



# Glasgow Sleep Effort Scale: Translation, Test, and Evaluation of Psychometric Properties of the Persian Version

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# Glasgow Sleep Effort Scale: Translation, Test, and Evaluation of Psychometric Properties of the Persian Version

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**Purpose:** The purpose of the current study is to translate, test and evaluate the psychometric properties of the Glasgow Sleep Effort Scale (GSES) in Persian language.

**Methods:** Participants consisted of two samples: a clinical sample of 120 patients (58%) with insomnia disorder meeting DSM-5 criteria for insomnia and a non-clinical sample of 110 participants (42%) with normal sleep. Both samples completed the following measures: GSES, Pittsburg Sleep Quality Index, Insomnia Severity Index, Dysfunctional Beliefs and Attitudes about Sleep Scale-10, Pre Sleep Arousal Scale-cognitive subscale, Depression-Anxiety-Stress Scale-21 and sleep diary.

**Results:** Significant correlations were found between GSES and related measures in both groups. Principal component analysis indicated a single component accounted for 64.77% of total variance in the clinical group. Results of the fit estimates for the one-factor model were consistent with the previously specified fit criteria and adequately fitted the data in the non-clinical group. Statistical analyses showed that the GSES has acceptable internal consistency in terms of Cronbach's Alpha in the clinical (0.75) and non-clinical (0.77) samples. Test-retest reliability for a 4-week interval was significant ( $r = 0.70$ ). The cut-off point, sensitivity, and specificity of the scale were 6, 85% and 94.5%, respectively.

**Conclusion:** The Persian translated and validated version of the GSES obtained adequate values in psychometric properties in both clinical and non-clinical samples and it can be used for research and clinical purposes in Iran.

**Keywords:** GSES, insomnia, sleep effort, psychometric properties, Persian scale

## Introduction

Insomnia is defined as a predominant complaint of dissatisfaction with sleep quantity or quality accompanied with considerable distress or impairment.<sup>1</sup> Studies show that insomnia is not a context-specific issue and it has been widely recognized as a public health problem in the UK,<sup>2</sup> U.S.,<sup>3,4</sup> Australia,<sup>5</sup> Africa,<sup>6</sup> and Asia.<sup>7</sup> Most relevant studies on insomnia have been conducted in western countries and little is known about the epidemiology of insomnia as a disorder in eastern countries such as Iran. The current statistics show that the number of individuals with poor sleep quality is growing in Iran.<sup>8-10</sup> There is a need for greater research attention for the implementation of psychological and medical services to these patients.

Prior studies have demonstrated that sleep problems are coexisting with a wide range of psychiatric disorders.<sup>11,12</sup> Insomnia, as a sleep problem, has been



associated with a variety of individual and work-related outcomes. At the individual level, it has been found to be associated with future episodes of anxiety and depression,<sup>13</sup> medications and health care services<sup>14</sup> and suicidal ideation.<sup>15</sup> At the workplace level, it has been found that individuals with insomnia are more likely to experience work-related accidents in comparison with individuals without insomnia.<sup>16</sup> Moreover, in spite of the psychiatric disorders, insomnia can detrimentally influence an individual's quality of life.<sup>17</sup> The effects of insomnia are not limited to the individual and workplace levels; they may even influence the performance of students in schools. For instance, a meta-analysis conducted by Dewald et al<sup>18</sup> showed that sleep quality, sleep duration, and sleepiness are negatively associated with school performance.

The detrimental impacts of insomnia are not limited to western countries as they have also been reported in Iran. For example, a qualitative study on patients with chronic insomnia referred to the sleep disorders center in the Kermanshah, Iran, identified the following five subthemes: insomnia as an unpleasant experience, insomnia as a worrying experience, treatment-seeking behavior, a boring new daily routine and being overshadowed by depressed mood.<sup>19</sup> Another cross-sectional study conducted in Iran found that poor sleep quality is associated with low academic performance in Iranian medical students.<sup>20</sup> The negative outcomes associated with insomnia reveal that the effects of insomnia are detrimental and there is great need for it to be identified and measured by standard and appropriate psychological scales.

There are several cognitive-behavioral models by which we can explain the maintenance of insomnia; however, each of them suggests various factors (i.e., physiological, cognitive, emotional and behavioral) that play a central role in the maintenance of insomnia.<sup>23</sup> Espie, Broomfield, MacMahon, Macphee, and Taylor<sup>24</sup> studied psychophysiological insomnia through the attention-intention-effort pathway. They studied three essential processes including selective attention to sleep-related cues, explicit intention (an attention for action mechanism) and sleep effort that impede sleep-wake automaticity. Sleep effort, a central factor in the maintenance of insomnia, was introduced as a multicomponent construct, including cognitive (e.g., "I must sleep" schema) and behavioral (e.g., performance effort) elements.<sup>21</sup> Sleep effort itself involves two related processes: direct effort (e.g., vigorously attempt to fall asleep) and indirect effort (e.g., expand sleep opportunity).<sup>24</sup>

Previous research demonstrated that in patients with mood and anxiety disorders, the sleep effort is negatively related to quality of sleep, even after controlling for other factors (e.g., trait vulnerabilities for emotional disorders).<sup>25</sup> This suggests the notion that the role of sleep effort in sleep disturbances which occurred in the context of emotional disorders is more than vulnerabilities caused merely by those disorders.<sup>25</sup> In addition, sleep effort is one of the basic mechanisms that explains differences in subjective and objective insomnia. For example, some studies show that the sleep effort is the predictor of severity of subjective insomnia, while dysfunctional beliefs about sleep are the predictor of objective insomnia.<sup>26</sup> The available treatments to reduce the sleep effort in patients with insomnia show that patients who received paradoxical intention therapy (e.g., deliberate practice of remaining awake) had lower sleep effort and performance anxiety in comparison with control group.<sup>27</sup> This urges researchers to develop measures that can precisely identify the individuals with high sleep effort for treatment purposes. Therefore, a correct identification of sleep effort would facilitate the treatment procedure. In addition, it encourages researchers to develop new treatments for individuals with insomnia and new insomnia prevention programs for larger populations.

