Original Article

Insomnia in higher education: Prevalence, validation, and measurement invariance in medical sciences students

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Abstract

Background & Objective: Insomnia, a widespread sleep disorder, impacts 15-35% of the general population and a concerning 30% of medical sciences students. This study aims to assesses the psychometric properties, factor structure and measurement invariance of the Insomnia Severity Index (ISI) in Iranian medical university students.

Materials & Methods: This cross-sectional study included 370 medical university students (54.9% females). After providing a detailed introduction regarding the purpose of the study and receiving participants' consent online, they were requested to fill out the Insomnia Severity Index (ISI) and Pittsburgh Sleep Quality Index (PSQI). Confirmatory factor analysis and hierarchical regression analysis were used to examine the factor structure and predict insomnia severity.

Results: The results of descriptive statistics showed that the prevalence of clinical insomnia was 22.6% in male and 27.9% in female students, and 62.2% of male and 67.5% of female students had poor sleep quality. CFA showed that the one-factor model with all items was the most suitable structure (x^2 = 13.82, df = 9, GFI = 0.990, CFI = .994, TLI = 0.986, RMSEA = 0.038). The study's findings indicate that the ISI exhibits measurement invariance across genders, ensuring its unbiased application for both male and female populations. Furthermore, this scale demonstrated acceptable reliability and validity. Finally, the results of hierarchical regression analysis indicated that the poor sleep quality was a significant predictor of insomnia severity (β = 0.389).

Conclusion: The Persian version of ISI showed strong validity and reliability. These findings indicate that insomnia severity could be measured adequately in Iranian samples using the ISI.

Keywords: medical students, insomnia disorder, prevalence study, psychometrics

Introduction

Insomnia is a widespread health issue, as it is one of the most commonly reported health complaints and the most common sleep disorder [1]. Sleeping disorders are estimated to affect 15-35% of the general public, and approximately 30% of medical students [2]. A comprehensive analysis of seven studies found that insomnia affects a significant portion of students, with prevalence rates ranging from 9.4% to 38.2% [3]. Moreover, Yassin et al. [4] reported an insomnia prevalence of 18.3% among medical students. Insomnia manifests as a range of sleep disturbances, including difficulty in falling asleep, staying asleep, waking up too early, or experiencing unsatisfactory sleep quality. Additionally, patients diagnosed with insomnia must also report experiencing impairment in their everyday functioning as a outcome of their sleep difficulties [5]. Insomnia disorder is usually accompanied by a wide range of negative health outcomes and elevates the likelihood of developing diverse psychological issues and challenges, including depression and anxiety [6]. Insomnia also significantly impairs academic performance [7]. A cross-sectional study of around

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50,000 Norwegian students showed that sleeping less than 5 hours and more than 10 hours, compared to those sleeping 7 to 9 hours, is associated with failing exams [8]. In general, daytime sleepiness, low levels of attention, and impaired memory/decision-making that arise from sleep deprivation can provide a suitable explanation for poor academic performance [9]. Heavy academic workload, professional attitudes and habits, as well as poor awareness of sleep hygiene are among the factors that reduce the duration and quality of sleep, in medical students, consequently leading to their poor academic performance [10].

Given the consequences of insomnia discussed for students, the existence of a instrument to diagnose and assess this disorder in the student population seems necessary. Although polysomnography has emerged as a crucial instrument in the assessment of many sleep disorders, it is not the recommended approach for diagnosing insomnia [5]. Consequently, the diagnosis of insomnia relies primarily on the individual's self-reported experiences and symptoms. While structured and semi-structured clinical interviews are becoming more commonly utilized in clinical settings, these methods are highly time- consuming and necessitate extensive knowledge about sleep disorders. As a result, there is a need for simple and efficient instruments to measure the severity of insomnia in order to facilitate the diagnostic process [11]. The Insomnia Severity Index (ISI) is a self-administered questionnaire that captures two of the most common insomnia complaints: difficulty falling asleep and frequent nighttime awakenings [12]. The ISI, developed in 1993, has emerged as a valuable instrument in both clinical practice and research studies, also the ISI demonstrates validity for use across a broad age range, and it has proven to be a valuable assessment instrument for individuals with diverse conditions, including mantal disorders [13], and other clinical problems [14]. Psychometric evaluations of the ISI have been conducted for the English [15], French [16], Spanish [17], and Chinese [18] versions, and studies have consistently demonstrated the instrument's reliability and adequate concurrent validity with other sleep assessment measures. In Iran, the psychometric characteristics of other tools in the field of sleep, including Pittsburgh Sleep Quality Index [19] and revised Adolescent Sleep Hygiene Scale [20], have been examined. These tools respectively address individuals' perceptions of their sleep quality and sleep hygiene behaviors, but none assess the severity of insomnia. Therefore, the advantage of the ISI is its direct measurement of insomnia severity. However, there is no validation for the Persian version of this questionnaire in the population of Iranian medical sciences students. Hence, the purpose of the present study is to examine the factor structure, psychometric properties, and measurement invariance of the ISI questionnaire in the population of Iranian medical sciences students.

