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ORIGINAL RESEARCH

# Pre-Sleep Arousal Scale (PSAS): Translation and Evaluation of Its Psychometric Properties in an Arabic Version

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**Purpose:** The Pre-Sleep Arousal Scale (PSAS) is a well-recognized instrument utilized for measuring cognitive and somatic arousal before sleep. Although the PSAS is useful, an Arabic version of the scale has not yet been developed and validated. The current study aimed to translate the PSAS into Arabic language and evaluate its psychometric properties, such as reliability and validity, in an Arabic-speaking population.

**Patients and Methods:** A cross-sectional survey was conducted with 438 participants who completed the Arabic version of the PSAS, along with other validated measures of insomnia, anxiety, and sleep effort.

**Results:** The results indicated that the Arabic version of the PSAS maintained the original scale's two-factor structure. The factor loadings for PSAS-Cognitive ranged from 0.57 to 0.75, and for PSAS-Somatic, from 0.45 to 0.70, with all loadings being statistically significant ($p < 0.001$). The Arabic version of the PSAS exhibited high internal consistency (McDonald's $\omega = 0.86$; Cronbach's $\alpha = 0.86$; Guttman's $\lambda 2 = 0.86$; Greatest Lower Bound = 0.90) and test–retest reliability (ICC = 0.88) over two weeks. The PSAS demonstrated good concurrent and convergent validity. We documented significant large differences between individuals with "no insomnia" and those with "insomnia" symptoms across cognitive, somatic, and total pre-sleep arousal (all $p < 0.001$). The insomnia group consistently scored higher scores for PSAP and its subscales.

**Conclusion:** These findings suggest that the Arabic version of the PSAS is a reliable and valid tool for assessing pre-sleep arousal in Arabic-speaking individuals.

**Keywords:** Arabic version, insomnia, pre-sleep arousal, PSAS, psychometric properties, reliability, validity

## Introduction

Sleep is a basic human need that is pivotal for health including physical health, mental health, cognitive function, and emotional well-being.[1] Adequate sleep quality and quantity are associated with numerous health benefits,[2] including enhanced immune function,[3] learning and memory,[4] emotional stability,[5] mental health,[6] and cardiovascular health.[7] Contrariwise, chronic sleep deprivation or poor sleep quality can lead to negative health outcomes such as obesity,[8] diabetes,[9] hypertension,[10] depression,[11] and even premature death.[12] Insufficient sleep can disrupt hormone balance,[13] impacting appetite regulation,[14] metabolism,[13] and overall health, potentially leading to weight gain[13] and metabolic

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diseases.[13] Therefore, prioritizing optimal sleep hygiene and addressing sleep-related dysfunctions are essential for promoting longevity and general well-being.[15]

Insomnia, as defined by criteria, is a prevalent sleep disorder characterized by difficulties in initiating or maintaining sleep or experiencing non-restorative sleep despite adequate opportunity and circumstances for sleep. It is diagnosed based on criteria outlined in the International Classification of Sleep Disorders (ICSD-3-TR),[16] the Diagnostic and Statistical Manual of Mental Disorders (DSM-5),[17] and the International Classification of Diseases, 11th Revision (ICD-11).[18] These criteria emphasize the presence of sleep difficulties that occur at least three times per week and persist for at least three months, causing significant distress or impairment in social, occupational, or other important areas of functioning.[16–18] Understanding these diagnostic criteria is crucial for identifying insomnia, as it helps distinguish it from other sleep disorders and guides appropriate treatment interventions.[16–18]

Hyperarousal, which involves cognitive and somatic components, plays an important role in insomnia by disrupting sleep onset and maintenance.[19] Research findings indicate that individuals with insomnia project higher levels of pre-sleep arousal, both cognitive and somatic.[19,20] Hyperarousal is also associated with increased cortical arousal during both non-rapid eye movement (NREM) and rapid eye movement (REM) sleep.[21,22] Earlier studies reveal that self-reported pre-sleep arousal mediates the relationship between sleep-wake state discrepancy and the severity of insomnia.[23,24] Individuals with insomnia also demonstrate altered heart rate dynamics during the sleep onset period reflecting lower vagal activity and reduced heart rate variability.[24] These findings highlight the significance of addressing hyperarousal (ie, cognitive and somatic) in the measurement and treatment of insomnia to improve sleep quality and overall well-being.[19,22]