The Glasgow Sleep Effort Scale (GSES) is a seven-item self-report scale developed by Broomfield and Espie.<sup>21</sup> The GSES measures the core components of an overall model on persistent preoccupation with sleep.<sup>21</sup> Broomfield and Espie<sup>21</sup> state that although there are some instruments available to measure sleep effort, measuring sleep effort requires a specific instrument which detects this construct diagnostically. This is the main reason they developed the GSES.<sup>21</sup> Kohen and Espie<sup>28</sup> introduced GSES as one of the best instruments to differentiate insomniac patients from good sleepers.<sup>28</sup>

The pilot version of the GSES was developed after a rigorous analysis of the existing instruments which led to a model of sleep effort, incorporating seven central components.<sup>21</sup> Although this version was used earlier in two separate studies,<sup>27,28</sup> the psychometric properties of this scale were not examined in detail. In the first validation study,<sup>21</sup> the GSES was conducted on a sample of 89 patients diagnosed with insomnia based on the DSM-IV, and 102 of good sleepers. Internal consistency of the scale using Cronbach's Alpha was 0.77 in patients. The GSES was statistically correlated with Dysfunctional Beliefs and Attitudes About Sleep Scale (DBAS) ( $r = 0.50$ ,  $p =$



0.0001) which represented its concurrent validity. The GSES also had good discriminant validity even after controlling for age, and it could differentiate good sleepers from insomniac patients. Results showed a cut-off point of 2 on the GSES could accurately detect 93.2% of insomniac patients and 87.3% of good sleepers. Factor analysis of the scale explored one factor which could explain 62.6% of the total variance of the scale.<sup>21</sup> Another research in a sample of Portuguese higher education students ( $n = 2995$ , age mean = 23.9) suggested the Cronbach's Alpha of 0.79. Factor analysis of the scale demonstrated one factor which explained 45% of total variance.<sup>22</sup> However, both studies lack to report test-retest reliability of the GSES. In this study, we will cover this deficit by measuring and reporting the test-retest reliability of this scale in Iran.

Although the psychometric properties of this scale have been studied in some other languages and countries,<sup>21,22</sup> this scale has not been extensively tested, validated and used in non-western populations such as Asian and Middle Eastern countries. Therefore, the main aim of this study is to translate, test and evaluate the psychometric properties of the Glasgow Sleep Effort Scale (GSES) for the first time in Iran. Evaluating the psychometric properties of the GSES in Iran, using two clinical and non-clinical samples, we aim to provide more empirical evidence in support of this scale in eastern countries. In addition, as the previous studies have not reported the test-retest reliability of this scale; thus, testing and reporting the test-retest reliability of this scale is the second goal of this study. Additionally, this study will determine an appropriate cut-off that can respond to the sensitivity and specificity of the Persian version of the GSES based on DSM-5 criteria.

## Participants and Methods

### Participants

This study included two clinical ( $n = 120$ ) and non-clinical ( $n = 110$ ) samples. The clinical samples were recruited from the Sleep Disorders Clinic of the Baharloo Hospital located in Tehran, Iran from September 2017 to July 2018. Participants were included if they met the DSM-5 criteria (sleep initiation, sleep maintenance, or early morning awakening problems which occurs three times per week, lasting for at least three months and makes clinically significant distress) for insomnia disorder.<sup>1</sup> Individuals diagnosed by other sleep disorders (e.g., sleep apnea, restless leg syndrome), severe psychiatric disorders (such as

bipolar disorder), substance abuse, and instable use of sleep or psychotropic medications were excluded. The non-clinical sample were good sleepers who were recruited from study announcements published at different locations. They met Research Diagnostic Criteria (RDC) for Normal Sleepers.<sup>29</sup> Of the total sample that was primarily invited to participate, less than 20% ( $n = 19$ ) refused to participate. Fifty-three percent of the clinical sample and 58% of the non-clinical sample were female. In the clinical sample, 37.4% of the sample identified their education level as diploma, 39.4% as bachelor, 20.6% as masters, and 2.6% as Ph.D. In the non-clinical sample, 41.2% of the sample identified their education level as diploma, 35.6% as bachelor, 19.8% as masters, and 3.4% as Ph.D. The clinical sample had an average age of 39.20 years ( $SD = 5.61$ , range: 18–71) and the non-clinical sample had an average age of 36.5 ( $SD = 4.82$ , range: 18–72). No significant difference ( $t = 1.58$ ,  $df = 228$ ,  $p = 0.11$ ) was found between clinical ( $M = 39.2$ ,  $SD = 5.61$ ) and non-clinical ( $M = 36.5$ ,  $SD = 4.82$ ) groups regarding age. Insomnia duration mean of the clinical sample was 8.42 years ( $SD = 7.41$ ) with an age mean of 29.64 years ( $SD = 14.23$ ). The average sleep onset latency (SOL), total time of awakenings after sleep onset (WASO), early morning awakening (EMA), total actual sleep time (TST), and total time spent in bed (TIB) as reported from the sleep diary were 97.31, 115.26, 48.61, 358.2, and 619.8 minutes, respectively. In addition, sleep efficiency of the clinical sample was 57.8%.

## Measures

### Glasgow Sleep Effort Scale (GSES)

The GSES consists of seven items and was developed by Broomfield and Espie<sup>21</sup>. This scale assesses a present state of sleep effort. Responses are recorded on a 3-point Likert scale including not at all (0), to some extent (1), and very much (2). Higher scores indicate greater effort to sleep over the past week. Psychometric properties of this scale have been examined in insomniac patients and good sleepers.<sup>21</sup> Results showed that the GSES had adequate internal consistency (Cronbach's Alpha = 0.77) and it can differentiate good sleepers from insomniac patients appropriately.<sup>21</sup>

### Dysfunctional Beliefs and Attitudes About Sleep Scale-10 (DBAS-10)

The DBAS-10 scale assesses dysfunctional cognitions and beliefs about sleep and it was developed by Espie, Inglis,



Harvey, and Tessier.<sup>30</sup> Each item is rated from 0 to 10, with higher scores indicating stronger agreement with dysfunctional beliefs. Internal consistency of DBAS-10 in terms of Cronbach's Alpha is 0.69 and it can differentiate insomniac patients from good sleepers. Factor analysis of DBAS-10 demonstrated three factors including: Beliefs about the immediate negative consequences of insomnia (5 items), beliefs about the long-term negative consequences of insomnia (3 items), and beliefs about the need for control over insomnia (2 items).<sup>30</sup> In an Iranian clinical sample (n = 120), the test-retest reliability of DBAS-10 for 2-weeks' interval was 0.83% and its internal consistency was 0.82.<sup>31</sup>

