.5	0.93	0.96	0.119 (0.087-0.153)	0.050

Notes: *k* = number of items; *df* = degrees of freedom; CFI = comparative fit index; GFI = goodness of fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean residual.

*$p < 0.01$

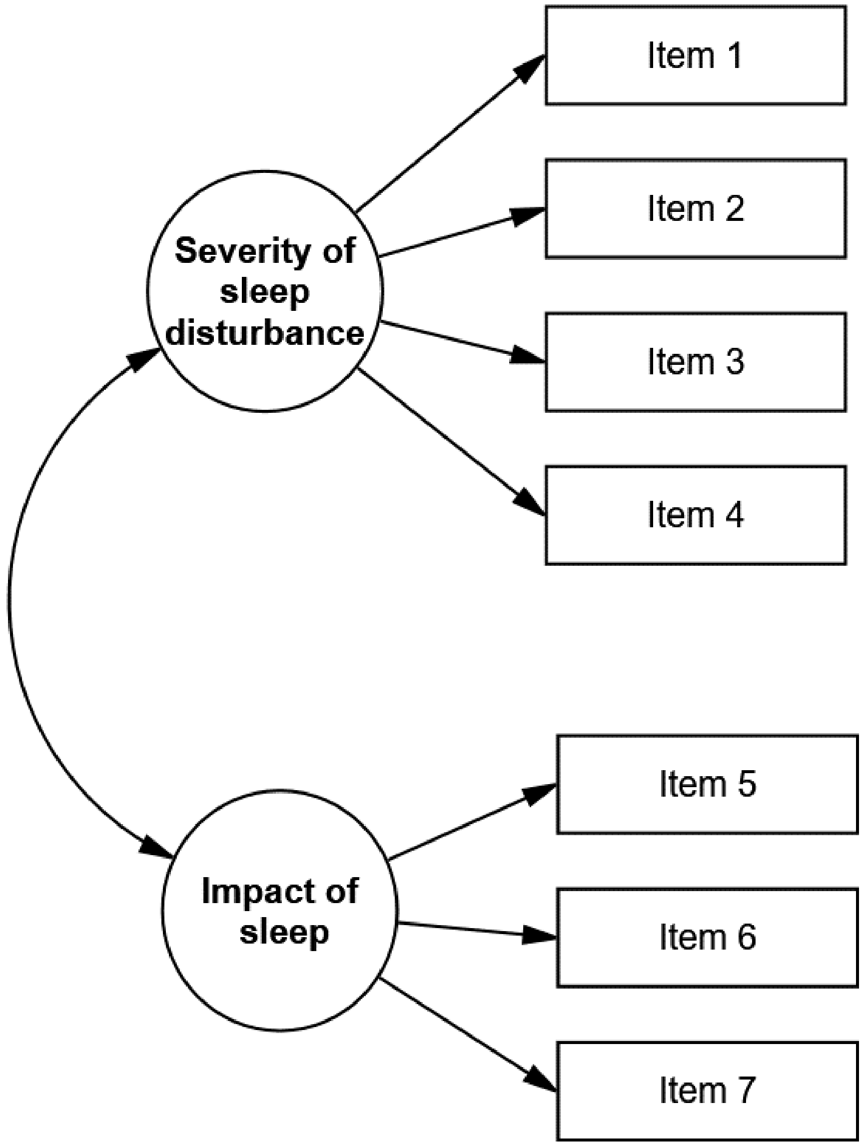

Figure 1 Two-factor model of the ISI.

3.4 Convergent Validity

The relationship between the total ISI scores and the PHQ-9 scores was obtained through Pearson's correlations. The correlation between total ISI scores and the PHQ-9 was significant and positive (r = 0.64, p < 0.01), confirming convergent validity. Moreover, the correlation between the ISI subscales and the PHQ-9 was positive in each case. Further, convergent validity was satisfied in that all factor loadings ranged between 0.53 and 0.84, exceeding the 0.50 threshold. The AVE values of all constructs also surpassed the cutoff value of 0.50, and the CR values exceeded the recommended computation of 0.60 for all two subscales, indicating adequate convergent validity (Table 4).

Table 4 Convergent validity of the Korean version of the ISI.

