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Sleep Hygiene Index: Dimensionality, internal consistency, and nomological validity among Colombian medical students*[1]

Índice de Higiene del Sueño: Dimensionalidad, consistencia interna y validez nomológica en estudiantes de medicina colombianos

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Abstract

This study aimed to determine the dimensionality, internal consistency, and nomological validity of the Sleep Hygiene Index (SHI-10) among medical students in Santa Marta, Colombia. A psychometric study was designed to determine indicators of validity and reliability in which 309 medical students between 18 and 39 years (20.83±2.68) and 54.69% were female. Construct validity was tested through confirmatory factor analysis, internal consistency, and nomological validity through correlations with the Athens Insomnia Scale, Epworth Sleepiness Scale, Generalized Anxiety Disorder, and Patient Health Questionnaire. The four-dimensional structure of the SHI-10 showed adequate indicators of goodness of fit; however, the internal consistency of the four dimensions was less than .70 and limited nomological validity (less than .30). In conclusion, the four dimensions of the SHI-10 present low internal consistency and limited nomological validity. More studies are needed to show the psychometric performance of the SHI-10.

Keywords:
Sleep Hygiene Index, factor analysis, internal consistency, nomological validity, medical students, validation studies.

Resumen

El objetivo fue determinar la dimensionalidad, consistencia interna y validez nomológica del Índice de Higiene del Sueño (IHS-10) en estudiantes de medicina de Santa Marta, Colombia. Se diseñó un estudio psicométrico en el que participaron 309 estudiantes de medicina entre 18 y 39 años (20,83±2,68) y el 54,69% eran mujeres. La validez de constructo se probó mediante análisis factorial confirmatorio, consistencia interna y validez nomológica mediante correlaciones con las Escalas de Insomnio de Atenas, Somnolencia de Epworth, Trastorno de Ansiedad Generalizada y el Cuestionario de Salud del Paciente. La estructura de cuatro dimensiones del IHS-10 mostró adecuada de bondad de ajuste; empero, la consistencia interna de las dimensiones fue inferior a .70 y la validez nomológica limitada (menor de .30). En conclusión, las cuatro dimensiones del IHS-10 presentan baja consistencia interna y validez nomológica limitada. Se necesitan más estudios para demostrar el rendimiento psicométrico del IHS-10.

Palabras clave:
Índice de Higiene del Sueño, análisis factorial, consistencia interna, validez nomológica, estudiantes de medicina, estudios de validación.

Introduction

Sleep hygiene refers to the activities of daily living that promote good sleep quality and full daytime alertness (De Biase et al., 2014). In college students, poor nighttime sleep is associated with daytime sleepiness, feelings of tiredness, changes in mood, impairment in global functioning, and other adverse health effects (Anwer et al., 2019; Irish et al., 2015; Kaur & Singh, 2017; Manzar et al., 2020; Wang & Bíró, 2021).

Sleep hygiene index

One of the instruments with the best psychometric indicators to quantify habits that affect sleep is the thirteen-item Sleep Hygiene Index (SHI-13). In the presentation article, the SHI-13 showed acceptable internal consistency, Cronbach's alpha of .66, high test-retest stability, *r* of .71 ($p<.01$), and acceptable nomological validity, with a modest high correlation with the Epworth Sleepiness Scale (ESS), *r* of .24 ($p<.01$) and adequate correlation with the Pittsburgh Sleep Quality Index, *r* of .48 (Mastin et al., 2006). These characteristics have been corroborated in other studies with the participation of university students, particularly internal consistency values, Cronbach's alpha, or McDonald's omega, less than .70 (Ali et al., 2021; Kaur & Singh, 2017; Seun-Fadipe et al., 2018; Tang et al., 2021). Generally, internal consistency values greater than .70 are recommended (González & Aspeé, 2021). Another limitation observed for the SHI-13 has been the poor reproducibility of dimensionality. Mastin et al. (2006) did not explore the dimensionality of the SHI-13, and between three and six dimensions have been documented in different populations (Ali et al., 2021; Anwer et al., 2019; Seun-Fadipe et al., 2018; Tang et al., 2021). Theoretically, these disparities in the dimensions of the SHI-13 undermine the overall validity of the instrument and limit its usefulness in clinical and epidemiological studies (Streiner et al., 2014).

