Zhang *et al. BMC Psychiatry* (2024) 24:696
https://doi.org/10.1186/s12888-024-06160-w

BMC Psychiatry

RESEARCH

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Psychometric evaluation of the Chinese version of the hospital-acquired insomnia scale (HAIS) and analysis of influencing factors

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Abstract

Background Adequate sleep and rest are essential for patient recovery; however, lack of sleep has become a common problem faced by Chinese patients during hospital stays. Reduced sleep is often associated with a higher risk of disease progression and is strongly associated with increased hospital stay. However, there is no specific tool in China to assess short-term insomnia caused by hospitalization. This study aimed to translate the Hospital-acquired Insomnia Scale (HAIS) into Chinese, test its applicability to Chinese inpatients through reliability and validity indicators, and investigate the potential influencing factors of hospital-acquired insomnia.

Methods Psychometric analysis from a sample of 679 hospitalized patients to whom the HAIS questionnaire was applied. The structural validity was assessed by exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), and the content validity of the scale was assessed using the content validity index. Cronbach's alpha coefficient, split-half reliability and test–retest reliability were calculated to evaluate the internal consistency of the scale. Multiple stepwise linear regression analysis was conducted to determine the potential correlates of hospital-acquired insomnia.

Results EFA supported a four-factor structure with factor loadings for all dimensions greater than 0.40. CFA showed good indicators of model fit. The content validity index of the scale was 0.94. the Cronbach's alpha of the scale was 0.915, the split-half reliability coefficient was 0.819, and the retest reliability was 0.844. Gender, age, total hours of sleep during the night, medical insurance, length of hospital stay, perceived stress level, and perceptions about sleep explained 46.2% of the variance in hospital-acquired insomnia.

Conclusion The Chinese version of HAIS has good psychometric characteristics and is an effective instrument for evaluating hospital-acquired insomnia. In addition, hospital-acquired insomnia is more common in women, of younger age, less than 5 h of sleep a night, without medical insurance, stressed, and patients with more misconceptions about sleep.

Keywords Hospital-acquired Insomnia Scale (HAIS), Sleep disorders, Inpatients, Scale validation

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Introduction

Insomnia is a common problem in modern society. The Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) defines insomnia as a sleep disorder characterized by frequent and persistent (at least three nights per week for at least three months) difficulty falling asleep and/or maintaining sleep, resulting in insufficient sleep satisfaction. Sleep disturbances that lasted less than three months but satisfied all other diagnostic criteria for insomnia were classified as transitory insomnia [1]. Acute short-term insomnia is a common problem faced by hospitalized patients [2], Patients often have difficulty falling asleep or wake up frequently during the night, experiencing transitory insomnia, such insomnia is defined as hospital-acquired insomnia [3].

A 10-year cohort study in the United States found a significant increase in the prevalence of insomnia among hospitalized patients in recent years [4], and insomnia symptoms were also reported in 32% of older adults with multiple complications in the North India Hospital study [5]. In fact, hospital-acquired insomnia also has been noted in China, the sleep study of hospitalized patients in China found that the incidence of sleep deprivation was as high as 48%, and patients complained that the quality of sleep in the hospital was significantly lower than that at home, and it was difficult to sustain sleep [6]. Notably, nocturnal insomnia not only implies impaired sleep quality and daytime functioning, but also poses some unique disease risks to patients. As a population with elevated sleep needs, sleep deprivation directly affects the immune response of hospitalized patients, increasing the risk of infections, delaying healing, and further prolonging the patient's hospital stay [7]. In addition, research revealed a strong association between insomnia and the frequency of hospital nighttime incidents, specifically in geriatric units where inadequate sleep negatively impacts senior patients' cognitive abilities, heightening the risk of falls, delirium, and worsening of nocturnal conditions [8]. Studies have shown that the effects of these sleep deficiencies persist in about three months even after recovery sleep is achieved [9], this finding debunks the idea that "the effects of insomnia can be overcome after discharge" [10], and that a patient's insomnia problem is not only accompanied by an elevated risk of disease progression during hospitalization and an increase in hospital costs, but also has a lasting impact on the patient's life after discharge. Sleep deprivation experienced during hospitalization has been identified as a potential source of harm to patient's health and well-being. These phenomena suggest the need to further explore the factors influencing hospital-acquired insomnia in inpatients.

Much of the prior clinical research focused on the relationship between surgical methodology, pain, anaesthetic medications, and sleep in hospitalized patients [11–14]. Gellerstedt believes that patients are more likely to suffer from sleep deprivation because they have already experienced physiological processes such as pain or infection [15]. There are also studies pointed out the impact of the ward environment on patients' sleep [16–18], such as machine noise, light, smell, room heat, night rounds, discomfort with pillows and bedding, and so on. What is certain is that the factors that cause insomnia in hospitalized patients are intricate, but the current exploration of insomnia in hospitalized patients is limited. Peiris attempts to explain the mechanism of insomnia from the perspective of behavioral patterns and neurocognition, and he emphasizes the key role of perceived stress and sleep beliefs [19]. As triggers of insomnia, stress and anxiety alter an individual's sleep structure by increasing levels of alertness and stimulating the sympathetic nervous system [20]. Negative emotions and misunderstandings about sleep, as a key factor in maintaining insomnia, will exacerbate patients' anxiety and worry about sleep, causing them to fall into a cycle of insomnia [21, 22]. However, it remains inconclusive whether perceived stress and sleep beliefs are also involved in the development of hospital-acquired insomnia and play a key role in this process.