### Depression Anxiety Stress Scale (DASS-21)

The DASS-21<sup>32</sup> is a short form of DASS-42<sup>33</sup> designed to measure symptoms of depression, anxiety and stress in adults. Respondents are asked to indicate the extent to which each of the statements is applied to them on a 4-point Likert scale ranging from never (1) to always (4).<sup>33</sup> This scale has demonstrated appropriate convergent, discriminant and construct validity.<sup>32</sup> Additionally, a study conducted on an Iranian sample of college students (n = 638) reported a test-retest reliability of 0.81, 0.78 and 0.80 and Cronbach's Alphas of 0.85, 0.75 and 0.87 for depression, anxiety and stress components of this scale, respectively.<sup>34</sup>

### Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a nineteen-item index consisting of seven components developed by Buysse et al.<sup>35</sup> The components are subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Individuals rated each item on a 4-point scale from 0 to 3. Cronbach's Alpha and test-retest reliability of this scale were reported as 0.83 and 0.85, respectively.<sup>35</sup> This scale has been previously examined within an Iranian sample and the Cronbach's Alpha was 0.52 for the patient group (n = 125) and 0.78 for the control group (n = 133). Also, the sensitivity and specificity of the Persian version were reported 0.95 and 0.72, respectively.<sup>36</sup>

### Insomnia Severity Index (ISI)

The ISI is a seven-item scale evaluating the nature, severity and impact of insomnia.<sup>37,38</sup> The items measure the severity of the following problems: falling sleep, staying asleep, waking up too early, satisfaction with sleep, noticeability of sleep problem, interference of sleep problems with

daytime functioning, and distress caused by sleep problems. Total scores of this scale range from 0 to 28, with higher scores indicating a greater perception of insomnia. Cronbach's Alpha of the scale in insomniac patients was 0.74. The scale consists of three components: Impact (3 items), severity (3 items), satisfaction (3 items).<sup>38</sup> Cronbach's Alpha of this scale for a group of Iranian patients was 0.82 and its item-total correlation coefficient was reported from 0.56 to 0.91.<sup>39</sup>

### Pre-Sleep Arousal Scale (PSAS)

The PSAS includes 16 items and it was developed by Nicassio, Mendlowitz, Fussell, and Petras<sup>40</sup> to assess both cognitive and somatic components of arousal. Participants are asked to rate each item from 1 (not at all) to 5 (extremely).<sup>40</sup> Test-retest reliability of the scale in a sample of college students (n = 30) has been reported as 0.72 and 0.76 for cognitive and somatic components, respectively. Also, Cronbach's Alpha of the cognitive and somatic components were 0.67 and 0.84 for the normal sleepers and 0.76 and 0.81 for the insomniacs, respectively.<sup>40</sup> Cronbach's Alpha of the Persian version in a sample of college students was 0.72 for the somatic and 0.84 for the cognitive components. Test-retest reliability of the scale in a two week interval was 0.88.<sup>41</sup>

### Consensus Sleep Dairy (CSD)

A sleep diary is a self-report scale about the pattern and quality of sleep over two weeks.<sup>42</sup> CSD has three versions known as core (includes a standard set of 9 items), expanded for the morning (includes optional morning completion items), and expanded for evening (includes optional morning and evening completion). It assesses the sleep onset latency (SOL), wakefulness after sleep onset (WASO), terminal WASO, total wake time, time in bed (TIB), and total sleep time (TST).<sup>43</sup> Validity, usability, and clinical utility of the scale have been previously studied.<sup>44</sup> The core version of the CSD was used in the current study.

### Procedure

The study was approved by the ethics committee at the Tehran University of Medical Sciences [Ethics code: IR.TUMS.REC.1396.2947]. All participants completed written informed consent before they took part in the study. They were informed that their participation in the study is completely voluntary. They could withdraw at any step without restriction. In addition, they were informed that



only the research team will have access to the data for academic purposes and the data will be treated confidentially and anonymously.

At first, the English version of the GSES was carefully translated into Persian by a group of specialists, including two psychiatrists, three sleep clinicians and two clinical psychologists. Then, the translated version was back-translated to English by two linguistics experts. Later a bilingual expert compared the back-translated and original versions of the scale and confirmed the back-translated version in Persian. In respect to wording, the Persian back-translated version was piloted with 30 Persian participants, who were asked to rate readability and clarity of the items on a response scale ranging from 0 (not understandable) to 5 (completely understandable). Over 95% of the participants chose the “completely understandable” which indicated no need for further item revision.

The clinical sample included individuals who were seeking treatment at the sleep disorders clinic of the Baharloo Hospital in Tehran. The non-clinical sample were good sleepers who responded to the study announcements via e-mail. Regarding the clinical sample, those who volunteered were interviewed by a sleep medicine specialist to evaluate them based on the inclusion criteria. Then, the eligible participants were asked to complete a sleep diary for 2-weeks with the aim to evaluate if they have SOL or WASO for more than 30 minutes. After that, participants were referred to a clinical psychologist and were asked to complete the study measures. All participants were asked to respond to the following scales: CSD, DASS-21, DBAS-10, PSAS-C, PSQI and ISI.

## Statistical Analysis

SPSS-21 IBM statistical package was used for statistical analysis. Cronbach's Alpha and mean inter-item correlation coefficients were computed for GSES to assess the internal consistency. Given the number of correlations and comparisons, the p-values were adjusted based on Bonferroni procedure.<sup>45</sup> an initial  $\alpha$  of 0.05 was divided by the number of measures. The factor structure of the GSES was evaluated by principal component analysis in the clinical sample.

A confirmatory factor analysis was used to examine the one-factor structure of the GSES<sup>21</sup> in the non-clinical sample. We used LISREL version 8.8<sup>46</sup> to measure the extent to which data collected from the non-clinical sample was compatible with the aforementioned model in the literature.<sup>21,22</sup> Confirmatory factor analysis offers

a variety of statistical tests and indices designed to assess the goodness-of-fit of identified models.<sup>47–49</sup> For this purpose, in the present study, the goodness-of-fit was evaluated using the following statistics: the goodness-of-fit index (GFI >.9), the adjusted goodness-of-fit index (AGFI >.90), the non-normal fit index (NNFI > 0.90), the comparative fit index (CFI > 0.90), the root mean square residual (RMSR < 0.08), the normal chi-square ( $3 > \chi^2/df < 2$ ), the root mean square error of approximation (RMSEA) and its 90% confidence interval (<0.05).<sup>47–49</sup> PRILIS software<sup>46</sup> was also applied to estimate the polychoric correlations and their Asymptotic Covariance Matrix (ACM) of the sample variance and covariance.