Construct	Items	β [a]	*B* [b]	SE [c]	CR [d]	AVE [e]
Severity of sleep disturbance	1	0.53	0.62	0.04	0.74	0.55
	2	0.72	1.00	0.05		
	3	0.61	1.02	0.06		
	4	0.84	1.72	0.19		
Impact of sleep	5	0.70	1.01	0.06	0.60	0.51
	6	0.64	0.69	0.03		
	7	0.76	1.23	0.11		

Notes. [a] Standardized coefficient. [b] Unstandardized coefficient. [c] SE = Standard error. [d] CR = Composite Reliability. [e] AVE = Average Variance Extracted

3.5 Discriminant Validity

Table 5 presents the square roots of the AVE indexes for all two subscales. All indexes (diagonal values in bold) were more extensive than the inner oblique value representing the correlations among constructs. Our results, therefore, confirm that the instrument had acceptable discriminant validity.

Table 5 Fornell–Larcker criterion.

Construct	Severity of sleep disturbance	Impact of sleep performance
Severity of sleep disturbance	**0.60**	
Impact of sleep	0.58	**0.79**

3.6 Item Analysis and Reliability of the ISI

Table 6 reports the analysis of the items of the ISI and its reliability. The coefficient omega value for the ISI total score was ω = 0.85 (95% CI = 0.82-0.88). The Cronbach's alpha of the ISI was 0.86, and no item removal was found to improve internal consistency values, thus indicating high internal consistency reliability. Corrected item-total correlations for the seven ISI items were calculated to test for scale homogeneity, resulting in item-total correlations of -0.52-0.72, which indicated that each item was associated with the overall scale. The if-item-deleted Cronbach's alpha coefficient values were less than or equal to 0.848, meaning all items contributed to the scale's internal consistency.

Table 6 The reliability of the ISI.

	Corrected item-total correlation	Cronbach's alpha if item deleted
1. Difficulty falling asleep	0.60	0.84
2. Difficulty staying asleep	0.69	0.83
3. Early morning awakenings	0.53	0.85
4. Sleep dissatisfaction	0.72	0.82

5. Interference of sleep problems with daytime functioning	0.69	0.83
6. Perception of sleep difficulties by others	0.62	0.84
7. Preoccupation and distress caused by sleep difficulties	0.52	0.85
Cronbach's alpha (α)	0.86	
Mcdonalds' omega coefficient (ω) and its 95% CI	0.85 (95% CI = 0.82-0.88).	

4. Discussion

This study comprehensively evaluated the psychometric properties of the Korean version of the ISI in a sample of Korean university students. Further evidence of the tool's convergent and discriminant validity and internal consistency was obtained. To our knowledge, no studies have validated the ISI using a university student sample in Korea; indeed, the present findings extend the scale's robust psychometric adequacy to be used with student populations. The results showed a mean ISI score of 10.5 (SD = 3.16), with 27% suffering from moderate to severe clinical insomnia, which is consistent with the nature of the studied sample, that is, young students, and comparable with the mean score obtained by Akram et al. [53] for university students in the United Kingdom. Also, mean ISI scores in this study were vastly higher than those reported by Lukowski et al. [54] for U.S. students and Spanhel et al. [55] for international students in Germany.

Concerning the scale's dimensionality, cross-validated exploratory and confirmatory factor analytic methods clarified and confirmed the latent structure of the ISI. Specifically, based on the EFA and CFA fit indices in this study, the two-factor model, consisting of the severity of sleep disturbance and the impact of sleep, provided the best fit for the data among Korean university students. These results are consistent with those from more recent studies that support the two-factor structure of the ISI [33, 37-40]. However, some scholars have suggested several other factor structures, compromising the consensus regarding the tool's dimensionality [32, 34-37, 41]. The different factor structures or discrepancies in the literature findings may be partly due to the use of (1) individuals with different cultural backgrounds, (2) differences in participant age ranges (e.g., 14-87 years), (3) participant characteristics (e.g., primary care patients vs. community-based participants), and (4) different statistical techniques (e.g., EFA vs. CFA). Nevertheless, our findings suggest that clinical practice and treatment studies examine each of the two factors [34]. The ISI provides a brief measure for determining whether insomnia treatment targets not only nighttime sleep difficulties but also the impacts of disorders on daily functioning (e.g., daytime fatigue, ability to function at work/daily chores) [34]. Because insomnia is associated with depression, the PHQ-9 was used to assess the convergent validity of the ISI. As expected, the total ISI and the two subscales were significantly and positively correlated with PHQ-9, indicating strong convergent validity. These results suggest that students with moderate to severe insomnia are more likely to report high levels of depression. This study thus confirms other studies' findings of a strong correlation between the ISI and depressive symptoms [3, 10, 11, 14, 34, 39, 41, 54]. High factor loadings and acceptable AVE and CR values also verified the convergent validity of the ISI. The AVE values for the two subscales were more significant than the r2 values for discriminant truth. The discriminant fact of each subscale was also supported.