In the previous several decades, multiple scales to assess sleep disorders have been created, validated and adapted to various cultural settings. These scales included Pittsburgh Sleep Quality Index (PSQI) [23], Insomnia Severity Index (ISI) [24], Epworth Sleepiness Scale (ESS) [25], etc. Whilst there are a number of recognized and commonly used insomnia assessment tools, their content focuses on the measurement of the degree of insomnia and there is no specific tool that focuses on the impact of hospitalization on a patient's sleep. This has resulted in medical staff failing to identify the causes of hospital-acquired insomnia, with no basis for targeting patients for early prevention and intervention, and hospitals missing out on the opportunity to optimize sleep environments to improve the quality of patients' sleep during their hospital stay. To remedy this shortcoming, Bahar et al. first developed the Hospital-Acquired Insomnia Scale (HAIS) in Turkey as a professional tool for assessing the severity of a patient's hospital-acquired insomnia [3]. The 18-item scale provides a comprehensive assessment of factors affecting sleep in hospitalized patients in five areas: physical environment, safety, psychology, socioeconomic and dietary nutrition. The HAIS, a specially developed measurement tool for assessing hospital-acquired insomnia in patients, has been validated in 221 local inpatients with high internal consistency reliabilities, test–retest reliabilities and construct validity, demonstrating that it has good psychometric properties. However, since its development in 2023, it has not been applied to the assessment of hospital-acquired insomnia across cultures in different countries and regions. Given the potential impact of hospital-acquired insomnia on the health of hospitalized patients, especially in countries and regions where there is a relative strain on healthcare resources, such as China. This phenomenon deserves to be evaluated with specialized validated tools and indicators.

The present study translated and cross-culturally adjusted the HAIS scale into Chinese and further assessed its psychometric properties in a Chinese hospitalized patient population. In addition, this study hypothesized that the level of hospital-acquired insomnia may be related to sociodemographic characteristics and that patients' perceived stress and misconceptions about the existence of beliefs about sleep would have a greater impact on hospital-acquired insomnia. Therefore, we carried a cross-sectional investigation of factors influencing the HAIS.

Materials and methods

Design and participants

In this study, cross-sectional investigation and convenient sampling were used to investigate the inpatients in a tertiary hospital in Jinzhou City, Liaoning Province from November 2023 to February 2024. The admission criteria for this study were :1. Adult patients hospitalized in general wards for more than 3 days; 2. Patients have clear knowledge and understanding of the questionnaire content; 3. Patients who voluntarily participated in this research with their informed consent. The exclusion criteria were: (1) Patients with serious physical diseases who could not complete the questionnaire; (2) Patients undergoing surgery; (3) A history of insomnia before admission (defined as difficulty falling asleep or taking medication for more than 3 days per week within the last month) [1]; (4) Patients with other forms of sleep-related disorders.

Instruments

Questionnaire for general information

The general demographic Characteristics questionnaire included additional information such as sex, age, department of admission, social security, and self-rated sleep during hospitalization.

Hospital-acquired insomnia scale (HAIS)

The HAIS was initially created by Prof. Bahar et al. in 2023 to accurately assess the level of insomnia in currently hospitalized patients [3]. There are five dimensions and eighteen items on the scale: environmental factors, psychological factors, safety factors, socioeconomic factors, and nutritional factors. With a total score of 18 to 90, the scale is graded on a 5-point Likert scale that goes from 1 (never) to 5 (always). The higher the score denotes the more severe the degree of hospital-acquired insomnia. The Turkish version of HAIS has excellent reliability and validity, Cronbach's alpha coefficient is 0.783. The Cronbach's α coefficient of this research was 0.915.

Insomnia severity index (ISI)

The ISI was proposed by Bastien et al. in 2001, which consists of 7 items on a 5-point Likert scale to measure the degree of insomnia in individuals, with a final score of 0–28, A higher score implies higher levels of insomnia [26]. The English version has a Cronbach's alpha coefficient of 0.900, and it was validated in a Chinese population with a Cronbach 's alpha coefficient of 0.835 [27]. In this research, the Insomnia Severity Index (ISI) was chosen to measure the level of insomnia in individuals, The Cronbach's α coefficient of this research was 0.919.

Dysfunctional beliefs and attitudes about sleep scale (DBAS)

The DBAS was developed by Morin in 2000 to assess misconceptions about sleep and insomnia [28]. The 16 items on the measure are rated on a 5-point Likert scale from 1 (strongly disagree) to 4 (strongly agree). More dysfunctional beliefs or misbehaviors toward sleep are indicated by higher scores. The original version has a Cronbach's alpha coefficient of 0.790 [28], and it was validated in a Chinese population with a Cronbach 's alpha coefficient of 0.894 [29]. Cronbach's α coefficient of the scale in this study was 0.900.