To evaluate concurrent validity, the correlation coefficient between the GSES and DBAS-10, PSAS-C, DASS-21, ISI and PSQI were investigated. For the purpose of test-retest analysis, Pearson correlation coefficients were calculated using a subsample who were selected randomly from the clinical sample (n = 50) and completed the GSES twice in a 4-week interval.

## Results

A number of steps composed of consistency, descriptive and graphical analysis checks (e.g., box plots, histograms, and scatter plots outlier detection) were conducted to screen the data. Data screening and the assumption of normality were examined which revealed a small skewness in items 3 and 6 of the GSES. Because of the non-normal sample distribution of some items, non-parametric statistics (Mann-Whitney *U*-test) were used at the item level, group mean (clinical vs non-clinical) and gender differences (male vs female). To make a decision regarding whether or not to keep outliers, the original mean and 5% trimmed mean ( $p > 0.05$ ) were compared. Excluding five cases as the outliers did not affect the major findings of the analysis; thus, the present results are reported including all of the data with the presence of the outliers. Data were analyzed with original data without removing outliers as along with powerful estimation of related statistical parameters.<sup>50</sup>

## Factor Structure of GSES

To evaluate the component structure of the GSES in the clinical sample, using principal components analysis,<sup>21</sup> a single component model was extracted. Two criteria were considered regarding components extraction including the Kaiser criterion (eigenvalues >1), and Cattell's



scree plot (Table 1, Figure 1). Acceptable conditions for conducting principal component analysis, that are inter item correlation coefficients about or above 0.30; Kaiser–Meyer–Olkin measure of sampling adequacy = 0.90, above the recommended minimum value of 0.50; significant Bartlett’s test of sphericity; and  $\chi^2(21) = 941.63$ ,  $p < 0.001$  were found.<sup>51,52</sup> Mainly, a single principal component was found (eigenvalue = 3.08), which explained 64.77% of total variance (Table 1).

Following the original scale<sup>21</sup>, we constructed a one-factor model in which all 7 items were loaded on a single factor. Preliminary analysis of data showed that the normality was violated. As such, the generalized weighted least squares estimation method was used as the distribution of the data which was less sensitive to normality.<sup>53</sup>

We also tested the factorial structure of the scale using confirmatory factor analysis (CFA). The results of the fit estimates for the one-factor model meet the previously specified fit criteria and adequate fit to the data. The chi-square test results were significant for all models, but that is to be expected with models with large degrees of freedom and relatively large sample sizes.<sup>54</sup> An examination of the fit indices approved the parsimonious aspect of the model [S-B  $\chi^2/df = 1.80$ ; CFI = 0.97; NNFI = 0.96; SRMR = 0.086, GFI = 0.94, AGFI = 0.92 and RMSEA = 0.086 (CI) 90% = 0.025, 0.13].

## Reliability, Concurrent and Discriminant Validity of GSES

To measure the test-retest reliability, 50 participants (41% male, 34% single; mean age of 37.5 years old) were recruited randomly from the clinical sample. They completed the GSES twice within a 4-week interval. The correlation between the first and second administrations was statistically significant ( $r = 0.70$ ,  $p < 0.01$ ) which indicates relatively temporal stability of the GSES.

Cronbach’s Alpha of the scale was found 0.75 for the clinical sample and 0.77 for the non-clinical sample which indicates a good internal consistency.<sup>55</sup> The results in Table 1 showed that the removal of any item did not increase the level of internal consistency. The minimum corrected item-total correlation was 0.22 in the clinical sample versus 0.35 in the non-clinical sample.

Mann–Whitney *U*-test as the non-parametric test was used to test the diagnostic validity of the GSES. The results in Table 1 indicated statistically significant differences between the clinical and non-clinical samples in the

**Table 1** Factor Loadings, Means, Standard Deviations, Internal Consistency Coefficients of GSES in Clinical ( $n = 120$ ) and Non-Clinical ( $n = 110$ ) Samples

	Structure Coefficients		Mean		SD		Mean		SD		Alpha Cronbach if Item Deleted		Mann–Whitney <i>U</i>	
	Component 1	H2	Clinical	Non-clinical	Clinical	Non-clinical	Male	Female	Male	Female	Non-clinical	Clinical	Samples	Gender
Item 1	0.69	0.71	1.48	0.40	0.72	0.52	0.93	1.26	0.81	0.84	0.68	0.70	9.79**	2.72**
Item 2	0.61	0.31	1.36	0.74	0.71	0.72	0.72	1.14	0.78	0.86	0.75	0.75	6.24**	3.35**
Item 3	0.49	0.35	0.73	0.09	0.81	0.28	0.45	0.56	0.70	0.77	0.75	0.72	6.95**	0.836
Item 4	0.69	0.71	1.54	0.47	0.67	0.60	0.91	1.25	0.84	0.86	0.67	0.70	9.74**	2.68**
Item 5	0.84	0.79	1.73	0.20	0.56	0.42	1.17	1.51	0.84	0.75	0.69	0.71	12.68**	2.94**
Item 6	0.72	0.78	1.34	0.15	0.75	0.38	1.06	1.25	0.77	0.81	0.65	0.70	10.73**	1.72
Item 7	0.71	0.72	1.48	0.35	0.68	0.55	1.09	1.30	0.80	0.79	0.69	0.68	10.15**	1.91
Total score	–	–	9.68	2.41	3.07	2.28	6.34	8.29	4.00	4.22	–	–	11.89**	3.26**

**Notes:** \* $p < 0.05$ , \*\* $p < 0.01$ , H<sup>2</sup> = communality coefficient.



GSES's items, and the total score suggesting that the GSES significantly discriminated the clinical sample from the non-clinical sample.

Table 2 shows the correlation matrix between research variables, number of items of each scale and the Cronbach's Alpha for the scales. As the table shows, the concurrent validity of the GSES was assessed by calculating Pearson's correlations between all of the study's measures. Statistically Significant correlations were found between total score of the GSES and DBAS-10 ( $r = 0.45$ ), PSAS-C ( $r = 0.48$ ), depression-DASS ( $r = 0.30$ ), anxiety-DASS ( $r = 0.31$ ), stress-DASS ( $r = 0.34$ ), ISI ( $r = 0.46$ ), and PSQI ( $r = 0.48$ ) in clinical sample.

Results of item-by-item Spearman correlation matrix of the GSES are also shown in Table 3. This table includes the correlations between items for both clinical and non-clinical groups. As it can be seen in Table 3, all correlation coefficients ranged from 0.13 to 0.51 in the clinical sample, and from 0.025 to 0.58 in the non-clinical sample.