Materials & Methods

Design and setting(s)

This cross-sectional, psychometric study investigated the ISI among Bachelor, Postgraduate, and PhD students at Zanjan University of Medical Sciences, Iran. The Research Ethics Committee of the Zanjan University of Medical Sciences approved the study (Approval ID: IR.ZUMS.REC.1396.35).

Participants and sampling

All participants of this study were Iranian and Persian-speaking, and were selected using convenience sampling. In various studies, different suggestions have been made for determining the appropriate sample size for psychometric studies. These suggestions range from 5 to 20 participants per item [21]. In the present study, 50 participants per item were used. The inclusion criteria for this study included informed consent and an age range of 18 to 50 years. The exclusion criterion was a desire to withdraw from the study or random response to the items.

Tools/Instruments

The following questionnaires were used for data collection, (ISI): The ISI is a 7-item questionnaire that measures the severity of insomnia experienced over the past two weeks. It is the most widely used instrument in research for assessing insomnia severity . Each item is rated on a 5-point Likert scale, with scores ranging from 0 to 28. Higher scores indicate greater severity of sleep disturbances and associated daytime symptoms. The ISI's validity and reliability have been confirmed in various studies [22]. The Pittsburgh Sleep Quality Index (PSQI): The PSQI is a self-administered questionnaire, developed by Buysse et al. [23], that assesses sleep quality over the past month. The questionnaire consists of 19 questions/items organized into seven components. Each component is scored from 0 to 3, resulting in a global score ranging from 0 to 21. A global score exceeding 5 indicates poor sleep quality. The PSQI has been validated in various countries and demonstrated good reliability and validity in both clinical and non-

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clinical samples [24]. In Iran, Shadzi et al. examined the reliability and validity of this questionnaire, among medical students and reporting satisfactory psychometric properties [25].

Data collection methods

To ensure accurate translation, the Persian version of the ISI was prepared in accordance with international guidelines for cross-cultural adaptation of self-report measures [26]. A team of experts, including a clinical psychologist and a psychiatrist, translated the ISI items into Persian. Subsequently, an English language expert conducted a back-translation into English to ensure the accuracy and complete alignment of the Persian and English versions [27]. Following several rounds of review and refinement to address any grammatical or content-related concerns, the translated Persian version of the ISI was finalized and prepared for implementation, maintaining close alignment with the original English instrument. Sampling was conducted through the online posting of brief explanations of the purpose of this research, along with a participation link, on university social media networks. Before completing the scale, participants were provided with informed virtual consent. Following data collection, the responses were screened for validity. Outliers were identified using Mahalanobis distance, and invalid responses were flagged. Invalid responses included fixed and contradictory responses.

Data analysis

The first step in the analysis was to conduct a descriptive analysis of the data to understand the distribution of demographic variables, insomnia severity, and sleep quality in students. this involved frequency distributions and graphical representations were used to visualize the data. To investigate the factor structure of the ISI, CFAs were conducted following an exploratory factor analysis. Three models were tested: a single-factor model with 7 items, a two-factor model with 7 items, and a three-factor model with 7 items. Model fit was assessed using the following indices: chi-square fit statistics (CMIN/DF), incremental fit index (IFI), Tucker-Lewis index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA, 90% CI). goodness of fit was defined as CMIN/DF ≤ 3, TLI, IFI, and CFI ≥ 0.900, and RMSEA ≤ 0.05 [28]. Measurement invariance was employed to assess the degree of invariance between genders (females vs. males). Measurement invariance was assessed to determine the extent to which the ISI exhibits equivalent psychometric properties across genders. This analysis evaluates whether the construct of intrusive thought appraisals is measured in the same way for both genders, ensuring the reliability and validity of comparisons across groups. Measurement invariance was tested using a series of increasingly constrained models including Configural, Metric, and Scalar. Model fit was compared using the change in CFI (ΔCFI) and RMSEA (ΔRMSEA) between the less restrictive and more restrictive models. Cutoff values for acceptable invariance were ΔRSMEA ≤ 0.015 and ΔCFI ≤ 0.01[29]. To assess the questionnaire internal consistency, Cronbach's alpha was calculated. Furthermore, the criterion validity was assessed by examining its correlations with sleep quality measure. The data were analyzed using SPSS version 27 for descriptive statistics, and AMOS version 24 for Confirmatory Factor Analysis (CFA).