Perceived stress scale (PSS)

The Perceived Stress Scale (PSS) was developed by Cohen et al. in 1983 to assess the level of stress experienced by an individual [30]. The scale consists of 2 dimensions, tension and loss of control, with 7 entries for each dimension, and is based on a 5-point Likert scale, with scores ranging from 0 to 4, from never to always, and a total score of 0 to 56. Higher scores correspond with perceived stress levels that are higher. The original version has a Cronbach's alpha coefficient of 0.840 [30], and it was validated in a Chinese population with a Cronbach 's alpha coefficient of 0.830 [31]. Cronbach's α coefficient of the scale in this study was 0.904.

Study procedures

Translation process

Prof Bahar provided the English version of the HAIS scale and allowed us to translate it as well as validate it. A forward-backward translation method based on the Brislin translation was applied [32]. First, two bilingual graduate nursing students who were familiar with the background of the study independently translated the HAS into Chinese, and the translation was then discussed and improved by the research team to create a translated version. The translated scale was back-translated by two translators (a university English teacher and an English graduate student) who hadn't previously seen the original version of the scale and were proficient in English. The back-translated version was developed after group discussion and revision. Controversial items were changed to render the scale better suited for the Chinese context after consultation with the original authors and their team's evaluations and comments on the scale's translation. Thirty hospitalized patients participated in a preliminary trial. After receiving the task to finish the scale, they were questioned regarding their comprehension of its entries. They reported no problems with comprehension, and eventually, a definitive Chinese version of the scale was created.

Cultural adaptation of HAIS

After consulting with the original authors, we recognized significant differences in the dietary patterns of hospitalized patients between the two countries. In Turkey, hospitals provide three meals a day for each patient and their relatives. This practice not only addresses the physiological needs of patients but also allows for the control, monitoring, and evaluation of the quantity and timing of their diets. As a result, hospitals can adjust diets promptly and address potential nutritional deficiencies. In contrast, hospital dining arrangements in China are more flexible, enabling patients and their families to select their own meals and adjust meal times according to their preferences. Considering that the nutritional dimension primarily assesses the impact of meal timing on patients' sleep, and with the original author's permission, We have made corresponding revisions to items 16 and 17. These changes follow Beaton's cross-cultural adaptation and testing guidelines [33].

Data collection procedure

In this study, we investigated inpatients at a tertiary hospital in Liaoning Province, from November 2023 to February 2024, and questionnaires were collected in the ward. Patients received thorough explanations of the goal and methods of the research, and data for the study were collected face-to-face after obtaining their consent. The survey procedures strictly adhered to the basic principles of medical research and ensured confidentiality and privacy. The sample size is determined according to the general rules of the factor analysis program, which require at least 10 respondents to be recruited for each item, but a larger sample helps ensure the accuracy of exploratory factor analysis and confirmatory factor analysis [34]. Eventually, 736 questionnaires in all were gathered. 679 valid questionnaires were recovered, and 57 invalid questionnaires with incomplete answers and continuous answers of more than half were excluded [35]. The recovery rate was 92.25%. Considering that patients in the respiratory departments of this hospital have longer hospital stays, after communication with the department, the names and admission numbers (AD) of this population were marked, and retest patients who remain hospitalized after two weeks. This study adhered to the ethical norms of the Helsinki Declaration as well as the Ethics Committee of Jinzhou Medical University (JZMULL2023150).

Data analysis

Categorical variables are expressed as percentage (%) and continuous variables are expressed as mean ± standard deviation (SD). AMOS (V24.0) and SPSS (V26.0) were used to analyze the statistical data. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to determine the potential factor structure of the Chinese version of HAIS. A sample of 679 participants was randomly divided into two groups for EFA ($N=341$) and CFA ($N=338$). The suitability for factor analysis is determined using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. When the KMO value is greater than 0.60 and Bartlett's test of sphericity is significant ($P<0.05$), the data are considered suitable for factor analysis. Factors with eigenvalues greater than 1 were extracted and subjected to varimax orthogonal rotation. Items with loadings of 0.50 or higher were considered for inclusion in separate factors. Factor extraction was guided by eigenvalues, total variance explained, and scree plot. The reliability of the internal consistency of the scale was determined by Cronbach's alpha coefficient. Cronbach's alpha coefficient above 0.7 is considered acceptable. Multiple stepwise linear regression analysis was used to investigate the potential determinants of hospital-acquired insomnia. $P<0.05$ was considered statistically significant.

Results

Demographic characteristics

A total of 679 hospitalized patients were finally included in the study (Table 1), of which 371 (54.6%) were male and 308 (45.4%) were female. The age of the patients was concentrated at 51–71 years (45.9%). Most of the participants were from the medical ward (57.7%), 43.9% of the patients were hospitalized for 1–2 weeks, the health insurance coverage reached 90.6%, and 41.8% of patients felt that their sleep was affected during their hospitalization. Table 2 illustrates participants' mean (SD) scores for each item of the revised HAIS.