## Sensitivity and Specificity of the GSES

A ROC curve, indicating sensitivity (or true positive rate) and specificity (or true negative rate) of every possible cut-off score, was constructed.<sup>56</sup> Youden's index (0.79,  $CI=0.71-0.85$ , cut-off = 6, 95%, Confidence interval with bootstrap interval = 4–6) was applied to assess the optimal cut-off point (using this formula: sensitivity + specificity - 1.00).<sup>56,57</sup> Sensitivity and specificity indices were computed for all the possible GSES cut-off scores. The GSES scores were analyzed to classify both clinical and non-clinical samples. GSES score ranges from 0 to 14. A GSES score of 6 or higher yielded a sensitivity of 85% and a specificity of 94.55%, highlighting that 5.45% of the non-clinical sample and 85.00% of the clinical sample exceeded the cut-off of 6. The area under the curve was 0.95 [(95% CI) = 0.91 to 0.97,  $p < 0.001$ ]. Appendix 1 illustrates the final version of the validated Persian items of the GSES.

## Discussion

This study translated, tested, and evaluated the psychometric properties of the Persian version of the GSES for both clinical and research purposes in Iran. The Persian validated version of the GSES provides a standard and reliable scale of sleep effort consistent with the recommendation of sleep experts in using more standardized assessments in sleep research.<sup>57</sup> This validation

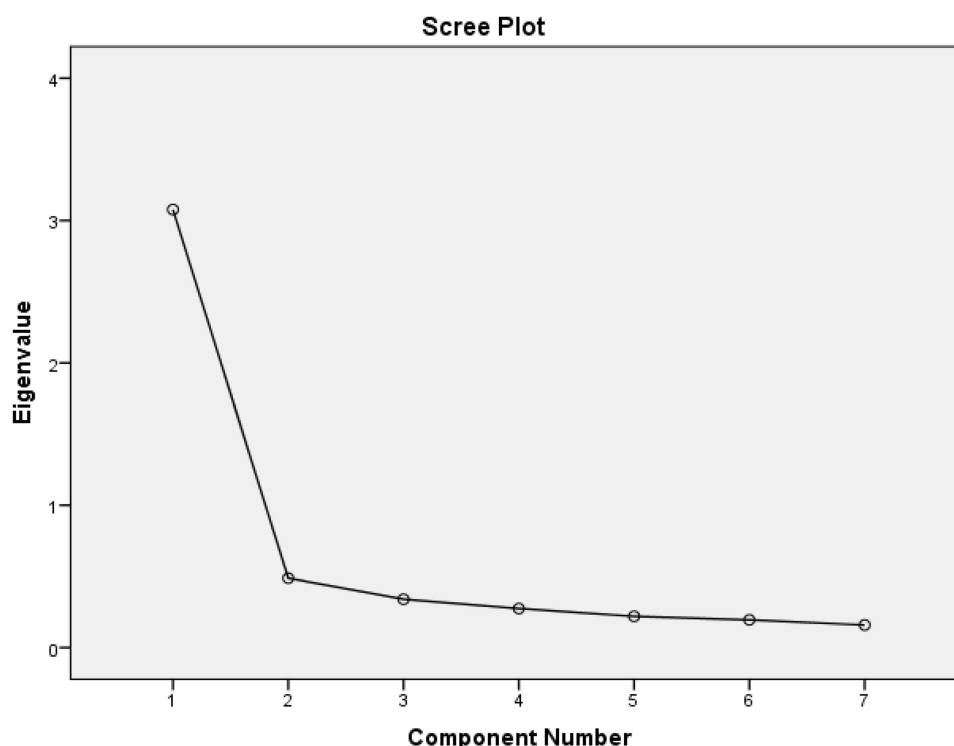
## Appendix I List of Original Items in English and Validated Items in Persian

	Original items of the GSES in English	Validated items of the GSES in Persian	
1	I put too much effort into sleeping when it should come naturally	من هنگامی که باید به طور طبیعی به خواب روم، برای به خواب رفتن بسیاری تلاش می‌کنم.	1.
2	I feel I should be able to control my sleep	من احساس می‌کنم که باید بتوانم کنترلی خوابم را داشته باشم.	2.
3	I put off going to bed at night for fear of not being able to sleep	از ترس ناتوانی برای به خواب رفتن، از رفتن به رخت‌خواب طفره می‌روم.	3.
4	I worry about not sleeping if I cannot sleep	هنگامی که در رخت‌خواب باشم و نتوانم بخوابم، درباره به خواب نرفتن نگران می‌شوم.	4.
5	I am no good at sleeping	من از نظر به خواب رفتن خوب نیستم.	5.
6	I get anxious about sleeping before I go to bed	من قبل از رفتن به رخت‌خواب، درباره به خواب رفتن مضطرب می‌شوم.	6.
7	I worry about the consequences of not sleeping	من درباره پیامدهای طولانی مدت به خواب نرفتن نگران هستم.	7.

contributes to the usability and the generalizability of this scale in both western and non-western countries. This is particularly important for non-western countries because it shows that regardless of the cultural differences between western and non-western countries, this scale is still useful for identifying relevant problems of sleep effort in eastern countries such as Iran. Moreover, it provides additional evidence for the adequate psychometric properties of this scale in non-western countries, which, can expand the generalizability of this scale for conducting joint research collaborations between Iran and other countries.

To fulfill the first aim of this study, evaluating the factorial structure of the scale previously proposed by Broomfield and Espie,<sup>21</sup> and Meia-Via et al,<sup>22</sup> Principal Component Analysis was used and it revealed a single component in the clinical sample matched with the original scale<sup>21</sup> and similar validation in a Portuguese sample.<sup>22</sup> Results of the confirmatory factor analysis





**Figure 1** The scree plot of GSES displays the number of the factor versus its corresponding eigenvalue.

**Note:** When no rotation is done, the eigenvalues of the correlation matrix equal the variances of the factors.

using the non-clinical sample confirmed the unidimensional structure of the scale. This is consistent with two previous studies that found a single component accounting for 44.8%<sup>21</sup> and 62.6%<sup>22</sup> of the total variance, respectively. Thus, our results verified the same one-factor model proposed by two previous studies.<sup>21,22</sup>

Additionally, the results suggested that the Persian version of the GSES has adequate internal consistency for the clinical (Cronbach's Alpha =0.75) and non-clinical (Cronbach's Alpha =0.77) samples. These findings are consistent with previous studies demonstrating good internal consistency of the GSES.<sup>21,22</sup> Notably, since no

research has previously examined the test-retest reliability of the GSES, this study was the first attempt to report a high test-retest reliability ( $r = 0.70$ ) of the GSES in a clinical sample. Totally, the Cronbach's Alpha coefficients, and the test-retest coefficients both confirmed the reliability of the GSES Persian version.