The Pre-Sleep Arousal Scale (PSAS) was developed by Nicassio et al in 1985.[23] The PSAS is a widely used instrument in research and clinical practice, with about 800 citations according to MEDLINE as of August 2024. The PSAS assesses pre-sleep arousal through two domains or subscales: cognitive and somatic.[23] Cognitive arousal involves thoughts and worries that prevent sleep onset.[23] Somatic arousal involves physiological symptoms such as palpitation or muscular tension.[23] The original PSAS has projected good reliability and validity across diversified populations as it has been translated into other languages, such as Portuguese,[25] Japanese,[26] Swedish.[27] The correlation between cognitive arousal and increased cortical arousal during NREM and REM sleep measured by the PSAS suggests a link between pre-sleep worry and rumination with nighttime arousal levels, highlighting the scale's importance in understanding insomnia mechanisms.[22,28]

The absence of a published validated Arabic version of the PSAS (or similar measure) poses a limitation in assessing pre-sleep arousal components in Arabic-speaking populations. Psychometric studies in the field of sleep medicine have highlighted the importance of having culturally adapted and validated scales to ensure accurate measurements in different populations.[29–32] Developing and validating an Arabic version of the PSAS could enhance its utility in assessing pre-sleep arousal in Arabic-speaking individuals, contributing to more comprehensive research and clinical practices in this population.

This study aimed to fill the above gap by translating the PSAS into Arabic and evaluating its psychometric properties, including reliability and structural validity. The translation process followed established guidelines to ensure the linguistic and cultural suitability of the Arabic version; thus, we hypothesize that the psychometric properties of the Arabic version of the PSAS echo the original English language version.

# Material and Methods

## The Translation Processes

The objective of this study was to translate and validate the PSAS scale[23] into Arabic. Prior to translation, Dr. Nicassio provided written approval in July 2024 for the questionnaire to be translated and validated in Arabic. We employed a rigorous method known as forward-backward translation to carry out the process of translation. Initially, the two members of our research team (HG & HJ) translated the English version of PSAS into Modern Standard Arabic. Subsequently, a proficient linguist (ZS), who is also affiliated with the research team, conducted an independent backward translation of the Arabic version into English. Three collaborators of the research team (AA, KT, and WHS)

reviewed the linguist's back-translated English version alongside the original English version of the PSAS to ensure accuracy and equivalence. Based on this comparison, any necessary changes were made to the Arabic version. The Arabic version of the questionnaire was tested with a group of 25 individuals from the target demographic to evaluate the clarity and understanding of the items. After the pilot, feedback was gathered on how well participants understood the questions and the overall structure of the questionnaire. This feedback was analyzed, leading to necessary revisions to enhance the questionnaire, ensuring it was culturally relevant and linguistically precise for the intended audience. Following this stage, the questionnaire demonstrated clarity, and no further changes were required. Participants who took part in the pilot test were excluded from the main analyses according to our study methodology protocol. Furthermore, an expert panel consisting of professionals in sleep medicine and psychology reviewed the questionnaire to ensure that the items were both understandable and relevant for the target population, including patients with insomnia. This combination of pilot testing and expert consultation allowed for necessary revisions to enhance the questionnaire's cultural appropriateness and linguistic accuracy, ensuring that it effectively addressed the needs of the intended audience. Following these adjustments, the final version of the questionnaire demonstrated clarity, and no further changes were deemed necessary.

To validate the translated Arabic version for use in Arabic-speaking populations, the final translated version of the PSAS was later assessed for its psychometric properties, including validity and reliability, on a large sample of individuals whose mother tongue is Arabic.

## Data Collection Approach

The Arabic version of the PSAS questionnaire was distributed via various social media channels in predetermined Arab countries, which was agreed upon among the researchers, including Bahrain, Saudi Arabia, Jordan, and Tunisia. For this purpose, various social media platforms were used. This includes, but is not limited to, instant messaging services (eg, LINE, Telegram, Viber, and WhatsApp) as well as social media platforms (eg, Discord, Facebook, Instagram, LinkedIn, Pinterest, and Twitter/X). This approach of utilizing social media platforms has been successfully employed in previous studies to translate and validate several scales in sleep medicine.[29–32] Prior to the initiation of the survey, all participants gave their informed consent. The questionnaire asked about age, sex, marital status, and other sociodemographic details. It also included the PSAS scale in Arabic translation. In addition, the participants completed the Athens Insomnia Scale (AIS),[33] Generalized Anxiety Disorder Scale-7 (GAD-7),[34] and Glasgow Sleep Effort Scale (GSES).[35] To evaluate test–retest reliability, the participants were asked to retake the PSAS around two weeks following the original administration. We excluded individuals with a known history of mental illness, chronic medical conditions, or those currently undergoing treatment for such conditions.

In our online data collection process, we implemented several measures to ensure data quality and prevent duplicate participation. We excluded no participants from the final analysis. To prevent re-participation, we employed procedures to identify and remove potential duplicate submissions. Furthermore, for each country, we used unique, single-use survey links distributed through our recruitment channels, further reducing the likelihood of multiple participations by the same individual.