Due to the limitations noted above, Prados et al. (2021) refined the SHI-13. After eliminating items 1, 4, and 6 due to low factor loadings, they observed that a 10-item version (SHI-10) showed better performance in 548 Spanish university students: The Exploratory factor analysis of the SHI-10 using the principal components extraction method showed a solution of four factors that explained 65.58% of the total variance (factor 1 28.11%, factor 15.00%, factor 3 11.63% and factor 4 10.84%). The factors were: Factor 1 (sleep-disrupting behaviors, items 5, 7 and 9, with McDonald's omega of 0.75), factor 2 (cognitive activation, items 8, 12 and 13; with McDonald's omega of 0.75), 78); factor 3 (bedroom comfort, items 10 and 11, with McDonald's omega of 0.88) and factor 4 (sleep/wake time, items 2 and 3, with McDonald's omega of 0.83). Likewise, nomological validity was limited because only factor 2 (cognitive activation) showed significant correlations, more excellent than .30, with the Depression, Anxiety, and Stress Scale (DASS-21) and the Pittsburgh Sleep Quality Index (PSQI). Consequently, the dimensions of the HSI-10 showed better internal consistency than that observed in other studies for the global SHI-13 (Ali et al., 2021; Kaur & Singh, 2017; Mastin et al., 2006; Seun-Fadipe et al., 2018; Tang et al., 2021).

Likewise, the four-dimensional structure of SHI-10 is similar to that reported by Anwer et al. (2019) for the SHI-13. However, factors 3 (bedroom comfort) and 4 (sleep/wake time) can be problematic because they only contain two items. The reliability of a factor is more likely guaranteed if this factor has at least three items (Nye, 2023).

The present study

The psychometric performance of health measurement instruments is highly variable according to the population's characteristics, which usually undermines the validity and reliability of the measurements made (Streiner et al., 2014). In the present study, to expand the knowledge of the psychometric performance of the SHI-10, a confirmatory factor analysis (CFA) is carried out in Colombian medical students using the maximum likelihood extraction method; this confirmation was omitted in the group of Spanish students (Prados et al., 2021). Furthermore, the extraction by the maximum likelihood method used in the CFA is indicated for the extraction of factors because the principal component method is indicated for the reduction of the number of unrelated variables as the items of a given item are expected to be a scale that measures the same construct (Streiner, 2014). Likewise, two coefficients will be calculated for internal consistency following the most recent recommendations in psychometrics (American Educational Research Association et al., 2014; International Test Commission, 2017).

Finally, to test nomological validity, the correlation of the scores of the HSI-10 dimensions with the scores on the Athens Insomnia Scale [AIS] (Soldatos et al., 2000), the Epworth Sleepiness Scale [ESS] (Johns, 1994) will be explored, the Generalized Anxiety Disorder [GAD-7 for anxiety] (Spitzer et al., 2006) and the Patient Health Questionnaire [PHQ-9 for depression] (Kroenke et al., 2001). These measurements were taken because it is documented that sleep problems are significantly correlated with scores for anxiety or depression symptoms (Ghrouz et al., 2019; Vanderlind et al., 2014).

Practical considerations

Sleep hygiene is essential in preventing and managing sleep disorders (American Academy of Sleep Medicine, 2023; De Biase et al., 2014). More than 50% of college students report poor sleep quality around the world (Abdulghani et al., 2012; Flores-Flores et al., 2021; Lu et al., 2011; Manzar et al., 2019; Perotta et al., 2021) due to inadequate sleep hygiene associated with academic demands, especially during exam times and rotating shifts like medical students (Ahrberg et al., 2012; Hershner & Chervin, 2014). The deterioration in the sleep pattern negatively affects cognitive processes (Ahrberg et al., 2012; Hudson et al., 2020; Seoane et al., 2020) and, consequently, academic performance and achievements (Menon et al., 2015; Mehta, 2022; Vanderlind et al., 2014).

Aim: Determine the dimensionality, internal consistency, and nomological validity of the SHI-10 among medical students at a university in Santa Marta, Colombia.

Methods

Study design

A psychometric study was implemented to determine indicators of validity (construct and nomological) and reliability (internal consistency).

Participants

The authors invited adult students to participate voluntarily. From the first to the tenth semester, three hundred nine medical students agreed to participate in the study. This number of participants was adequate for evaluating a 10-item scale at a ratio superior to 20 participants for each SHI item (Nye, 2023). The ages of students were observed between 18 and 39 years (20.83±2.68). The most significant participants were students under 20, female students, low-income students, and from urban areas. More details of the participants' characteristics are presented in Table 1.