Concurrent validity of the Persian version of the GSES was supported by significant correlations between its total score and related measures, moving in expected directions that exist in the current literature.<sup>21,22</sup> Statistical analysis showed a significant but mild positive correlation between GSES and subscales of DASS-21, indicating that the

**Table 2** Correlation Matrix Between Research Variables in Clinical Sample (n = 120)

		Items	Alpha	1	2	3	4	5	6	7	8
1	GSES	7	0.88	1	0.45**	0.48**	0.48**	0.46**	0.30**	0.31**	0.34**
2	DBAS	10	0.84		1	0.37**	0.39**	0.49**	0.38**	0.34**	0.39**
3	PSAS-C	8	0.90			1	0.38**	0.36**	0.52**	0.51**	0.58**
4	PSQI	19	0.88				1	0.58**	0.25**	0.29**	0.33**
5	ISI	7	0.93					1	0.38**	0.42**	0.44**
6	Depression-DASS	7	0.89						1	0.65**	0.74**
7	Anxiety-DASS	7	0.78							1	0.72**
8	Stress-DASS	7	0.88								1

**Note:** \*\* $p < 0.01$ .



**Table 3** Glasgow Sleep Effort Scale (GSES) Item-by-Item Spearman's Rho Correlation Matrix in Clinical (n = 120) and Non-Clinical (n = 110) Samples

	GSES <sub>1</sub>	GSES <sub>2</sub>	GSES <sub>3</sub>	GSES <sub>4</sub>	GSES <sub>5</sub>	GSES <sub>6</sub>	GSES <sub>7</sub>
GSES <sub>1</sub>	–	0.13	0.30**	0.44**	0.51**	0.37**	0.27**
GSES <sub>2</sub>	0.12	–	0.22*	0.23**	0.16	0.16	0.48**
GSES <sub>3</sub>	0.25**	0.025	–	0.23*	0.45**	0.37**	0.31**
GSES <sub>4</sub>	0.56**	0.14	0.17	–	0.27**	0.43**	0.40**
GSES <sub>5</sub>	0.40**	0.23*	0.14	0.34**	–	0.31**	0.32**
GSES <sub>6</sub>	0.44**	0.33**	0.25**	0.58**	0.38**	–	0.47**
GSES <sub>7</sub>	0.37**	0.20*	0.19*	0.32**	0.45**	0.39**	–

**Notes:** \* $P < 0.05$ , \*\* $P < 0.01$ ; correlations for the clinical sample are above and for the non-clinical sample are below diagonal.

GSES is not simply measuring depression, anxiety or stress. Moreover, a significant correlation was found between GSES and DBAS-10 and between GSES and PSAS-C, demonstrating the concurrent validity of the scale in relation to existing cognitive sleep measures. The significant observed correlations between GSES and two widely used sleep screening questionnaires (i.e., ISI and PSQI) revealed that sleep effort is related to the severity and quality of sleep. As the two previous studies<sup>21,22</sup> assessing the psychometric properties of GSES did not report the correlation between GSES and PSQI and ISI; no comparison can be made between these associations in the two previous studies and our study. However, in this study the results suggest that GSES and PSQI and ISI are statistically associated in the clinical sample. The current study also provided additional support for the ability of the GSES to discriminate individuals with insomnia disorder from individuals with normal sleep, verifying previous studies.<sup>21,22</sup> A cut-off score of 6 correctly identified 85% of insomnia patients and 94.55% of good sleepers. We found a lower sensitivity and a higher specificity and cut-off point in our sample: This means that a higher level of sleep effort is needed to identify a person with significant sleep effort in an Iranian sample. These results make it possible to screen and identify patient groups according to their GSES scores and consequently target sleep effort in treatment protocols.

The original study<sup>21</sup> showed that the GSES could discriminate between individuals with and without insomnia separated by DSM-IV criteria. Additionally, a Portuguese study<sup>22</sup> showed that the GSES was capable of distinguishing three subgroups (i.e., no sleep problems, insomnia symptoms, and other sleep problems) based on a self-report measure. As our participants were diagnosed according to the DSM-5 criteria, the results of the present study demonstrated that the GSES is able to discriminate individuals with and without insomnia

according to the DSM-5 criteria, which can be considered as another achievement of this study.

## Suggestions and Limitations

Although the present sample included individuals with different ages, it did not evaluate the outcomes across the life span. Therefore, it is not specified if the results hold up in older or younger age groups. Thus, it is important to replicate the current study in different age groups, various settings and, especially with larger sample sizes. In addition, our clinical sample did not consist of the participants diagnosed based on structured diagnostic interviews of sleep disorders. This was due to no structured interview of sleep disorders having been validated in the Persian language. Future studies may design or validate versions of these interviews to fill this gap. The current study was conducted using self-report measures. This may distort the relations among research variables by shared method variance and the participants may be prone to under- or over-estimation of their symptoms. In addition, an examination of the relations between the GSES and common objective measures (e.g., polysomnography and actigraphy) is suggested for future psychometric studies.

Despite several limitations, the present study provides evidence for intercultural validity of the GSES. One of the unique strengths of the current study is that both clinical and non-clinical samples were matched regarding age and gender. This has been ignored in previous insomnia studies. Also, to increase the generalizability to real-world clinical samples, the participants were not excluded from the study if they were taking a stable dose of medication. Lastly, since the GSES can be used for the clinical assessment and change,<sup>21</sup> the Persian version of the scale provides Iranian clinicians with a standardized and validated



tool for screening insomniac patients and providing suggestions for suitable psychological treatments.

## Conclusions

The current study makes the first attempt to evaluate the psychometric properties of the GSES in a non-western country, using both clinical and non-clinical samples. This study revealed that the Persian version of the GSES is a valid and reliable instrument for application in Persian speaking populations. The cost-effective aspect of this scale reduces the burden on examiners to measure sleep effort of the participants in research activities. GSES can be used as a valid scale to assess one of the most important maintaining factors of insomnia. It is hoped that the validation of the Persian version will encourage Persian-speaking clinicians and researchers to use it during assessment and treatment of their patients with insomnia.