## Participation and Power Calculation

Factor analysis required a minimum sample size of about 160 respondents for Arabic validation. For every question on the questionnaire, five to ten participants were required. Nonetheless, a total of 438 people filled out the forms, with 100–120 participants from each of the following countries: Bahrain, Saudi Arabia, Jordan, and Tunisia. These countries were deliberately selected to represent the broad spectrum of Arabic dialects across different regions.

To ensure the integrity of our data all fields were mandatory thereby avoiding any missing data in our analyses.

## Instruments

### Pre-Sleep Arousal Scale (PSAS)

The Pre-Sleep Arousal Scale (PSAS) includes 16 items.[23] The items are divided into two subscales namely cognitive and somatic arousal.[23] The response to each item ranges between 1 and 5, in which 1 = not at all and 5 = extremely.[23] Thus,

the total score ranges between 16 and 80.[23] A high total score indicates greater pre-sleep arousal, suggesting higher difficulty in falling asleep.[23] In the original English-language version of the PSAS good reliability was demonstrated by the PSAS items and subscales ($\alpha$= 0.79–0.81; test-retest $r$ = 0.72–0.76).[23] The PSAS distinguishes between people who have "insomnia" and those with "no insomnia" symptoms.[23]

### Athens Insomnia Scale (AIS)

The eight-item self-assessment list included in the AIS was created in 2000 by Soldatos et al based on the diagnostic criteria of insomnia proposed by the International Classification of Diseases (ICD-10).[33] The eight questions measure the following: the time at which sleep is initiated, the duration and quality of sleep, the frequency and duration of complaints, the commencement of insomnia that caused discomfort, and the interference with day-to-day activities.[33] Each item is given a 4-point rating: 0 represents absolutely no difficulty, 1 indicates a minor problem, 2 indicates unquestionably a problem, and 3 indicates a very serious problem.[33] A higher score signifies higher symptoms of insomnia.[33] The total score runs from 0 to 24. The optimal conformation score for pathological insomnia was found to be 6 which was used in this research study to define individuals with insomnia.[33,36] Participants scoring below 6 were considered to have no significant insomnia symptoms, while those scoring 6 or higher were classified as having insomnia. This distinction helps in accurately identifying and assessing the severity of insomnia within the study population. A recent meta-analysis found that the AIS has an excellent internal consistency and retest reliability of 0.84 (95% CI: 0.81 to 0.86) and 0.86 (95% CI: 0.80 to 0.92), respectively.[36] The Arabic version was employed in this research which has excellent psychometric properties, $\alpha$ =0.84.[36]

### Generalized Anxiety Disorder-7 Scale (GAD-7)

One tool for determining the severity of GAD is the GAD-7 self-assessment scale. Spitzer et al established a basic score that was designed at the outset for primary care settings to facilitate the identification of GAD.[34] The seven items in the GAD-7 assess nearly all of the major diagnostic characteristics of generalized anxiety disorder (GAD) (ie, tense sensations, anxiety, or on edge and excessive concern over things not similar to things).[34] A 4-point Likert scale is used to rate the items (0 = not at all, 1 = several days, 2 = more than half of the days, and 3 = almost every day).[34] This score has a range of 0 to 21, with a higher number denoting more severe GAD. It was shown that the ideal cutoff score for GAD was 10.[34] In the current investigation, the GAD-7 Arabic version—which boasts an exceptional internal consistency of >0.85—was employed.[34] The Arabic version was employed in this research, which has excellent psychometric properties, $\alpha$ = 0.85.[37]

### Glasgow Sleep Effort Scale (GSES)

Seven items make up the GSES and are identified as essential elements of sleep effort.[35,38] Each item has a response option that ranges from 0 to 2: where 0 means not at all, 1 means somewhat, and 2 means very much.[35] The overall result can be anything from 0 to 14. A high overall score suggests that getting sleep requires more effort.[35] The Arabic version was employed in this research, which has excellent psychometric properties, $\alpha$ = 0.87.[31]

## Ethical Conformity

The study was carried out in compliance with the 1964 helsinki Declaration and its subsequent revisions (1975, 1983, 1989, and 1996). The Research Committee of the Government Hospitals in Bahrain reviewed and approved the study (Code: REC/2024-187). Participation in the study was voluntary. The Participants could withdraw from the study at any time without facing any penalties. Every participant in the study was an adult, aged at least eighteen years. Participants did not receive any financial or non-financial incentives.