Regarding internal consistency, the Korean version of the ISI showed good reliability, in line with other foreign validations of the questionnaire [32-39]. A meta-analysis of the psychometric properties of the ISI found Cronbach's alpha values to be between 0.70 and 0.94 and estimated a pooled overall Cronbach's alpha reliability of 0.83 [56]. In addition, item-total correlations exceeded the accepted cutoff of 0.30, indicating that each item assessed the same construct.

Mental health professionals must also use insomnia screening tools that account for the multidimensionality of insomnia symptoms and ensure that such devices are appropriate for the targeted population. Also, mental health services in campus settings can benefit significantly from accessible insomnia screening and evaluation instruments. Therefore, our study suggests that sleep problems among university students have important clinical implications, as insomnia is a risk factor associated with academic, physical, and psychological impairment. Furthermore, because the ISI-7 significantly correlated with the PHQ-9, the former can be an efficient tool for first-line psychiatric professionals needing short and valid instruments for symptom mapping and screening in everyday care.

5. Limitation

This study has some limitations. First, the demographics of its sample consisted of a homogenous group of undergraduate students, which limits the generalizability of the results to models of varying ages. This necessitates an assessment of factor structure and psychometric properties using different clinical samples or more heterogeneous samples. Second, this study employed a cross-sectional design; meanwhile, longitudinal studies may further advance knowledge of the potential relations between insomnia and depression symptoms among university students and may confirm insomnia as a risk factor for the development of new-onset or recurrent depression. Third, self-report measures such as the ISI run the risk of response bias. Hence, studies using multimethod assessments incorporating clinical interviews would address this issue. Fourth, this study collected notest–retest data from the ISI. Thus, future research would benefit from examining the extent to which scores remain stable over time. Finally, the convergent validity of the ISI should be further confirmed by examining its relations to other sleep health measures. For example, the ISI focuses on the severity and symptoms of sleep problems. In contrast, other scales (e.g., the Sleep Quality Scale, Sleep Hygiene Questionnaire, and the Mini Sleep Questionnaire) measure different aspects of sleep, such as sleep habits, quality, and hygiene. Examining the relations between the ISI subscales and the corresponding instruments for these constructs could have been included to strengthen the findings significantly.

6. Conclusions

Notwithstanding these limitations, our findings strengthen the evidence regarding the psychometric properties of the Korean version of the ISI and suggest that the ISI is a valid and reliable tool for evaluating the subjective severity of insomnia in Korean university students. Our study also supports the two-dimensional nature of the ISI and suggests that its two-factor structure confirms its clinical utility. Compared with other commonly used instruments that identify and quantify sleep disturbance, the ISI offers essential and practical advantages in the clinical assessment of mental health in university settings because of its brief nature, robust psychometric properties, and content that is well-grounded in the diagnostic criteria for insomnia as defined in the DSM-IV [36]. These advantages make the ISI an effective screening tool for students complaining of insomnia.

Author Contributions

Conceptualization, B.L.; methodology, Y.K.; formal analysis, Y.K., B.L.; investigation, Y.K.; data curation, Y.K.; writing—original draft preparation, B.L.; writing—review and editing, visualization, B.L.; supervision, Y.K.; project administration, Y.K. All authors have read and agreed to the published version of the manuscript.

Funding

This research was supported by Woosong University.

Competing Interests

The authors have declared that no competing interests exist.