## Ethical Approval

All procedures performed in studies involving human participants were in accordance with the Declaration of Helsinki.

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## Disclosure

Mojtaba Habibi's researcher ID is: [L-1485-2018](#). The authors declare no other conflicts of interest in this work.

## References

1. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders: DSM-5. Washington, DC: American Psychiatric Association; 2013.
2. Morphy H, Dunn KM, Lewis M, Boardman HF, Croft PR. Epidemiology of insomnia: a longitudinal study in a UK population. *Sleep*. 2007;30(3):274–280.
3. Chung KF, Yeung WF, Ho FY, Yung KP, Yu YM, Kwok CW. Cross-cultural and comparative epidemiology of insomnia: the diagnostic and statistical manual (DSM), international classification of diseases (ICD) and international classification of sleep disorders (ICSD). *Sleep Med*. 2015;16(4):477–482. doi:10.1016/j.sleep.2014.10.018
4. Taylor DJ, Bramoweth AD, Grieser EA, Tatum JI, Roane BM. Epidemiology of insomnia in college students: relationship with mental health, quality of life, and substance use difficulties. *Behav Ther*. 2013;44(3):339–348. doi:10.1016/j.beth.2012.12.001
5. Appleton SL, Gill TK, Lang CJ, et al. Prevalence and comorbidity of sleep conditions in Australian adults: 2016 Sleep Health Foundation national survey. *Sleep Health*. 2018;4(1):13–19. doi:10.1016/j.sleh.2017.10.006
6. Gureje O, Oladeji BD, Abiona T, Makanjuola V, Esan O. The natural history of insomnia in the Ibadan study of ageing. *Sleep*. 2011;34(7):965–973. doi:10.5665/SLEEP.1138
7. Wang Y-M, Chen H-G, Song M, et al. Prevalence of insomnia and its risk factors in older individuals: a community-based study in four cities of Hebei Province, China. *Sleep Med*. 2016;19:116–122. doi:10.1016/j.sleep.2015.10.018
8. Asghari A, Farhadi M, Kamrava SK, Ghalehbaghi B, Nojomi M. Subjective sleep quality in urban population. *Arch Iran Med*. 2012;15(2):95–98.
9. Malakouti SK, Foroughan M, Nojomi M, Ghalebandi MF, Zandi T. Sleep patterns, sleep disturbances and sleepiness in retired Iranian elders. *Int J Geriatr Psychiatry*. 2009;24(11):1201–1208. doi:10.1002/gps.2246
10. Ahmadvand A, Sepehrmanesh Z, Ghoreishi F, Mousavi G. Prevalence of insomnia among 18 years old people and over in Kashan city, Iran in 2008. *Feyz, Journal of Kashan University of Medical Science*. 2010;13(4):313–320.
11. Ohayon MM. Insomnia: a ticking clock for depression? *J Psychiatr Res*. 2007;41(11):893–894. doi:10.1016/j.jpsychires.2007.07.008
12. Ohayon MM. Observation of the natural evolution of insomnia in the american general population cohort. *Sleep Med Clin*. 2009;4(1):87–92. doi:10.1016/j.jsmc.2008.12.002
13. Jansson-Frojmark M, Lindblom K. A bidirectional relationship between anxiety and depression, and insomnia? A prospective study in the general population. *J Psychosom Res*. 2008;64(4):443–449. doi:10.1016/j.jpsychores.2007.10.016
14. Sivertsen B, Krokstad S, Overland S, Mykletun A. The epidemiology of insomnia: associations with physical and mental health. The HUNT-2 study. *J Psychosom Res*. 2009;67(2):109–116. doi:10.1016/j.jpsychores.2009.05.001
15. McCall WV, Blocker JN, D'Agostino R Jr, et al. Insomnia severity is an indicator of suicidal ideation during a depression clinical trial. *Sleep Med*. 2010;11(9):822–827. doi:10.1016/j.sleep.2010.04.004
16. Léger D, Guilleminault C, Bader G, Lévy E, Paillard M. Medical and socio-professional impact of insomnia. *Sleep*. 2002;25(6):621–625. doi:10.1093/sleep/25.6.621
17. Katz DA, McHorney CA. The relationship between insomnia and health-related quality of life in patients with chronic illness. *J Family Practice*. 2002;51(3):229–235.
18. Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, Bögels SM. The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: a meta-analytic review. *Sleep Med Rev*. 2010;14(3):179–189. doi:10.1016/j.smrv.2009.10.004
19. Rezaie L, Khazaie H, Yazdani F. Exploration of the experience of living with chronic insomnia: a qualitative study. *Sleep Sci*. 2016;9(3):179–185.
20. Rasekhi S, Pour Ashouri F, Pirouzan A. Effects of sleep quality on the academic performance of undergraduate medical students. *Health Scope*. 2016;5(3):e31641. doi:10.17795/jhealthscope-31641