## Statistical Analysis

For continuous data, descriptive statistics were computed, including mean, standard deviation (±SD), skewness, and kurtosis.[39] Multiple coefficients were used to analyze the PSAS's dependability.[40] These offered a thorough assessment of internal consistency and included the Greatest Lower Bound, Guttman's $\lambda 2$, McDonald's $\omega$, and Cronbach's $\alpha$.[40] We

used the intraclass correlation coefficient (ICC) to measure the test–retest reliability.[41] ICC is an analytical tool used to evaluate the degree of consistency or agreement between measurements made at various times.[41]

The structural validity of the two-component model of cognitive and somatic arousal was assessed using confirmatory factor analysis (CFA)[42] using the Maximum likelihood estimator with no rotation. To establish the appropriateness of the model, factor loadings, residual variances, and other fit indices were computed.[43] Construct validity was further evaluated by calculating the Heterotrait-Monotrait Ratio (HTMT) and Average Variance Extracted (AVE).[42] Fit quality was assessed using the comparative fit index (CFI) and the Tucker-Lewis index (TLI) with a cutoff of CFI > 0.90 and TLI > 0.90.[44,45] Additional calculations were conducted for the root mean square error of approximation (RMSEA) and its 95% confidence interval (95% CI), the normal chi-square ($3 > \chi 2/df < 2$), and the root mean square residual (RMSR < 0.08).[43]

The decision to conduct a CFA rather than an Exploratory Factor Analysis (EFA) was based on the existing literature, where the PSAS has been translated into several other languages and consistently demonstrated a stable two-factor structure.[20,23,25–27,46] Given this well-established factorial stability, we hypothesized that the Arabic version would exhibit a similar structure. Therefore, performing a CFA was appropriate to confirm this expected model in our study. Additionally, previous research indicates that both EFA and CFA would likely yield similar solutions, supporting the robustness of the two-factor model across different cultural contexts.[20,23,25–27,46]

Correlations between the PSAS subscales, PSAS total scores, and related measures (AIS, GAD-7, and GSES) were used to evaluate concurrent validity.

Independent samples *t*-tests were used to compare the PSAS scores of individuals with and without insomnia to assess criterion validity.

Statistical analysis was performed using the R Statistical Foundation R version 4.4.0 (Puppy Cup), released on 2024–04-24. A p-value < 0.05 was considered statistically significant.

## Results

The study sample comprised 438 participants with a mean age of 34.86 years (*SD* = 4.25). The sex distribution was relatively balanced, with 236 females (53.9%) and 202 males (46.1%).

The PSAS consists of two factors: Cognitive (F1) and Somatic (F2). The Cognitive-PSAS had a mean of 15.03 (*SD* = 6.34) with slight positive skewness (0.12) and negative kurtosis (−0.20). The Somatic-PSAS showed a higher mean of 18.55 (*SD* = 5.69) with moderate negative skewness (−0.48) and positive kurtosis (0.46). The total PSAS score averaged 33.58 (*SD* = 10.57). The AIS, GAD-7, and GSES yielded a mean of 5.22 (*SD* = 3.19), 9.4 (*SD* = 5.2), and 6.37 (*SD* = 4.16), respectively (Table 1).

The reliability analysis of the PSAS was conducted on the entire sample of 438 participants, examining both the Cognitive and Somatic subscales. For the PSAS-Cognitive subscale, McDonald's $\omega$, Cronbach's $\alpha$, and Guttman's $\lambda 2$ all showed identical values of 0.86 (95% CI: 0.84, 0.88), while the Greatest Lower Bound was slightly higher at 0.90 (95% CI: 0.88, 0.92). For the PSAS-Somatic subscale, the reliability coefficients were also strong, with McDonald's $\omega$, Cronbach's $\alpha$, and Guttman's $\lambda 2$ all at 0.80 (95% CI: 0.77, 0.83 for $\omega$ and $\alpha$; 0.76, 0.83 for $\lambda 2$), and the Greatest Lower Bound at 0.85 (95% CI: 0.83, 0.88). Test–retest reliability of the PSAS after two weeks was 0.88 (95% CI: 0.86, 0.90). When analyzing the impact of removing individual items from the PSAS-cognitive subscale or the PSAS-somatic subscale, the reliability coefficients remained unchanged (Table 2).

The structural validity analysis of the PSAS was conducted by examining a two-factor model consisting of Cognitive (F1) and Somatic (F2) subscales. Factor loadings for all items under both subscales were statistically significant ($p < 0.001$), indicating that each item contributes meaningfully to its respective factor. For the Cognitive subscale (F1), factor loadings ranged from 0.57 to 0.75, with PSAS2 showing the highest loading (0.75) and PSAS5 the lowest (0.57). Residual variances for this subscale ranged from 0.43 to 0.68, suggesting varying degrees of item-specific variance not accounted for by the factor (Table 3).