Item analysis

Given that item validity is a prerequisite and foundation for the establishment of psychometric indicators for the scale, item analyses were performed before validity and reliability assessments. The total score of the HAIS was ranked from high to low, with the top 27% being the high group and the bottom 27% being the low group. The t

Table 1 Demographic characteristics ($N=679$)

Variable	Total(N%)
Gender	
Male	371(54.6)
Female	308(45.4)
Age (years old)	
18–30	51(7.6)
31–50	159(23.4)
51–70	312(45.9)
71 and above	157(23.1)
Per capita monthly income (rmb)	
<1999	181(26.7)
2000–3999	400(58.9)
>4000	98(14.4)
Department	
Internal medicine	392(57.7)
Surgery	233(34.3)
Others	54(8.0)
Hospitalization (day)	
3–7	202(29.7)
8–16	298(43.9)
17–21	157(23.1)
22 and above	22(3.20)
Medical insurance	
Yes	615(90.6)
No	64(9.4)
Time to sleep(minute)	
0–15	252(37.1)
16–30	310(45.7)
31–45	117(17.2)
Sleep disruption duration (minute)	
0–15	184(41.8)
16–30	288(42.4)
31–45	107(17.2)
Length of sleep per night(hours)	
<5	166(24.4)
>5	166(24.4)
Self-rated sleep	
Very good	99(14.6)
Good	284(41.8)
General	114(16.8)
Bad	141(20.8)
Very bad	41(6.0)

values obtained by the t-test of independent samples of high and low subgroups were used as Critical Ratio Decision Value (CR) to evaluate the differences of items [36]. The results showed that the CR values of the 18 items in the scale ranged from 12.454 to 24.647, all showing statistical differences (Table 3), indicating that the Chinese version of HAIS items had good differentiation and could effectively measure the response level of different subjects. Using Pearson correlation analysis, the correlation coefficients between the overall scores on the scale and the scores on each item were determined, to assess the degree of agreement of their measurement attributes [37]. The correlation coefficients between each item and the total score of the scale ranged from 0.430 to 0.672 ($P<0.001$). Therefore, all 18 entries were retained (Table 3).

Validity analysis

Content validity

Content Validity Index (CVI) includes item-level content validity index (I-CVI) and universal agreement scale-level content validity index (S-CVI/UA) [38]. Two sleep specialists and five medical experts were invited to rate each item of the scale on a 4-point scale (1–4 for " no association ", " little correlation ", " significant correlation ", and " extremely strong correlation ") [39]. The results showed that the I-CVI value of HAIS was 0.857 ~ 1.000, and the S-CVI/UA value was 0.94. Most experts believed that the individual and overall contents of the scale were consistent with the measurement objectives, which ensured the objectivity and scientific nature of the scale [40].

Construct validity

Exploratory factor analysis (EFA) and Confirmatory factor analysis (CFA) were used to test the structural validity of HAIS. The 679 samples were randomly divided into two groups: 341 completed EFA and 338 completed CFA.

Exploratory factor analysis (EFA)

The matrix of sample 1 ($n=341$) is preliminarily evaluated by factors. The Bartlett test of sphericity had statistical significance ($\chi^2=6,610,260$, $P<0.05$) [41], and the KMO value was 0.914, which exceeded the minimum allowable value of 0.6 [42], suggesting that there was sufficient correlation between the variables to be suitable for factor analysis [43]. Principal component analysis and maximum variance orthogonal rotation method were used for EFA analysis [44], and four factors with feature roots greater than 1 were extracted, which were different from the original 5-factor structure model. The cumulative variance contribution of the four factors supported by gravel blocks is 67.921%. The factor loads of 18 projects ranged from 0.648 to 0.877, and all projects were subject to a single factor load (Table 4). The structure of the four factors was further explained by the weaker decreasing trend of the gravel blocks after point 4 (Fig. 1).

Confirmatory factor analysis (CFA)

Sample 2 ($n=338$) was further analyzed by CFA to confirm the EFA-derived model [45]. After constructing the correlation between the relevant residual variables of item 11 and item 12 according to the modified index, the data fitting of the four-factor 18-item structure is satisfactory: χ^2 /df=2.115, RMSEA=0.058, GFI=0.919, NFI=0.923, TLI=0.949, CFI=0.958, indicating that the

Table 2 Mean (SD) scores for all participants in the Chinese revised hospital-acquired Insomnia Scale ($N=679$)