Table 1
Demographic characteristics of participating students

Variable	Frequency	%
Age		
Between 18 and 19	166	53.72
20 or more	143	46.28
Gender		
Female	169	54.69
Male	140	45.31
Income		
Low	194	62.78
High	115	37.22
Origin residence		
Urban	266	86.08
Rural	43	13.92
Semester		
First	29	9.51
Second	23	7.43
Third	19	6.14
Fourth	32	10.34
Fifth	24	7.76
Sixth	53	17.14
Seventh	46	14.88
Eighth	32	10.35
Nineth	22	7.11
Tenth	27	8.74

Source. Own elaboration of authors.

Instruments

Sleep Hygiene Index [*SHI-10*] (Prados et al., 2021): The SHI-10 comprises ten items that explore behaviors that can affect the quantity and quality of sleep. These items contribute to four factors: Factor 1 (sleep-disrupting behaviors, items 3, 4, and 6), factor 2 (cognitive activation, items 5, 9, and 10), factor 3 (bedroom comfort, items 7 and 8), and factor 4 (sleep/wake time, items 1 and 2 (Prados et al., 2021). A version with five response options was applied, from never to always, and is rated from zero to four with total scores between 0 and 40; the higher the score, the worse the sleep hygiene (Prados et al., 2021).

Athens Insomnia Scale [*AIS*] (Soldatos et al., 2000): The AIS is an inventory quantifying sleep difficulties related to insomnia over the past month. The AIS consists of eight items with four response options, scored from zero (meaning it is not a problem) to three (most acute difficulty sleeping), with total scores between 0 and 24; the higher the score, the more insomnia, and associated symptoms (Soldatos et al., 2000). The AIS has shown high internal consistency in previous Colombian research (Pedrozo-Pupo et al., 2022). In the present study, the AIS showed Cronbach's alpha of .80.

Epworth Sleepiness Scale [*ESS*] (Johns, 1994): The ESS is an eight-item instrument that quantifies the probability of falling asleep in eight daily situations. The EES provides four response options, scored between zero and three, with total scores between 0 and 24 (Johns, 1994). This instrument has presented acceptable dimensionality and internal consistency in Colombian studies (Pedrozo-Pupo et al., 2020). The ESS showed Cronbach's alpha of .83 in this present group of students.

Generalized Anxiety Disorder [*GAD-7*] (Spitzer et al., 2006): The GAD-7 is a seven-item scale to assess anxiety symptoms during the most recent two weeks. This instrument presents four response options from "none of the days" to "almost every day" that are scored from zero to three, the higher the anxiety score (Spitzer et al., 2006). The GAD-7 presented high internal consistency in a previous Colombian study (Monterrosa-Blanco et al., 2021). In the present sample, the GAD-7 showed Cronbach's alpha of .91.

Patient Health Questionnaire [*PHQ-9*] (Kroenke et al., 2001): The PHQ-9 explores symptoms of a major depressive episode in the past 15 days. It consists of nine questions with four response options from "not at all" to "almost every day" rated from zero to three; the higher the score, the greater the depression (Kroenke et al., 2001). This instrument has shown adequate validity and reliability indicators in studies in Colombia (Cassiani-Miranda & Scoppetta, 2018). Cronbach's alpha was .88 in the present research.

Procedures

Students completed an online questionnaire in the classroom on a group application after a research assistant explained the study's objectives and that participation was voluntary. This information was completed in the second half of 2022.

Statistical analysis

Dimensionality: The dimensionality of the SHI-10 was tested using CFA, with the maximum likelihood extraction method and Promax rotation. The Promax rotation is the most indicated when the theoretical assumption is made that the factors or dimensions of an instrument have a high correlation between them (Streiner et al., 2014). The loadings were observed, and the goodness-of-fit indicators were calculated: Satorra-Bentler's chi-square and normalized chi-square, Root Mean Square Error of Approximation (RMSEA) with a 90% confidence interval (90%CI), Comparative Fit Index (CFI), the Tucker-Lewis index (TLI) and the Standardized Mean Square Residual (SRMR).