The Somatic subscale (F2) demonstrated factor loadings ranging from 0.45 to 0.70, with PSAS9 having the highest loading (0.70) and PSAS12 the lowest (0.45). Residual variances for this subscale were generally higher, ranging from 0.52 to 0.79, indicating more item-specific variance compared to the Cognitive subscale (Table 3).

**Table 1** Descriptive Statistics of the Study Sample (N =438)

| Variable | Mean | SD | Skewness | Kurtosis |
|---|---|---|---|---|
| Age (in years) | 34.86 | 4.25 | −0.16 | 0.08 |
| Sex | Female (236, 53.9%) and Male (202, 46.1%) | | | |
| F1 Cognitive-PSAS | 15.03 | 6.34 | 0.12 | −0.20 |
| F2 Somatic-PSAS | 18.55 | 5.69 | −0.48 | 0.46 |
| PSAS | 33.58 | 10.57 | −0.07 | 0.57 |
| AIS | 5.22 | 3.19 | 0.37 | −0.58 |
| GAD-7 | 9.4 | 5.2 | 0.27 | −0.53 |
| GSES Total | 6.37 | 4.16 | 0.27 | −0.94 |

**Notes**: Factor 1 = PSAS-Cognitive. Factor 2 = PSAS-Somatic.
**Abbreviations**: PSAS, pre-sleep arousal scale; AIS, Athens insomnia scale; GAD-7, Generalized Anxiety Disorder Scale - 7 items; GSES, Glasgow sleep effort scale.

**Table 2** Reliability Analysis of the PSAS (N =438)

| Domain/Item | McDonald's $\omega$ | Cronbach's $\alpha$ | Guttman's $\lambda 2$ | Greatest Lower Bound |
|---|---|---|---|---|
| **PSAS-Cognitive** | **0.86 (0.84, 0.88)** | **0.86 (0.84, 0.88)** | **0.86 (0.84, 0.88)** | **0.90 (0.88, 0.92)** |
| If item deleted - PSAS-Cognitive | | | | |
| PSAS1 | 0.84 | 0.84 | 0.85 | 0.89 |
| PSAS2 | 0.83 | 0.83 | 0.83 | 0.88 |
| PSAS3 | 0.85 | 0.85 | 0.85 | 0.88 |
| PSAS4 | 0.84 | 0.84 | 0.84 | 0.88 |
| PSAS5 | 0.85 | 0.85 | 0.85 | 0.89 |
| PSAS6 | 0.84 | 0.84 | 0.84 | 0.88 |
| PSAS7 | 0.84 | 0.84 | 0.84 | 0.88 |
| PSAS8 | 0.85 | 0.85 | 0.85 | 0.89 |
| **PSAS-Somatic** | **0.80 (0.77, 0.83)** | **0.80 (0.77, 0.83)** | **0.80 (0.76, 0.83)** | **0.85 (0.83, 0.88)** |
| If item deleted - PSAS-Somatic | | | | |
| PSAS9 | 0.76 | 0.76 | 0.76 | 0.81 |
| PSAS10 | 0.77 | 0.77 | 0.77 | 0.82 |
| PSAS11 | 0.78 | 0.77 | 0.78 | 0.83 |
| PSAS12 | 0.79 | 0.79 | 0.79 | 0.85 |
| PSAS13 | 0.78 | 0.78 | 0.78 | 0.83 |
| PSAS14 | 0.78 | 0.78 | 0.78 | 0.82 |
| PSAS15 | 0.78 | 0.78 | 0.78 | 0.83 |
| PSAS16 | 0.78 | 0.78 | 0.78 | 0.83 |

**Notes**: Factor 1 = PSAS-Cognitive. Factor 2 = PSAS-Somatic. All values are expressed as estimate (95% confidence intervals).