Items on the Chinese Revised Hospital-acquired Insomnia Scale	Mean (SD)
1. I could not sleep due to the discomfort (talking on the phone, watching TV, etc.) caused by the other patients and their relatives in my room.	2.07(0.987)
2. I couldn't sleep because the room was stuffy/airless.	2.20(0.915)
3. I could not sleep because the lights in the room were constantly on.	1.88(0.940)
4. I couldn't sleep because the number of patients in the room was too much.	1.93(1.008)
5. Couldn't sleep as not enough privacy was provided.	1.94(0.934)
6. I couldn't sleep because I was worried about the procedures to be done or not being given enough information about my disease.	2.12(0.858)
7. I couldn't sleep because I felt emotionally/mentally exhausted.	2.19(0.909)
8. I couldn't sleep because I thought my disease would not get better.	2.10(0.920)
9. I couldn't sleep because I felt like I was stuck in four walls.	2.14(0.942)
10. I couldn't sleep because of the anxiety caused by the thought that I wouldn't be able to wake up if I sleep.	2.04(0.927)
11. I couldn't sleep because I didn't feel safe.	2.11(1.017)
12. I couldn't sleep because of the uncertainty of my illness or anxiety about my illness.	2.11(0.936)
13. During my stay in the hospital, I could not sleep due to the possibility of getting bad news.	2.02(0.859)
14. I couldn't sleep because I was away from my family.	1.99(0.849)
15. During my stay in the hospital, I could not sleep because I was afraid of losing my job, suffering economic loss, and not being able to financially support my family.	2.04(0.876)
16. I was hungry because I ate dinner too early, which prevented me from sleeping.	1.93(0.808)
17. I had to wake up for breakfast.	1.91(0.778)
18. I could not sleep because the amount of food given was insufficient.	1.91(0.890)

Table 3 Item analysis for Chinese version of the Hospital-acquired Insomnia Scale ($N=679$)

Itme	Critical Ratio	Corrected Item-Total Correlation	*P*-value	Cronbach's Alpha if Item Deleted
1	21.128	0.653	< 0.001	0.909
2	24.647	0.666	< 0.001	0.909
3	23.325	0.658	< 0.001	0.909
4	21.740	0.637	< 0.001	0.909
5	19.673	0.616	< 0.001	0.910
6	18.969	0.558	< 0.001	0.911
7	21.101	0.660	< 0.001	0.909
8	20.809	0.642	< 0.001	0.909
9	18.583	0.583	< 0.001	0.911
10	19.853	0.610	< 0.001	0.910
11	23.158	0.672	< 0.001	0.908
12	22.898	0.617	< 0.001	0.910
13	16.045	0.526	< 0.001	0.912
14	14.188	0.502	< 0.001	0.913
15	15.031	0.492	< 0.001	0.913
16	12.454	0.430	< 0.001	0.914
17	14.947	0.502	< 0.001	0.913
18	15.379	0.471	< 0.001	0.914

four-factor model is effective in measuring potential variables [46]. The graphical expression for the CFA result is represented in Fig. 2.

Convergent validity and discriminant validity

According to the result of model fitting, the convergence validity of each dimension is calculated. The average variance extracted (AVE) values of F1, F2, F3, and F4 are all greater than 0.5, indicating good convergent validity. The CR values are all greater than 0.7, and the composite reliability is good. In addition, the square root of the AVE value exceeds the inter-factor correlation coefficient (0.430–0.672, $P<0.001$), indicating that the model has good discriminant validity [47]. Detailed results are shown in Table 5.

Table 4 Exploratory factor analysis ($N=341$)

Item number	Factor1	Factor2	Factor3	Factor4
10	0.778			
7	0.772			
6	0.749			
8	0.747			
11	0.719			
12	0.718			
9	0.707			
2		0.833		
3		0.781		
1		0.757		
4		0.721		
5		0.648		
17			0.877	
16			0.834	
18			0.796	
14				0.819
13				0.784
15				0.761

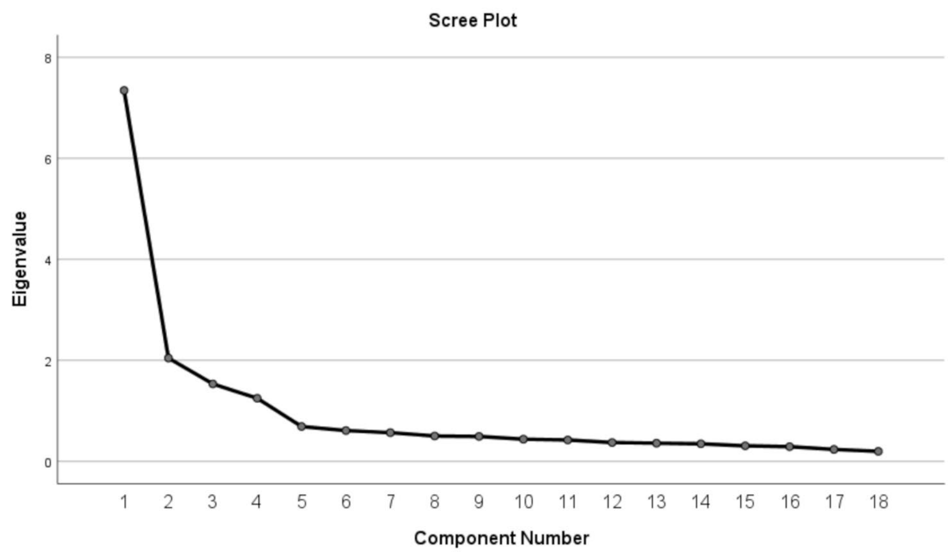

Fig. 1 Scree plot of exploratory factor analysis for Chinese version of the HAIS (N=341)

Criterion-related validity

In this study, the ISI scale was used as a standard tool and the Pearson correlation was used to analyze the comprehensive scores and total ISI scores of 18 items in Chinese HAIS, and the correlation coefficient was 0.772, indicating that ISI could provide preliminary inference for the validity of HAIS.