It is desirable to observe a value of normalized chi-square less than 3.00 (Hahs-Vaughn, 2016). RMSEA is acceptable if it is less than 0.06, the CFI and TLI should be greater than 0.90, and the SRMR is expected to be less than 0.05 (Cheung et al., 2023).

Internal consistency: Internal consistency was determined and calculated using Cronbach's alpha (1951) and McDonald's omega (1970) coefficients. McDonald's omega is a better indicator of internal consistency when the tau-equivalence principle necessary for the calculation of Cronbach's alpha is not met; that is, the factor loadings of the items are similar (Hayes & Coutts, 2020; Trizano-Hermosilla & Alvarado, 2016).

Nomological validity: Nomological or hypothesis validity was estimated with Pearson's (1909) correlation of the point of each dimension of the SHI and the total scores on the AIS, the ESS, GAD-7, and PHQ-9. Those with a r value equal to or greater than .30, with a probability value lower than .01, were accepted as significant correlations (Streiner et al., 2014).

Ethical considerations

According to minutes 005 of the ordinary virtual session of June 9, 2022, this project was approved by an institutional ethics committee of the Omitted University for Blind Evaluation. The students signed an online informed consent form, and measurement scales were used for free, in line with national and international standards for research involving humans (World Medical Association, 2018).

Results

Dimensionality

The four-dimensional structure of SHI-10 was corroborated. Satorra-Bentler's chi-squared was 43.30 (df of 29, p=.04), and the normalized chi-squared was 1.49. CFI was 97, TLI was

.96, and SRMR was .04. The loadings for the SHI-10 items were observed between .40 and .81. All loadings are presented in Table 2.

Table 2
Confirmatory factor analysis using the maximum likelihood method and promax rotation for the four-dimensional solution

Item/factor	1	2	3	4
1. I go to bed at different times from day-to-day				.62
2. I get out of bed at different times from day-to-day				.65
3. I stay in bed longer than I should two or three times a week	.53			
4. I do something that may wake me up before bedtime (for example, play video games, use the Internet, or clean)	.56			
5. I go to bed feeling stressed, angry, upset, or nervous		.74		
6. I use my bed for things other than sleeping or sex (for example, watch television, read, eat, or study)	.56			
7. I sleep on an uncomfortable bed (for example, poor mattress or pillow, too much or not enough blankets)			.87	
8. I sleep in an uncomfortable bedroom (for example, too bright, too stuffy, too hot, too cold, or too noisy)			.81	
9. I do important work before bedtime (for example, pay bills, schedule, or study)		.40		
10. I think, plan, or worry when I am in bed		.69		
Cronbach's alpha	.49	.68	.68	.61
McDonald's Omega	.50	.69	.68	.62

Source. Own elaboration of authors. *Note.* [1]Sleep-disrupting behaviors. [2]Cognitive activation. [3]Bedroom comfort. [4]Sleep/wake time.

Internal consistency

The internal consistencies of the four dimensions of the SHI-10 were observed between .49 (factor 1, sleep-disrupting behaviors) and .68 (factors 2 and 3, cognitive activation and bedroom comfort) for Cronbach's alpha and .50 (factor 1, sleep-disrupting behaviors) and .69 (factor 2, cognitive activation) for McDonald's omega. See the coefficients at the bottom of Table 2. Overall, the HSI-10 items showed Cronbach's alpha of .72 and McDonald's omega of .73.

Nomological validity

The scores in the AIS were between 0 and 21 (8.88±3.97), in the ESS between 0 and 24 (11.63±4.92), in the GAD-7 between 0 and 21 (7, 92±5.36), in the PHQ-9 between 0 and 27 (8.94±5.95) and in the HSI-10 between 0 and 38 (24.04±5.55). These scores in factor 1 were observed between 1 and 12 (7.61±2.65), in factor 2 between 2 and 12 (8.37±2.20), in factor 3 between 0 and 8 (2 .39±2.04), and in factor 4 between 1 and 8 (5.70±1.63).

The HSI dimensions' correlations with the scores in AIS, ESS, GAD-7, and PHQ-9 ranged between .09 and .56. Factor 1 (sleep-disrupting behaviors) and factor 3 (bedroom comfort) showed poor correlations with all scales, and factor 2 (cognitive activation) presented statistically significant coefficients with all scales. See the values in Table 3.