**Table 3** Confirmatory Factor Analysis/Structural Validity of the PSAS (N =438)

| Factor | Indicator | Factor Loading | | | | Residual Variance | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Estimate | SE | z-Value | p-Value | Estimate | SE | z-Value | p-Value |
| F1 | PSAS1 | 0.63 | 0.05 | 13.79 | <0.001 | 0.61 | 0.06 | 13.39 | <0.001 |
| | PSAS2 | 0.75 | 0.05 | 17.55 | <0.001 | 0.43 | 0.04 | 11.89 | <0.001 |
| | PSAS3 | 0.62 | 0.05 | 13.51 | <0.001 | 0.62 | 0.06 | 13.35 | <0.001 |
| | PSAS4 | 0.71 | 0.05 | 16.15 | <0.001 | 0.5 | 0.04 | 12.54 | <0.001 |
| | PSAS5 | 0.57 | 0.05 | 12.1 | <0.001 | 0.68 | 0.06 | 13.77 | <0.001 |
| | PSAS6 | 0.69 | 0.05 | 15.38 | <0.001 | 0.53 | 0.06 | 12.74 | <0.001 |
| | PSAS7 | 0.68 | 0.05 | 15.37 | <0.001 | 0.53 | 0.05 | 12.83 | <0.001 |
| | PSAS8 | 0.63 | 0.05 | 13.85 | <0.001 | 0.6 | 0.06 | 13.3 | <0.001 |
| F2 | PSAS9 | 0.7 | 0.05 | 15.16 | <0.001 | 0.52 | 0.05 | 11.77 | <0.001 |
| | PSAS10 | 0.65 | 0.05 | 13.82 | <0.001 | 0.58 | 0.05 | 12.52 | <0.001 |
| | PSAS11 | 0.58 | 0.06 | 12.05 | <0.001 | 0.67 | 0.07 | 13.19 | <0.001 |
| | PSAS12 | 0.45 | 0.05 | 9.14 | <0.001 | 0.79 | 0.07 | 13.97 | <0.001 |
| | PSAS13 | 0.54 | 0.05 | 11.03 | <0.001 | 0.71 | 0.06 | 13.46 | <0.001 |
| | PSAS14 | 0.58 | 0.05 | 11.99 | <0.001 | 0.67 | 0.06 | 13.07 | <0.001 |
| | PSAS15 | 0.57 | 0.06 | 11.85 | <0.001 | 0.68 | 0.07 | 13.3 | <0.001 |
| | PSAS16 | 0.56 | 0.06 | 11.42 | <0.001 | 0.69 | 0.07 | 13.19 | <0.001 |

**Notes**: F1 = PSAS-Cognitive. F2 = PSAS-Somatic. All values are standardized. The estimator used is Maximum Likelihood (ML). The baseline model has a $X^2$ of 2392.89 with 120 degrees of freedom. The factor model shows a $X^2$ of 336.42 with 103 degrees of freedom ($p < 0.001$). Fit Indices: Comparative Fit Index (CFI): 0.90 Tucker-Lewis Index (TLI): 0.88 Bentler-Bonett Non-normed Fit Index (NNFI): 0.88 Bentler-Bonett Normed Fit Index (NFI): 0.86 Parsimony Normed Fit Index (PNFI): 0.74 Bollen's Relative Fit Index (RFI): 0.84 Bollen's Incremental Fit Index (IFI): 0.90 Relative Noncentrality Index (RNI): 0.90 Information Criteria: Log-likelihood: −9637.20 Number of free parameters: 49 Akaike Information Criterion (AIC): 19,372.40 Bayesian Information Criterion (BIC): 19,572.43 Sample-size Adjusted Bayesian Information Criterion (SSABIC): 19,416.93. Other Fit Measures: Root Mean Square Error of Approximation (RMSEA): 0.07 RMSEA 90% Confidence Interval Lower Bound: 0.06 RMSEA 90% Confidence Interval Upper Bound: 0.08 RMSEA *p*-value: 1.73 × 10^-5 Standardized Root Mean Square Residual (SRMR): 0.05 hoelter's Critical N ($\alpha$ = 0.05): 167.25 hoelter's Critical N ($\alpha$ = 0.01): 182.36 Goodness of Fit Index (GFI): 0.96 McDonald Fit Index (MFI): 0.77 Expected Cross Validation Index (ECVI): 0.99. Average Variance Extracted (AVE) PSAS-Cognitive: 0.44 PSAS-Somatic: 0.34. Heterotrait-Monotrait Ratio (HTMT) The HTMT ratio for PSAS-Cognitive to PSAS-Somatic is 0.64.

The model fit indices suggest an acceptable fit: CFI (0.90) and TLI (0.88) are at or close to the recommended threshold of 0.90. The RMSEA of 0.07 (90% CI: 0.06–0.08) indicates a reasonable fit, while the SRMR of 0.05 suggests a good fit. The chi-square test was significant ($X^2$ = 336.42, df = 103, $p$ <0.001), which is common in large samples (Table 3).

The AVE for PSAS-Cognitive (0.44) and PSAS-Somatic (0.34) are below the ideal threshold of 0.50, suggesting that more variance is due to measurement error than to the underlying construct. The HTMT of 0.64 between the two factors indicates good discriminant validity (Table 3).

The convergent validity analysis of the PSAS was conducted on a sample of 438 participants, examining correlations between the PSAS subscales (Cognitive and Somatic), total PSAS score, and related measures, including the AIS, GAD-7, and GSES (Table 4).