Reliability analysis

Internal consistency reliability

Reliability analysis results show that the Chinese version of HAIS (18 items) has good internal consistency. The Cronbach's alpha coefficient was 0.915, higher than the original Cronbach's alpha coefficient of 0.783. Table 3 shows that removing any item individually results in an overall decrease in Cronbach's alpha coefficient. In addition, the split-half reliability is 0.819, indicating that HAIS has high internal consistency [48, 49].

Test-retest reliability

The intraclass correlation coefficient (ICC) was used to evaluate the stability of the scale. Two weeks after the first test, 50 patients whose names and AD had been marked and who were still hospitalized were asked to complete the questionnaire again. Spearman correlation method was used to evaluate the correlation between the two tests, and the correlation coefficient was 0.844, greater than 0.7 [50]. This implies that HAIS is less affected by time and has greater stability.

Multiple regression analysis of hospital-acquired insomnia among Chinese inpatients

The average total HAIS score of 679 Chinese inpatients was 36.43±10.49. Multiple stepwise linear regression analyses revealed that female gender, lack of health insurance, age, longer hospitalization, insufficient total sleep duration at night, perceived higher stress, and misconceptions about sleep were potential factors influencing HAIS. These variables contributed 46.2% to the variance of hospital-acquired insomnia (Table 6).

Discussion

In this study, HAIS was translated into Chinese for the first time and validated after cultural adaptation in 679 Chinese inpatients. The results reveal that the Chinese version of HAIS has good reliability and validity, and HAIS is a practical tool for evaluating patients with hospital-acquired insomnia in China.

In this study, the Cronbach's α value of the HAIS scale was 0.915, and the coefficients of each dimension ranged from 0.799 to 0.895, which were all higher than the original version. This could be the result of variations in hospital environments and cultural backgrounds between nations. The convenience sample of a single hospital selected in this study may also have influenced the results. Furthermore, following a 2-week interval, the test-retest reliability calculation yielded a value of 0.844, suggesting high temporal stability for the scale.

Four factors were extracted from 18 items through EFA, and the cumulative variance contribution rate reached 67.921%. At the same time, the CFA showed that the four-factor model had a good fit, and showed a good convergent validity, composite reliability, discriminant validity, content validity, and criterion-related validity. It can be seen that this study has changed the five-dimensional structure of the original version. The reasons for the differences are as follows: First, in the translation process, we adjusted the sentences in the original scale that