Results

As shown in **Table 1**, a total of 370 students participated in the study, with 45.1% (n = 167) being male and 54.9% (n = 203) being female. The mean age of the participants was 23.79 years (SD = 4.48), with ages ranging from 18 to 51 years. Most participant were single (91.6% of men; 75.4% of women). In terms of educational status, 73.1% of men and 29% of women were postgraduate students. The prevalence of clinical insomnia was 22.6% in men and 27.9% in women. In addition, 37.8% of men and 32.5% of women had good sleep quality.

Table 1. Sociodemographic and clinical variables according to gender

	Men (n=167)		**Women (n=203)**	
	n	%	n	%
Marital status				
Single	153	91.6	153	75.4
Married / In relationship	14	8.4	50	24.6
Educational attainment				
Undergraduate	45	26.9	144	71
Postgraduate	122	73.1	59	29
Insomnia severity				
Non-clinical	58	34.8	64	31.6
Sub-clinical	71	42.6	83	40.8
Mild-clinical	37	22	50	24.6
Sever-clinical	1	0.6	6	3
Sleep quality				
PSQI score < 5	63	37.8	66	32.5
PSQI score > 5	104	62.2	137	67.5
Age mean (SD)	24.59 (4.35)		23.13 (4.48)	

Abbreviations: SD, standard deviation; PSQI, Pittsburgh sleep quality index; n and %, sample size and percentages.

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Table 2 displays the mean, standard deviation, skewness, kurtosis, and Cronbach's alpha for the items. the distribution of samples based on the kurtosis and skewness of the items does not exceed the standard range of +2. The corrected item-total correlation indicates a moderate and significant relationship between the items and the total score. The internal consistency coefficients based on Cronbach's alpha did not exceed 0.80 after removing any of the items. Participants responded to all questionnaire items in a nearly uniform manner, and the dispersion was low.

CFA was conducted using Amos version 24. To further assess and validate the factor structures identified in exploratory factor analysis, CFA was performed. The examination of the results showed that the one-factor model exhibited the best and most appropriate fit indices. The results of the CFAs are presented in **Table 3**. As shown in **Table 3**, the final full-item model, has the following characteristics $x^2 = 13.82$, df = 9, GFI = 0.990, CFI = 0.994, TLI = 0.986, RMSEA = 0.038. In the final one-factor model, the path coefficients of each item with its underlying factor range from 0.49 to 0.81. This indicates that each item has an acceptable predictive weight with its main factor. **Table 2** displays the factor loadings of the items. According to, the factor loading values of the items were above 0.596, ranging from 0.596 in item 3 to 0.815 in item 2.

Table 3 presents the results of the measurement invariance testing for the single-factor model. The model displayed satisfactory fit indices for both males and females, as indicated by the TLI, CFI, and RMSEA. Additionally, the configural, metric, and scalar invariance models tested between gender groups showed satisfactory fit indices based on the TLI, CFI, and RMSEA. Only the configural invariance models exhibited minimal degradation in model fit (Δx^2 = 15.428; p = - 0.042; ΔCFI = - 0.012; ΔTLI = - 0.013; ΔRMSEA = 0.007), as well as between the metric and scalar invariance models (Δx^2 = 1.954; p= - 0.001; ΔCFI = - 0.001; ΔTLI = - 0.001; ΔRMSEA = < 0.001). Consequently, invariance was established across both genders.