The Cognitive and Somatic subscales of the PSAS showed a moderate positive correlation ($r$ = 0.543, $p < 0.05$), indicating that while related, they measure distinct aspects of pre-sleep arousal. Both subscales were strongly correlated

**Table 4** Convergent Validity of the PSAS (N = 438)

| Variable | Cognitive | Somatic | PSAS | AIS | GAD-7 | GSES Total |
|---|---|---|---|---|---|---|
| 1. Cognitive | — | | | | | |
| 2. Somatic | 0.543* | — | | | | |
| 3. PSAS | 0.892* | 0.864* | — | | | |
| 4. AIS | 0.442* | 0.339* | 0.447* | — | | |
| 5. GAD-7 | 0.518* | 0.412* | 0.533* | 0.501* | — | |
| 6. GSES Total | 0.313* | 0.215* | 0.303* | 0.722* | 0.358* | — |

**Notes**: Factor 1 = PSAS-Cognitive. Factor 2 = PSAS-Somatic. *$p$-value <0.05.
**Abbreviations**: PSAS, pre-sleep arousal scale; AIS, Athens insomnia scale; GAD-7, Generalized Anxiety Disorder Scale - 7 items; GSES, Glasgow sleep effort scale.

with the total PSAS score (Cognitive: $r = 0.892$, Somatic: $r = 0.864$, both $p < 0.05$), as expected, given that they compose the total score (Table 4).

The PSAS and its subscales demonstrated moderate positive correlations with the AIS, supporting their relationship with insomnia symptoms. The Cognitive subscale ($r = 0.442$, $p < 0.05$) showed a slightly stronger correlation with the AIS compared to the Somatic subscale ($r = 0.339$, $p < 0.05$), suggesting that cognitive arousal might be more closely linked to insomnia symptoms in this sample (Table 4).

Similarly, the PSAS and its subscales showed moderate to strong positive correlations with the GAD-7, indicating a relationship between pre-sleep arousal and anxiety symptoms. Again, the Cognitive subscale ($r = 0.518$, $p < 0.05$) demonstrated a stronger correlation with anxiety compared to the Somatic subscale ($r = 0.412$, $p < 0.05$) (Table 4).

The GSES Total score showed significant, positive correlations with the PSAS and its subscales (PSAS Total: $r = 0.303$, Cognitive: $r = 0.313$, Somatic: $r = 0.215$, all $p < 0.05$). This suggests a relationship between pre-sleep arousal and sleep effort, with cognitive arousal showing a slightly stronger association (Table 4).

The independent samples $t$-test revealed significant differences between "no insomnia" individuals and those with "insomnia" symptoms across all PSAS and its factors. PSAS scores showed the largest disparity. Healthy participants ($M = 30.7$, $SD = 9.57$) exhibited markedly lower pre-sleep arousal than those with insomnia ($M = 38.9$, $SD = 10.32$), $t(436) = -8.29$, $p < 0.001$, $d = -0.832$. Cognitive scores were significantly lower in the healthy group ($M = 13.4$, $SD = 5.66$) compared to the insomnia group ($M = 18.1$, $SD = 6.44$), $t(436) = -7.87$, $p < 0.001$, $d = -0.790$. Somatic symptoms also differed significantly. The healthy group ($M = 17.3$, $SD = 5.62$) reported fewer somatic complaints than the insomnia group ($M = 20.8$, $SD = 5.12$), $t(436) = -6.39$, $p < 0.001$, $d = -0.642$.

## Discussion

Our results demonstrated robust reliability for both the cognitive and somatic components of the PSAS. The cognitive subscale showed slightly higher reliability than the somatic subscale. The analyses maintained the original two-factor structure of the PSAS similar to other languages.[23,25–27] The results also provided evidence for the convergent validity of the PSAS. The PSAS and its subscales show the anticipated correlations with measures of insomnia, anxiety, and sleep effort.

The study demonstrated strong reliability for both cognitive and somatic components of the PSAS, with the cognitive subscale showing slightly higher reliability. This finding indicates that the PSAS consistently measures pre-sleep arousal across its two main dimensions. Moreover, confirming the original two-factor structure in the new linguistic context of Arabic supports the cross-cultural validity of the PSAS. This result aligns with previous studies in other languages, suggesting that the concept of pre-sleep arousal, divided into cognitive and somatic components, is relatively universal across different cultures.[20,23,25–27,46]

The convergent validity analysis revealed moderate to strong correlations between the PSAS and related measures of insomnia symptoms (ie, AIS), anxiety (ie, GAD-7), and sleep effort (ie, GSES). Notably, the Cognitive subscale consistently showed stronger correlations with these measures compared to the Somatic subscale. This suggests that cognitive arousal may play a more significant role in sleep disturbances and related psychological factors than somatic arousal. This finding has important implications: (a) It suggests that cognitive arousal may play a more significant role in sleep disturbances than somatic arousal. (b) The stronger relationship between cognitive arousal and anxiety measures indicates a potential overlap between cognitive processes involved in anxiety and those affecting sleep. (c) These results highlight the importance of addressing cognitive factors in sleep interventions.