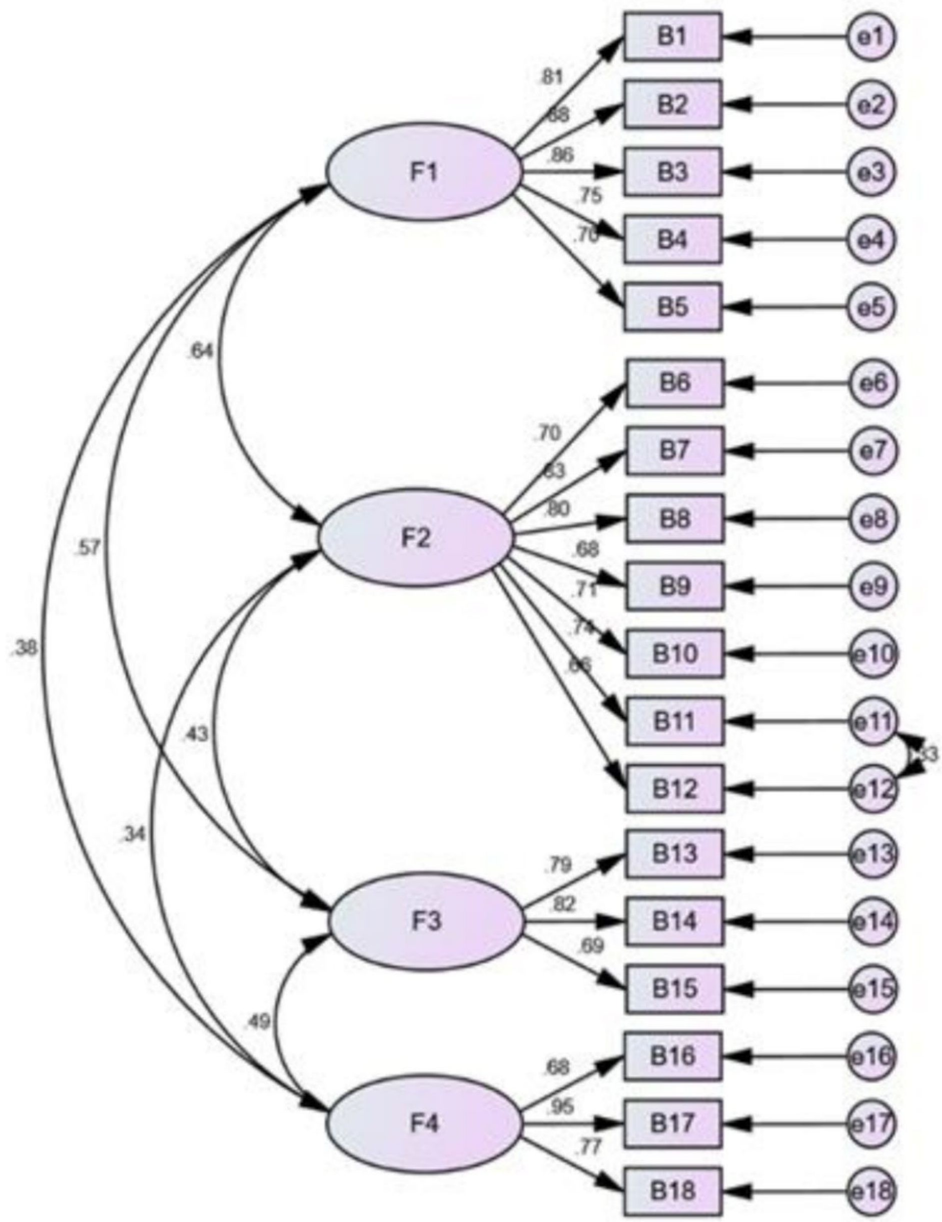

Fig. 2 Standard four-factor structural model for the Chinese version of HAIS $n=338$. F1 (Physical Environment, five items), F2 (Psychological, seven items). F3 (Socio-economic, three items), F4 (Nutrition, three items)

did not conform to the Chinese expression, which had an impact on the project content. Secondly, such differences may be partly due to the cultural background and national psychology of different countries and regions, and the understanding of the two concepts of security and psychology will be greatly affected by cultural factors [51]. Foreign countries believe that safety and psychology are two completely different concepts, and China is more inclined to take safety as one of the criteria to evaluate a person's psychological state. Maslow also proposed that safety, as a necessary condition for maintaining individual survival and life order, has inherent psychological attributes [52]. Understandably, the "safety" and "psychological" dimensions consistently reflect the psychological state of patients in a hospital setting. Therefore, the third dimension (safety factor) of the original scale is included in the second dimension (psychological factor) in this study. In addition, HAIS was significantly positively correlated with ISI ($r=0.772$, $P<0.05$), suggesting that it had good concurrent validity. To sum up, the Chinese version of the HAIS scale on the one hand confirms the effectiveness of the HAIS scale in evaluating hospital-acquired insomnia in hospitalized patients, and on the other hand, provides a verified Chinese version of the scale for

Table 5 Convergent validity and discriminant validity of the Chinese version of the HAIS(N2 = 338)

Item			Standardized Factor Load	AVE	√AVE	CR
B1	<---	F1	0.805	0.66	0.81	0.90
B2	<---	F1	0.881			
B3	<---	F1	0.864			
B4	<---	F1	0.748			
B5	<---	F1	0.701			
B6	<---	F2	0.692	0.55	0.74	0.89
B7	<---	F2	0.815			
B8	<---	F2	0.789			
B9	<---	F2	0.675			
B10	<---	F2	0.719			
B11	<---	F2	0.773			
B12	<---	F2	0.699			
B13	<---	F3	0.789	0.59	0.77	0.81
B14	<---	F3	0.818			
B15	<---	F3	0.693			
B16	<---	F4	0.677	0.65	0.80	0.84
B17	<---	F4	0.945			
B18	<---	F4	0.768			

evaluating the influencing factors of insomnia in Chinese hospitalized patients.

In addition, using the validated Chinese version of HAIS, this study confirmed the hypothesis that hospital-acquired insomnia is associated with sociodemographic characteristics, and that perceived stress and misconceptions about sleep have a greater impact on hospital-acquired insomnia. The existing literature supports the study's conclusions as well. Several studies on sleep quality have shown that women possess a higher risk of insomnia than men [53–55]. On a physiological level, this may be related to female-specific hormonal changes, which lead to an increased probability of insomnia due to factors such as decreased levels of estrogen and melatonin, as well as deprivation of deep rapid eye movement sleep [56]. In addition, a stronger sense of privacy among Chinese may also be a key factor in hospital-acquired insomnia. An earlier study on patients' perception of privacy in healthcare also revealed that women prefer to choose a single room due to concerns about personal privacy [57], further highlighting the impact of the ward environment on Chinese women's sleep. Notably, in contrast to the findings of previous studies that found high rates of insomnia in older populations [2, 54, 58], in this study, younger individuals were more likely to experience insomnia in the hospital setting. Studies have shown that younger patients may be more sensitive to light in the ward environment, equipment sounds, and night rounds or nursing operations than older patients with degraded sensory functions, resulting in sleep arousal and disruption [58, 59]. On the other hand, relevant studies have revealed a link between mobile phone addiction and delayed sleep in young people [60], which may lead to shorter night sleep duration in this group. In addition, studies on sleep rhythms and sleep structure in hospitalized patients have shown that bedridden patients show more pronounced compensatory sleep during the day [61], which compensates for their lack of night-time sleep duration.