Table 2. Item-Level statistics and factor structure of the ISI (n = 370)

Items	Mean (SD)	Skewness	Kurtosis	Corrected item-total r	Cronbach's α if deleted	Factor loading
1a. Difficulty falling asleep	1.16 (1.06)	0.68	- 0.21	0.56	0.79	0.700
1b. Difficulty staying asleep	1.04 (1.05)	0.88	0.18	0.50	0.80	0.644
1c. Problem waking up too early	1.61 (1.26)	0.36	- 0.90	0.48	0.80	0.625
2. Sleep satisfaction	1.72 (1.02)	0.26	- 0.44	0.70	0.76	0.815
3. Interference	2.09 (1.10)	- 0.09	-.72	0.45	0.80	0.596
4. Noticeability	1.61 (1.09)	0.21	- 0.83	0.54	0.79	0.677
5. Distress	1.18 (1.09)	0.62	- 0.49	0.65	0.77	0.770
Eigenvalues						**3.367**
Percentage of variance						**48.10**

Abbreviations: SD, standard deviation.
Note: The loadings indicate the strength of the relationship between each item and its respective factor. Eigenvalue represents the eigenvalue associated with each factor. Percentage of variance indicates the proportion of variance explained by each factor. Cronbach's alpha value represents the reliability coefficient. Corrected coefficient indicates the Cronbach's alpha value after the removal of each item. skewness and Kurtosis measure the shape of the distribution. M signifies the average response to each item. SD represents the standard deviation of responses.

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Table 3. Fit statistics for the confirmatory factor analysis model and Measurement invariance (n = 370)

Model	X^2	df	GFI	CFI	TLI	RMSEA
Factor structure invariance						
• **Model 1. 1-factor full-item ISI**	13.825	9	0.990	0.994	0.986	0.038
• **Model 2. 2-factor full -item ISI**	28.737	11	0.978	0.978	0.957	0.066
• **Model 3. 3-factor full -item ISI**	42.597	9	0.968	0.958	0.901	0.101
Measurement invariance	$\chi 2$ (*df*)	P	CFI	TLI	RMSEA (90% CI)	
• **Configural invariance**	28.383 (18)	0.050	0.987	0.970	0.970	0.040 (0.000; 0.066)
• **Metric invariance**	43.811 (24)	0.008	0.975	0.957	0.957	0.047 (0.024; 0.069)
• **Scalar invariance**	45.756 (25)	0.007	0.974	0.956	0.956	0.047 (0.025; 0.069)

Note: $p < 0.05$ indicates significance at the 5% level, and $p < 0.01$ indicates significance at the 1% level.
Abbreviations: X^2, chi-square statistic; df, degrees of freedom; GFI, goodness of fit index; CFI, comparative fit index; TLI, Tucker-Lewis index; RMSEA, root mean square error of approximation; P, p-value for the chi-square test of invariance; CI, confidence interval.

Convergent validity was assessed using the Average Variance Extracted (AVE) index. An AVE value greater than 0.5 is generally considered acceptable. In the present study, the AVE was estimated to be 0.51. In order to assess Criterion validity of the 7-item ISI, we analyzed the correlation between its total score with other sleep-related scales. The results demonstrate that the relationship between the total score of the ISI with Pittsburgh Sleep Quality Index, show significant correlations, ranging from weak to moderate ($r = 0.52$ $p < 0.01$). Internal consistency and composite reliability were used to assess the reliability of the present questionnaire.