Table 3
Correlations between factors and scores for insomnia (AIS), somnolence (ESS), anxiety (GAD-7), and depression (PHQ-9)

Factor/variable	AIS	ESS	GAD-7	PHQ-9
1. Sleep-disrupting behaviors	.24	.19	.20	.24
2. Cognitive activation	.54*	.43*	.56*	.51*
3. Bedroom comfort	.26	.09	.19	.21
4. Sleep/wake time	.37*	.17	.27	.34*

Source. Own elaboration of authors. *Note.* *The correlation is significant at the .01 level (two-tailed).

The SHI-10 total scores showed statistically significant Pearson correlations ($p<.01$) with the total scores for insomnia ($r = .53$), excessive sleepiness ($r = .34$), anxiety ($r = .46$), and depression ($r = .48$).

Discussion

The current study shows that the four-dimensional structure of the SHI-10 is unlikely among medical students from Santa Marta, Colombia. The four dimensions of the SHI-10 show low consistency and limited nomological validity compared to scores for anxiety, depression, insomnia, and somnolence.

The present study's findings are sufficiently similar to those reported in the introductory article of the SHI-10 concerning the instrument's four-dimensionality and the low correlations of the dimension scores with external measurements. However, internal consistencies were

found in the analyzed data, measured with two coefficients below the minimum expected values (Prados et al., 2021).

Ideally, a valid instrument is expected, for example, in dimensionality and nomological and reliable validity, with high internal consistency (American Educational Research Association et al., 2014; International Test Commission, 2017; Streiner, 2014). An instrument with limited validity and poor reliability has limited usefulness in the measurements (Streiner et al., 2014). This point suggests the need to review the construct, the theoretical basis that supports the instrument, or the content or wording of the items (De Souza, 2017), for example, considering the possibility of designing a unidimensional scale or dimensions with three or more items; consequently, having a four-dimensional structure for the 10-item version of the SHI is complex (Nye, 2023). The discrepancy between the validity indicators and the reliability of a measurement scale constitutes a challenge for professionals in clinical and epidemiological studies, mainly when there is a lack of a reference criterion to test the performance of an instrument (Demyttenaere & Heirman, 2023; Streiner, 2014).

Practical considerations

All health professionals must remember the need to corroborate the validity and reliability of measurement instruments. The findings show that the SHI's validity and reliability are questionable in Colombian medical students. The 'validation' process of health measurement scales requires a permanent review and refinement to make the necessary adjustments so that the validity and reliability indicators are within the recommended parameters (Campo-Arias & Pineda-Roa, 2022). Likewise, it must be kept in mind that the validity and reliability indicators of the scales may present significant divergences between different population groups (De Souza, 2017; Streiner et al., 2014). Consequently, it may be more appropriate to report 'psychometric performance' than 'psychometric properties' or 'validation' of a measurement scale, given that it refers more to the response pattern of a population than to the intrinsic characteristics of the instrument (Campo-Arias & Pineda-Roa, 2022; De Souza, 2017; González & Aspeé, 2021; Streiner et al., 2014). Psychometric theory is the basis for developing clinical mental health research assessment instruments. However, the psychometric model shows limitations for concepts more related to clinical ones due to the high heterogeneity of the populations (Fava et al., 2022).

Study's strengths and limitations

This study is advanced by performing a CFA, calculating two indicators of internal consistency (Cronbach's alpha and McDonald's omega). The SHI-10 introductory paper omitted this approach (Prados et al., 2021). An attempt was made to test the performance of the SHI-10 in people from a different cultural context. Cultural aspects can significantly affect the response pattern in a measurement instrument (American Educational Research Association et al., 2014; International Test Commission, 2017). Additionally, it extensively tested the nomological validity of the SHI-10 dimensions or factors by looking at correlations with scores for anxiety, depression, insomnia, and sleepiness. However, this research has the

same limitation as psychometric studies that only apply to the participating sample without being able to generalize to other populations, although these populations, in theory, are considered similar (De Souza, 2017; Streiner, 2014). It is necessary to continue exploring the psychometric performance of the SHI-10 in different populations or cultural contexts (Campo-Arias & Pineda-Roa, 2022).

Conclusions

The four-dimensional structure of the SHI-10 took much work to accept among Colombian medical students. The internal consistencies of the four factors were observed below recommended values, and nomological validity was only demonstrated for factor 2 (cognitive activation). Testing other structures that show dimensions with high internal consistency and acceptable nomological validity is necessary.

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