The strengths of our study include its large sample size, comprehensive psychometric evaluation, and the inclusion of multiple related measures for convergent validity assessment. The use of various reliability coefficients and structural equation modeling provides a robust evaluation of the scale's psychometric properties. However, the limitations must also be noted. First, any causal inferences about the relationships between pre-sleep arousal and other variables are not possible, and the study was cross-sectional. Second, the sample's demographic characteristics were not fully described, which may limit the generalizability of our findings.

Future research should address these limitations by conducting longitudinal studies to examine the stability of pre-sleep arousal over time and its predictive validity for sleep outcomes. Additionally, studies should explore the PSAS's performance across diverse populations, including different age groups and clinical samples. Further investigation into the lower AVE values is warranted, potentially leading to item refinement or the development of additional items to better capture the constructs.

This study has other limitations that should be considered. First, data collection was conducted online, which may introduce biases related to internet accessibility and self-selection, potentially limiting the generalizability of the findings. Second, the study did not include objective measures such as polysomnography (PSG) or actigraphy to validate self-reported data, which could have provided more comprehensive insights into the participants' sleep patterns. Third, while the sample size was adequate for confirmatory factor analysis, it remains relatively small, which might affect the robustness of the results. Furthermore, we chose not to perform an EFA due to the established two-factor structure in other languages; however, conducting an EFA might have provided further insights into the factor structure in the Arabic context. Furthermore, the study did not employ Item Response Theory (IRT) or network analysis, which could have offered a deeper understanding of the relationships between items and the underlying constructs. Future research should address these limitations by incorporating objective sleep measures, increasing sample size, and exploring alternative analytical approaches.

The significant differences in PSAS scores between individuals with and without insomnia highlight the scale's potential clinical utility.[47] Practitioners can use the PSAS to assess pre-sleep arousal levels in patients with sleep complaints, with particular attention to cognitive arousal, which showed stronger associations with insomnia symptoms and anxiety.[46] This information can guide targeted interventions, such as cognitive restructuring techniques for those with high cognitive arousal or relaxation strategies for those with elevated somatic arousal.[46]

The stronger relationship between cognitive arousal and sleep-related measures suggests that cognitive interventions may be particularly beneficial in treating sleep disturbances.[48] Clinicians should consider incorporating cognitive techniques, such as mindfulness or cognitive behavioral therapy for insomnia (CBT-I), into their treatment plans for patients with high pre-sleep cognitive arousal.[49,50]

The findings of this study open several avenues for future research and practice in sleep science and clinical psychology. Researchers should investigate how cultural and environmental factors moderate the relationship between pre-sleep arousal and sleep outcomes, as this exploration could reveal the universality and cultural specificity of sleep-related cognitive and somatic processes. From a methodological standpoint, integrating ecological momentary assessment techniques with the PSAS could provide a more nuanced understanding of how pre-sleep arousal fluctuates in real time and its immediate impact on sleep quality. For clinicians, the stronger association between cognitive arousal and sleep disturbances highlights the need to develop and test targeted cognitive interventions that specifically address nighttime rumination and worry. Exploring the potential use of the PSAS as a screening tool in primary care settings could facilitate the early identification of individuals at risk for developing chronic insomnia and enable timely

interventions. Future research should also examine the responsiveness of the PSAS to various sleep interventions, which could establish its utility as an outcome measure in clinical trials and help refine treatment protocols for sleep disorders.

## Conclusion

Our findings demonstrate that the Arabic PSAS retained the two-factor structure of the original scale, with all factor loadings being statistically significant. The PSAS revealed strong internal consistency and test–retest reliability over two weeks. Furthermore, the PSAS displayed good concurrent and convergent validity. These results suggest that the Arabic version of the PSAS is a reliable and valid tool for measuring pre-sleep arousal in individuals who speak Arabic. Our findings provide evidence for the use of the Arabic version of PSAS as a reliable measure in sleep research and clinical assessment.

## Disclosure

Pre-Sleep Arousal Scale (PSAS): translation and evaluation of its psychometric properties in an Arabic version is available online at OSF HOME: https://osf.io/4cdhw/. The authors report no conflicts of interest in this work.

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