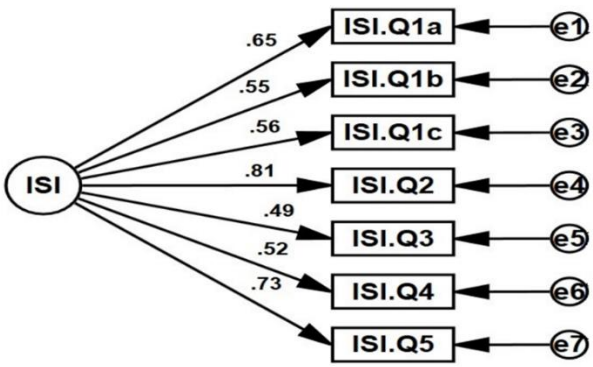


Figure 1. The final model

According to the research findings, the Composite Reliability (CR) was calculated to be 0.865, and the Cronbach's alpha was 0.813. These results indicate that the questionnaire has adequate reliability in the Iranian population. A hierarchical Multiple regression analysis was conducted to examine the contribution of Sleep Quality in predicting sleep-related problems (**Table 4**). In this investigation, the severity of insomnia was examined as the result variable, with demographic factors and Sleep Quality serving as predictors. The regression analysis was carried out in a two-step process. In the first step age, gender and marital were entered into the model. The results indicated that none of them can significantly predicted insomnia severity. In the second step, age, gender, marital, and Sleep Quality were entered into the model. The results showed that in this step, only Sleep Quality ($\beta = 0.389$) significantly predicted insomnia severity. This suggests that for each 0.389 unit rise in PSQI, revealing of poor sleep quality, there is a corresponding one-unit increase in the severity of insomnia. The R^2 value for the regression models in the two steps were 0.006 and 0.395, respectively representing that the final model predicts 38.9% of the insomnia severity.

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Table 4. Hierarchical regression model of insomnia severity

	R	R^2	R^2 change	B	SE	β	t	Sig.
Step 1	**0.079**	**0**	**0.006**					**0.512**
Age				0.035	0.068	0.029	0.513	0.608
Gender				0.698	0.585	0.066	1.193	0.234
Marital				0.331	0.807	0.024	0.410	0.682
Step 2	**0.395**	**0.156**	**0.150**					< 0**.001**
Age				0.024	0.062	0.020	0.381	0.703
Gender				0.350	0.541	0.033	0.646	0.519
Marital				0.569	0.745	0.041	0.763	0.446
Sleep quality				1.03	0.128	0.389	8.060	< 0.001

Abbreviations: R, correlation coefficient; R^2, coefficient of determination; R^2 change, change in R^2 when a new variable is added to the model; B, unstandardized regression coefficient; SE, standard error; β, standardized regression coefficient; t, t-statistic; Sig, Significance level.

Discussion

The aim of the present research was to examine the psychometric characteristics, factorial structure, and measurement invariance of the Insomnia Severity Index among Iranian medical sciences students. The ISI demonstrated appropriate internal reliability and convergent validity. The findings suggested that the single-factor model proved to be the most suitable model in the student sample, aligning with previous research outcomes.

The current research demonstrates that clinical insomnia affected 22.6% of male students and 27.9% of female students. This outcome aligns with the findings of the meta-analysis study carried out by Zeng et al. [30], which revealed a higher occurrence of insomnia among female students as compared to male students. The explanations for the higher prevalence of insomnia in women, especially female students, seem to be multifactorial [30]. In general, women tend to be more exposed to unfavorable socioeconomic conditions, such as acquiring lower income or attaining lower educational levels [31], and therefore female students may experience more stress regarding their future and career. Furthermore, women are more likely to face psychiatric problems like depression and anxiety [32], which serve as risk factors for insomnia in women. As a result, female students experience greater emotional dysfunction and report more insomnia.

Furthermore, the results showed that 62.2% of male students and 67.5% of female students had poor sleep quality. In general, caffeine consumption, stress, and irregular sleep-wake patterns can decrease sleep quality, and mental health issues (such as depression, psychiatric disorders, perceived stress, and anxiety) are undoubtedly detrimental to sleep quality [33]. Given that students may stay up late at night and wake up early due to academic demands and social interactions, and tend to sleep more on holidays, their sleep-wake patterns are irregular. Additionally, due to academic and work-related issues, students experience high levels of stress. Furthermore, during exam periods, students may increase their caffeine consumption to stay more alert and awake. As a

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result of all these factors, the sleep quality of students decreases. Moreover, the gender differences in sleep quality problems are mainly attributed to the prioritization of emotional disorders and socioeconomic inequalities [34], which lead to higher levels of experienced stress. The susceptibility of women to poor sleep quality may also stem from gender-based differences in sleep biology, which are exacerbated by the higher levels of emotional disorders in women [35]. Therefore, all of these factors synergistically contribute to a greater reduction in the sleep quality of female students compared to male students.