References

1. Matricciani L, Bin YS, Lallukka T, Kronholm E, Wake M, Paquet C, et al. Rethinking the sleep-health link. Sleep Health. 2018; 4: 339-348.
2. Ramar K, Malhotra RK, Carden KA, Martin JL, Abbasi-Feinberg F, Aurora RN, et al. Sleep is essential to health: An American Academy of Sleep Medicine position statement. J Clin Sleep Med. 2021; 17: 2115-2119.
3. Mbous YPV, Nili M, Mohamed R, Dwibedi N. Psychosocial correlates of insomnia among college students. Prev Chronic Dis. 2022; 19: E60.
4. Vedaa Ø, Erevik EK, Hysing M, Hayley AC, Sivertsen B. Insomnia, sleep duration and academic performance: A national survey of Norwegian college and university students. Sleep Med X. 2019; 1: 100005.
5. Lima PF, De Medeiors AL, Rolim SA, Junior SA, Amondes KM, Araujo JF. Changes in sleep habits of medical students according to class starting time: A longitudinal study. Sleep Sci. 2009; 2: 92-95.
6. Saruhanjan K, Zarski AC, Bauer T, Baumeister H, Cuijpers P, Spiegelhalder K, et al. Psychological interventions to improve sleep in college students: A meta-analysis of randomized controlled trials. J Sleep Res. 2021; 30: e13097.
7. Jiang X, Zheng X, Yang J, Ye C, Chen Y, Zhang Z, et al. A systematic review of studies on the prevalence of insomnia in university students. Public Health. 2015; 129: 1579-1584.
8. Dai H, Mei Z, An A, Lu Y, Wu J. Associations of sleep problems with health-risk behaviors and psychological well-being among Canadian adults. Sleep Health. 2020; 6: 657-661.
9. Almojali AI, Almalki SA, Alothman AS, Masuadi EM, Alaqeel MK. The prevalence and association of stress with sleep quality among medical students. J Epidemiol Glob Health. 2017; 7: 169-174.
10. Barahona-Correa JE, Aristizabal-Mayor JD, Lasalvia P, Ruiz ÁJ, Hidalgo-Martínez P. Sleep disturbances, academic performance, depressive symptoms and substance use among medical students in Bogota, Colombia. Sleep Sci. 2018; 11: 260-268.
11. Kenney SR, LaBrie JW, Hummer JF, Pham AT. Global sleep quality as a moderator of alcohol consumption and consequences in college students. Addict Behav. 2012; 37: 507-512.

12. El Abiddine FZ, Aljaberi MA, Gadelrab HF, Lin CY, Muhammed A. Mediated effects of insomnia in the association between problematic social media use and subjective well-being among university students during COVID-19 pandemic. Sleep Epidemiol. 2022; 100030.
13. Shaik L, Boike S, Ramar K, Subramanian S, Surani S. COVID-19 and sleep disturbances: A literature review of clinical evidence. Medicina. 2023; 59: 818.
14. Lee H, Kim J, Moon J, Jung S, Jo Y, Kim B, et al. A study on the changes in life habits, mental health, and sleep quality of college students due to COVID-19. Work. 2022; 73: 777-786.
15. Al-Tammemi AB, Nheili R, Jibuaku CH, Al Tamimi D, Aljaberi MA, Khatatbeh M, et al. A qualitative exploration of university students' perspectives on distance education in Jordan: An application of Moore's theory of transactional distance. Front Educ. 2022; 7: 960660.
16. Pilatti A, Read JP, Pautassi RM. ELSA 2016 Cohort: Alcohol, tobacco, and marijuana use and their association with age of drug use onset, risk perception, and social norms in Argentinean college freshmen. Front Psychol. 2017; 8: 1452.
17. Sirtoli R, Balboa-Castillo T, Fernández-Rodríguez R, Rodrigues R, Morales G, Garrido-Miguel M, et al. The association between alcohol-related problems and sleep quality and duration among college students: A multicountry pooled analysis. Int J Ment Health Addict. 2023; 21: 2923-2940.
18. Huang T, Liu Y, Tan TC, Wang D, Zheng K, Liu W. Mobile phone dependency and sleep quality in college students during COVID-19 outbreak: The mediating role of bedtime procrastination and fear of missing out. BMC Public Health. 2023; 23: 1200.
19. Bollu PC, Kaur H. Sleep Medicine: Insomnia and Sleep. Mo Med. 2019; 116: 68-75.
20. Fortier-Brochu E, Beaulieu-Bonneau S, Ivers H, Morin CM. Insomnia and daytime cognitive performance: A meta-analysis. Sleep Med Rev. 2012; 16: 83-94.
21. Morin CM, Benca R. Chronic insomnia. Lancet. 2012; 379: 1129-1141.
22. Osorio RS, Pirraglia E, Agüera-Ortiz LF, During EH, Sacks H, Ayappa I, et al. Greater risk of Alzheimer's disease in older adults with insomnia. J Am Geriatr Soc. 2011; 59: 559-562.
23. 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.
24. Babicki M, Piotrowski P, Mastalerz-Migas A. Insomnia, daytime sleepiness, and quality of life among 20,139 college students in 60 countries around the world-A 2016-2021 Study. J Clin Med. 2023; 12: 692.
25. Hwang E, Shin S. Prevalence of sleep disturbance in Korean university students: A systematic review and meta-analysis. Korean J Health Promot. 2020; 20: 49-57.
26. Cho YW, Song ML, Morin CM. Validation of a Korean version of the insomnia severity index. J Clin Neurol. 2014; 10: 210-215.
27. Johns MW. A new method for measuring daytime sleepiness: The Epworth sleepiness scale. Sleep. 1991; 14: 540-545.
28. Buysse DJ, Reynolds CF, 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.
29. Morin CM. Insomnia: Psychological assessment and management. New York: Guilford; 1993.
30. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Washington, DC: American Psychiatric Association; 2000.
31. American Academy of Sleep Medicine. International classification of sleep disorders: Diagnostic and coding manual. 2nd ed. Westchester, NY: American Academy of Sleep Medicine; 2005.