21. Broomfield NM, Espie CA. Towards a valid, reliable measure of sleep effort. *J Sleep Res.* 2005;14(4):401–407. doi:10.1111/j.1365-2869.2005.00481.x
22. Meia-Via MS, Marques DR, Espie CA, da Silva CF, Allen Gomes A. Psychometric properties of Glasgow Sleep Effort Scale in Portuguese language. *Psychological Assessment.* 2016;28(3):e12–18. doi:10.1037/pas0000178
23. Jansson M, Linton SJ. Psychological mechanisms in the maintenance of insomnia: arousal, distress, and sleep-related beliefs. *Behav Res Ther.* 2007;45(3):511–521. doi:10.1016/j.brat.2006.04.003
24. Espie CA, Broomfield NM, MacMahon KM, Macphee LM, Taylor LM. The attention-intention-effort pathway in the development of psychophysiological insomnia: a theoretical review. *Sleep Med Rev.* 2006;10(4):215–245. doi:10.1016/j.smrv.2006.03.002
25. Fairholme CP, Manber R. Safety behaviors and sleep effort predict sleep disturbance and fatigue in an outpatient sample with anxiety and depressive disorders. *J Psychosom Res.* 2014;76(3):233–236. doi:10.1016/j.jpsychores.2014.01.001
26. Hertenstein E, Nissen C, Riemann D, Feige B, Baglioni C, Spiegelhalder K. The exploratory power of sleep effort, dysfunctional beliefs and arousal for insomnia severity and polysomnography-determined sleep. *J Sleep Res.* 2015;24(4):399–406. doi:10.1111/jsr.12293
27. Broomfield NM, Espie CA. Initial insomnia and paradoxical intention: an experimental investigation of putative mechanisms using subjective and actigraphic measurement of sleep. *Behav Cogn Psychother.* 2003;31(3):313–324. doi:10.1017/S1352465803003060
28. Kohn L, Espie CA. Sensitivity and specificity of measures of the insomnia experience: a comparative study of psychophysiological insomnia, insomnia associated with mental disorder and good sleepers. *Sleep.* 2005;28(1):104–112. doi:10.1093/sleep/28.1.104
29. Edinger JD, Bonnet MH, Bootzin RR, et al. Derivation of research diagnostic criteria for insomnia: report of an American Academy of Sleep Medicine Work Group. *Sleep.* 2004;27(8):1567–1596. doi:10.1093/sleep/27.8.1567
30. Espie CA, Inglis SJ, Harvey L, Tessler S. Insomniacs' attributions: psychometric properties of the dysfunctional beliefs and attitudes about sleep scale and the sleep disturbance questionnaire. *J Psychosom Res.* 2000;48(2):141–148. doi:10.1016/S0022-3999(99)00090-2
31. Doos Ali Vand H, Ahmadian Vargahan F, Birashk B, Habibi M, Sadeghniai Haghighi K, Fereidooni F. Validity and reliability of the dysfunctional beliefs and attitudes about sleep scale-10 in Iranian clinical population. *Iran J Psychiatry Behav Sci.* 2018;12(2):e12288. doi:10.5812/ijpbs.12288
32. Henry JD, Crawford JR. The short-form version of the Depression Anxiety Stress Scales (DASS-21): construct validity and normative data in a large non-clinical sample. *British J Clin Psychol.* 2005;44(Pt 2):227–239. doi:10.1348/014466505X29657
33. Lovibond PF, Lovibond SH. The structure of negative emotional states: comparison of the Depression Anxiety Stress Scales (DASS) with the Beck depression and anxiety inventories. *Behav Res Ther.* 1995;33(3):335–343. doi:10.1016/0005-7967(94)00075-U
34. Samani S, Jokar B. Validity and reliability of short version of anxiety, depression, and stress scale. *J Social Sci Humanities Shiraz University.* 2007;26(3):65–77.
35. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res.* 1989;28(2):193–213. doi:10.1016/0165-1781(89)90047-4
36. Farrahi Moghaddam J, Nakhaee N, Sheibani V, Garrusi B, Amirakfi A. Reliability and validity of the Persian version of the Pittsburgh Sleep Quality Index (PSQI-P). *Sleep Breathing.* 2012;16(1):79–82. doi:10.1007/s11325-010-0478-5
37. Morin CM. *Insomnia, Psychological Assessment and Management.* New York: Guilford Press; 1993.
38. Bastien CH, Vallieres A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med.* 2001;2(4):297–307. doi:10.1016/S1389-9457(00)00065-4
39. Yazdi Z, Sadeghniai-Haghighi K, Zohal MA, Elmizadeh K. Validity and reliability of the Iranian version of the insomnia severity index. *Malaysian J Med Sci.* 2012;19(4):31–36.
40. Nicassio PM, Mendlowitz DR, Fussell JJ, Petras L. The phenomenology of the pre-sleep state: the development of the pre-sleep arousal scale. *Behav Res Ther.* 1985;23(3):263–271. doi:10.1016/0005-7967(85)90004-X
41. Doos Ali Vand H, Gharraee B, Asgharnejad FAA, Ghaleh BMF. Prediction of insomnia severity based on cognitive, metacognitive, and emotional variables in college students. *Explore.* 2014;10(4):233–240. doi:10.1016/j.explore.2014.04.005
42. Morin CM, Espie CA. *Insomnia: A Clinical Guide to Assessment and Treatment.* New York: Springer; 2004.
43. Carney CE, Buysse DJ, Ancoli-Israel S, et al. The consensus sleep diary: standardizing prospective sleep self-monitoring. *Sleep.* 2012;35(2):287–302. doi:10.5665/sleep.1642
44. Maich KHG, Lachowski AM, Carney CE. Psychometric properties of the consensus sleep diary in those with insomnia disorder. *Behav Sleep Med.* 2016;1–18.
45. Tabachnick B, Fidell L. *Multivariate Analysis of Variance and Covariance In: Using Multivariate Statistics.* (6th Edition). Boston, MA: Pearson; 2013:272.
46. Jöreskog, K.G. & Sörbom, D. (2006). LISREL 8.80 for Windows [Computer Software]. Lincolnwood, IL: Scientific Software International, Inc.
47. Mulaik SA, James LR, Van Alstine J, Bennett N, Lind S, Stilwell CD. Evaluation of goodness-of-fit indices for structural equation models. *Psychol Bull.* 1989;105(3):430–445. doi:10.1037/0033-2909.105.3.430
48. Cole DA. Utility of confirmatory factor analysis in test validation research. *J Consulting Clin Psychology.* 1987;55(4):584–594. doi:10.1037/0022-006X.55.4.584
49. Breckler SJ. Applications of covariance structure modeling in psychology: cause for concern? *Psychol Bull.* 1990;107(2):260–273. doi:10.1037/0033-2909.107.2.260
50. Pallant J. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows (Version 12).* Australia: Allen & Unwin; 2005.
51. Field A. *Discovering Statistics Using SPSS.* (2nd edition). London: Sage; 2005.
52. Pallant J. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows.* (3rd ed.). New York: Open University Press; 2007.
53. Bentler PM, Bonett DG. Significance tests and goodness of fit in the analysis of covariance structures. *Psychol Bull.* 1980;88(3):588–606. doi:10.1037/0033-2909.88.3.588
54. Shi D, DiStefano C, McDaniel HL, Jiang Z. Examining chi-square test statistics under conditions of large model size and ordinal data. *Structural Equation Modeling: A Multidisciplinary Journal.* 2018; 25:924–945.
55. Nunnally JC. *Psychometric Theory.* 2nd ed. New York: McGraw-Hill; 1978.
56. Fawcett T. An introduction to ROC analysis. *Pattern Recognit Lett.* 2006;27(8):861–874. doi:10.1016/j.patrec.2005.10.010
57. Buysse DJ, Ancoli-Israel S, Edinger JD, Lichstein KL, Morin CM. Recommendations for a standard research assessment of insomnia. *Sleep.* 2006;29(9):1155–1173. doi:10.1093/sleep/29.9.1155



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