The study also indicated that lack of medical insurance, higher levels of perceived stress, more misconceptions about sleep, and longer hospitalization were other important risk factors for HAIS. In animal models and human research, stress disrupt various aspects of sleep [62–64]. In particular, fragmented non-rapid eye movements (NREM) due to frequent brief arousals (microarousals) disrupts sleep continuity and may cause cognitive impairment and anxiety [13, 65]. Furthermore, REM abnormalities are often observed in patients with insomnia, depression, and post-traumatic stress disorder (PTSD) [66, 67]. For humans, psychosocial stressors are one of the main sources of stress. The inadaptability to the unfamiliar environment, the worry of the disease progression, the absence of family members, and other factors will bring psychological pressure to the hospitalized patients. In rodents, social stress—in particular, a conflict with an aggressive mouse—has been considered to disrupt sleep [68, 69]. These changes in the sleep architecture generated by social stress may result from interactions between stress and sleep regulatory circuits. In addition, a longer hospital stay is not only detrimental to the mental health of patients, but also means that hospitalized patients will

Table 6 Multiple stepwise linear regression model for overall HAIS score (*n*=679)

	B	β	*t*	*p*	95% CI	Collinearity statistics		Model R^2
						Tolerance	VIF	
Constant	42.726		15.051	<0.001	37.152, 48.300			0.462
Medical insurance	1.517	0.084	2.952	0.003	0.508, 2.526	0.982	1.018	
Sex	1.478	0.070	2.458	0.014	0.297, 2.658	0.980	1.021	
Hospitalization	0.855	0.066	2.317	0.021	0.130, 1.580	0.986	1.014	
DBAS	0.191	0.208	6.952	<0.001	0.137, 0.245	0.888	1.126	
PSS	0.163	0.171	5.469	<0.001	0.104, 0.221	0.813	1.230	
Age	-0.050	-0.077	-2.676	0.008	-0.087, -0.013	0.958	1.044	
Length of sleep	-11.835	-0.485	-15.83	<0.001	-13.304, -10.367	0.851	1.176	

bear a heavier economic burden, and economic pressures such as medical tests, drugs, and daily bed costs will also affect the quality of sleep of patients during hospitalization. The multi-level medical security system implemented in China shares part of the hospital expenses for urban residents, workers, and farmers, to some extent easing the financial burden brought to patients by hospitalization. This may well explain the more severe expression of HAIS in uninsured individuals. Also, individuals with more misperceptions about sleep are more likely to experience HAIS. Earlier studies have confirmed that sleep cognitions have a greater impact on insomnia than Physical disorders [70, 71]. Patients with misconceptions about sleep are more inclined to visualize negative events such as the impact of sleep deprivation on disease recovery as catastrophic, and develop a negative bias towards perceived sleep-related threats and perceptions, which prevents them from adopting positive coping strategies during periods of poorer sleep. As an alternative to conventional pharmacological therapies, several researchers have also advocated the application of sleep cognitive behavioral therapy as a first-line therapy for insomnia to enhance sleep quality [72].

Limitations

First, there are flaws of recall bias and extended causal inferences, as in most cross-sectional studies. Second, the conclusion's generalizability might be somewhat constrained by the handy sample that was chosen by a single hospital, and it is essential to expand the sampling scope and level in subsequent studies to make the research objects more representative. This is the first foreign study to translate and test the validity and reliability of the HAIS, and despite some shortcomings, our study provides a validated Chinese-language scale to measure the effects of hospitalization on patients' insomnia in a Chinese cultural context.

Conclusions

The Chinese version of the HAIS scale contains 18 items supporting a four-factor structure and shows good validity and reliability, therefore, the validated Hospital Acquired-insomnia Scale is more suitable for the Chinese population. Future studies should further explore its applicability in other population groups and analyze the potential influencing factors of sleep in hospitalized patients. In addition, in the process of developing public health intervention strategies, initial screening and identification of individuals who are female, younger, uninsured, have longer hospitalization, do not sleep long enough at night, and perceive more stress with more misconceptions about sleep can help to identify qualified high-risk groups for early intervention, which is essential to promote good sleep hygiene in general wards in China.

Acknowledgements
Thanks to the participants who helped us with this study and Professor Bahar, author of the hospital-Acquired Insomnia Scale, for providing us with tools and encouragement.

Author contributions
All authors conceived the study. FZ, XW, QC and CL conceived and designed the study. FZ, HX and CL helped with data collection. CZ, QC and KX provided statistical advice on study design and performed data analysis. FZ, QC contributed to manuscript preparation and revision. All authors read and approved the final manuscript.

Funding
The study did not receive any specific funding from funding organizations in the public, commercial or non-profit sectors.

Data availability
The data used in the study will not be shared publicly, as doing so could compromise patient privacy. However, a legitimate request for data may be made to the corresponding author.

Declarations

Ethics approval and consent to participate
This study adhered to the ethical norms of the Helsinki Declaration as well as the Ethics Committee of Jinzhou Medical University (JZMULL2023150). All participants (or their proxies/legal guardians) provided informed consent to participate in the study. In addition, All the patients included in this study signed the informed consent form.

Consent for publication
All authors approved the final manuscript and the submission to this journal.

Competing interests
The authors declare no competing interests.

Received: 11 July 2024 / Accepted: 8 October 2024
Published online: 17 October 2024

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