32. 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.
33. Yu DS. Insomnia Severity Index: Psychometric properties with Chinese community-dwelling older people. J Adv Nurs. 2010; 66: 2350-2359.
34. 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.
35. Dragioti E, Wiklund T, Alföldi P, Gerdle B. The Swedish version of the Insomnia Severity Index: Factor structure analysis and psychometric properties in chronic pain patients. Scand J Pain. 2015; 9: 22-27.
36. Gerber M, Lang C, Lemola S, Colledge F, Kalak N, Holsboer-Trachsler E, et al. Validation of the German version of the insomnia severity index in adolescents, young adults and adult workers: Results from three cross-sectional studies. BMC Psychiatry. 2016; 16: 174.
37. Chahoud M, Chahine R, Salameh P, Sauleau EA. Reliability, factor analysis and internal consistency calculation of the Insomnia Severity Index (ISI) in French and in English among Lebanese adolescents. eNeurologicalSci. 2017; 7: 9-14.
38. Al Maqbali M, Madkhali N, Dickens GL. Psychometric properties of the insomnia severity index among Arabic chronic diseases patients. SAGE Open Nurs. 2022; 8: 23779608221107278.
39. Clemente V, Ruivo Marques D, Miller-Mendes M, Morin CM, Serra J, Allen Gomes A. The European Portuguese version of the insomnia severity index. J Sleep Res. 2021; 30: e13198.
40. Savard MH, Savard J, Simard S, Ivers H. Empirical validation of the Insomnia Severity Index in cancer patients. Psychooncology. 2005; 14: 429-441.
41. Jiménez-Gonzalo L, Romero-Moreno R, Pedroso-Chaparro MDS, Gallego-Alberto L, Barrera-Caballero S, Olazarán J, et al. Psychometric properties of the Insomnia Severity Index in a sample of family dementia caregivers. Sleep Med. 2021; 82: 65-70.
42. Kim JH, Park EY. The factor structure of the center for epidemiologic studies depression scale in stroke patients. Top Stroke Rehabil. 2012; 19: 54-62.
43. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
44. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. Sleep Med. 2001; 2: 297-307.
45. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: Validity of a brief depression severity measure. J Gen Intern Med. 2001; 16: 606-613.
46. Park SJ, Choi HY, Kim K, Hong JP. Reliability and validity of the Korean version of the Patient Health Questionnaire-9 (PHQ-9). Anxiety Mood. 2010; 6: 119-124.
47. Marsh HW, Hau KT, Wen Z. In search of golden rules: Comment on hypothesis testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu & Bentler’s (1999) findings. Struct Equ Modeling. 2004; 11: 320-341.
48. Byrne BM. Testing for multigroup equivalence of a measuring instrument: A walk through the process. Psicothema. 2008; 20: 872-882.
49. Browne MW, Cudeck R. Alternative ways of assessing model fit. Sociol Methods Res. 1992; 21: 230-258.
50. Fan X, Sivo SA. Sensitivity of fit indices to model misspecification and model types. Multivariate Behav Res. 2007; 42: 509-529.

51. Hair JF, Hult GT, Ringle CM, Sarstedt M. A primer on partial least squares structural equation modeling (PLS-SEM). New York: Sage publications; 2021.
52. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. J Mark Res. 1981; 18: 39-50.
53. Akram U, Akram A, Gardani M, Ypsilanti A, McCarty K, Allen S, et al. The relationship between depression and insomnia symptoms amongst a sample of UK university students. Sleep Med Res. 2019; 10: 49-53.
54. Lukowski AF, Tsukerman D. Temperament, sleep quality, and insomnia severity in university students: Examining the mediating and moderating role of sleep hygiene. PLoS One. 2021; 16: e0251557.
55. Spanhel K, Burdach D, Pfeiffer T, Lehr D, Spiegelhalder K, Ebert DD, et al. Effectiveness of an internet-based intervention to improve sleep difficulties in a culturally diverse sample of international students: A randomised controlled pilot study. J Sleep Res. 2022; 31: e13493.
56. Manzar MD, Jahrami HA, Bahammam AS. Structural validity of the Insomnia Severity Index: A systematic review and meta-analysis. Sleep Med Rev. 2021; 60: 101531.