The findings indicated that the ISI is a reliable instrument for assessing the severity of insomnia in the Iranian medical student population. Specifically, the results demonstrating the good internal consistency of this scale are consistent with the findings from previous research [36]. In this study, three models were tested: one, two, and three-factor model (without item deletion). The results of the CFA indicated that the one-factor model was the most appropriate model for the Iranian medical sciences student population, accounting for 48.10% of the total variance of the questionnaire. This finding is consistent with the results of studies in Sweden [37], and the United States [36], but inconsistent with other studies (11, 38). In explaining this finding, it can be said that in the present study, the two-factor and three-factor models were also fairly suitable, but the one-factor model was the best and most appropriate model for explaining the Insomnia Severity Index in the Iranian medical student population. Additionally, the linguistic and cultural differences between the Iranian population and the populations of other studies can be mentioned.

The measurement invariance implies that the ISI can be utilized in a sufficiently unbiased manner among both male and female respondents. Putnick and Bornstein [39] have suggested that scalar measurement invariance analyses serve as dynamic and informative evaluations of a construct's functioning across groups, rather than serving as gateway tests. These results contribute to the growing body of literature on the psychometric robustness of the ISI and underscore its cross-gender applicability. Furthermore, the results indicated that the Persian version of the ISI (ISI-P) had satisfactory convergent validity (significant positive correlation) with the sleep quality measurement instrument, $r = 0.52$, $p < 0.001$. This psychometric property is aligns with the findings of previous studies [17].

The results of the hierarchical regression analysis point to the predictive role of sleep quality in the severity of insomnia ($\beta = 0.389$). This indicates that sleep quality accounts for 38.9% of the variance in insomnia severity. The PSQI, used in our study to measure sleep quality, has been widely validated and shown to be effective in assessing various dimensions of sleep quality, including subjective sleep quality, sleep duration, sleep latency, sleep disturbances, habitual sleep efficiency, and daytime dysfunction [23]. Poor scores on these dimensions were significantly correlated with higher ISI scores, indicating more severe insomnia. This is align with previous studies that have found a strong relationship between sleep quality, as measured by the PSQI, and insomnia severity [40].

In examining the broader implications of these findings, it is essential to consider the multifaceted nature of sleep quality and its determinants. Factors such as sleep hygiene, psychological stress, academic workload, and lifestyle habits can significantly influence sleep quality. In other words, practices that compromise good sleep hygiene, such as extensive screen usage before bed, inconsistent sleep schedules, and excessive caffeine intake, can worsen sleep quality and heighten the risk of developing insomnia [41]. Moreover, psychological factors play a critical role in sleep quality. There is a strong connection between stress, anxiety, and depression, as well as poor sleep quality and insomnia. Research has found that people with higher stress levels and negative affect are more prone to experiencing poor sleep quality and, in turn, developing more pronounced insomnia [15]. The interplay between psychological factors and sleep quality suggests that interventions aimed at reducing stress and improving mental health could be effective in mitigating insomnia severity.

This study had a few limitations such as did not controling for medication treatment in the sample data. Future studies can address this factor. The convergent validity of the ISI-P scale was assessed using only one measurement instrument. The study relied on a single source of data (self-report) for evaluating insomnia severity. Future research could consider incorporating additional measures, such as sleep diaries or objective sleep assessments, to provide a more comprehensive evaluation. Despite these limitations, the findings contribute to the growing body of evidence supporting the psychometric properties of the ISI in the Iranian medical student population.

Conclusion

In this study, the cross-cultural adaptation of the ISI was rigorously conducted in accordance with established

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guidelines, and its factor structure, psychometric properties and measurement invariance were examined in a sample of Iranian medical sciences students. The results of this study strengthen the psychometric validity of the ISI and further reinforce its structural validity. Additionally, the results of the regression analysis showed that sleep quality is the best predictor of insomnia severity. Overall, the findings of this study can facilitate future research and clinical interventions related to the severity of insomnia. However, further studies are needed to deepen our understanding of insomnia severity and its relationship with other variables that impact individual functioning.

Ethical considerations

The Research Ethics Committee of the Zanjan University of Medical Sciences (ZUMS), in Zanjan, Iran approved the study (Approval ID: IR.ZUMS.REC.1402.176). All participants gave written informed consent, and they could withdraw from the study at any stage.

Artificial intelligence utilization for article writing

The authors declare that they did not use generative Artificial Intelligence (AI) and AI-assisted technologies in the writing process of this paper.

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Conflict of interest statement

The authors have no conflicts of interest to declare

Author contributions

ZNE, AR and OS and designed, conducted the study, performed the statistical analyses, and wrote the manuscript. HTS participated in the design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript

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Data availability statement

Data will be made available on request.

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