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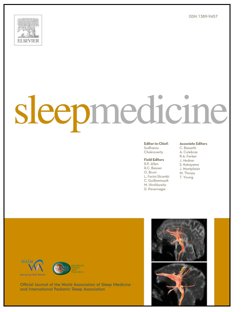

Pre-Sleep Arousal Scale (PSAS): Psychometric study of a European Portuguese version

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Title:

Pre-Sleep Arousal Scale (PSAS): Psychometric study of a European Portuguese version

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Abstract

Objective/Background: Pre-sleep arousal constitutes one of the major features of insomnia. As such, it is imperative to have adequate instruments to measure this construct in both clinical and research settings. The Pre-Sleep Arousal Scale (PSAS) is the most well-known measure to evaluate pre-sleep arousal. The current study aimed to examine some of the psychometric properties of a European Portuguese version of the scale.

Participants/Methods: For this purpose, data from 691 undergraduate students from a medical school were analyzed. Internal consistency indices and factor analysis were performed. In addition, the association between the PSAS and its subscales with other measures was also examined. Finally, PSAS scores of self-reported insomniacs were compared with those of self-reported non-insomniacs.

Results: The results indicated that the PSAS comprises a cognitive scale and a somatic scale, both with adequate internal consistency indices (α=0.82 and 0.79, respectively). However, a three-factor solution also seemed plausible, suggesting that the original somatic arousal subscale might be divided into two subscales. Significant associations between the PSAS total score and its subscales were found with other concurrent measures such as sleep reactivity to stress, arousability and neuroticism. Self-defined insomniacs presented higher levels of cognitive and somatic arousal than healthy individuals. **Conclusions:** Further investigations of the PSAS are needed to refine its psychometric properties and explore its research and clinical utility in other populations.

Keywords:

Arousal

Insomnia

Pre-Sleep Arousal Scale (PSAS)

Scale

Sleep

Introduction

Insomnia has been characterized as a disorder of hyperarousal (Marques, Gomes, Clemente, Santos, & Castelo-Branco, 2015; Riemann et al., 2010). Patients with insomnia frequently report high levels of negative affect and physiological arousal and, in particular, a pronounced state of cognitive arousal is denoted by a flow of intrusive thoughts related to ruminations and worries. This hyperarousal state is often accompanied by significant impairment in social and academic functioning (Marques et al., 2015; Riemann et al., 2010). The hyperarousal hypothesis in insomnia states that insomnia patients will present higher levels of activity in all relevant human systems compared to so-called "good sleepers". Although this is accepted and widespread in insomnia research, it is also true that new and complementary theoretical viewpoints such as the "psychobiological inhibition model" are emerging (Espie, Broomfield, MacMahon, Macphee, & Taylor, 2006; Marques et al., 2015).

One of the most widely used self-report instruments in insomnia research and clinical practice is the Pre-Sleep Arousal Scale (PSAS) (Nicassio, Mendlowitz, Fussell, & Petras, 1985). The PSAS was the first questionnaire specifically developed to measure both cognitive and somatic manifestations of arousal experienced at bedtime. Despite the fact that the PSAS is one of the most widely used scales in the published research on insomnia, evidence of the scale's psychometric properties is lacking. Even so, the PSAS is one of the most cited instruments in insomnia research (Ong, Arnedt, & Gehrman, 2016). It is believed that few studies have explicitly focused on the psychometric characteristics of the PSAS. Three of these studies focused on university students (Azevedo et al., 2010; Gieselmann, de Jong-Meyer, & Pietrowsky, 2012;

Shahzadi & Ijaz, 2014) and one pertained to the general population (Jansson-Fröjmark & Norell-Clarke, 2012).

The original study by Nicassio et al. (1985), included samples of 147 university students (85 men) with a mean age of 19.33 years, 30 individuals (16 men) with sleep-onset insomnia and a mean age of 39.27 years (range 19-65), and 30 adult normal sleepers (17 women) with an average age of 35.27 years (range 21-65). The study reported adequate internal consistency values for both cognitive and somatic arousal subscales. Concerning the college student sample, the cognitive and somatic values were α=0.88 and α=0.79, respectively; for adult normal sleepers the values were α=0.67 and α=0.84; and for insomnia subjects the values were α=0.76 and α=0.81. However, it should be noted that while the content validity of the subscales was based on full agreement among three clinical psychologists who rated the items, a factor analysis of the PSAS was not performed.

In a previous study with the Portuguese translation of the PSAS, Azevedo et al. (2010) performed a principal components analysis (PCA) with varimax rotation in a sample of 321 (79.6% women) undergraduate students with a mean age of 20.2 years (range 17-25) from diverse academic fields, including medicine (36.9%), dentistry (30.3%), pre/primary-school education (17.2%), and psychology (15.6%). Prior to performing PCA, some assumptions were assessed: inspection of the correlation matrix revealed the presence of several correlation coefficients >0.3; The Kaiser-Meyer-Oklin value was 0.89, which exceeded the recommended value of 0.6 (Field, 2013), and Barlett's Test of Sphericity reached statistical significance ($p<0.001$), supporting the factorability of the correlation matrix. PCA revealed three components with eigenvalues exceeding 1, explaining 40.7%, 11.4%, 7.0% of variance, respectively. An inspection of the scree plot revealed a clear break after the second component. Catell's scree test suggested a two-component solution, with both components showing a number of moderate loadings and all items loading substantially on one component: loadings on component 1 (somatic arousal) ranged from 0.632 (item “cold feeling in your hands, feet or your body”) to 0.726 (item “a tight, tense feeling in your muscles”) and on component 2 (cognitive arousal) ranged from 0.519 (item “being distracted by sounds, noise in the environment”) to 0.767 (item “can't shut off your thoughts”). Both components had adequate internal consistencies: Cronbach´s α for component 1 was 0.85 (variance explained 40.7%) and for component 2 it was 0.86 (variance explained 11.4%). The total variance explained was 52.07%. There was a strong correlation (r=0.580) between the two factors. The test-retest coefficient (1 month) for the total scale was 0.805 (p<0.01).

A study by Gieselmann et al. (2012), comprising a sample of 268 individuals aged 18-50 years (M=24.81, SD=5.18) who were predominantly college students (65.7% women and 34.3% men) found adequate properties for the German version of the PSAS. Initially, through a PCA followed by a varimax rotation, the authors found a three-factor solution accounting for 62.4% of total variance. Through parallel analysis, a two-factor structure was derived with cognitive and somatic factors explaining 33.4% and 22.4% of total variance, respectively. The correlation between factors was r=0.71. Cronbach´s alpha for the cognitive factor was 0.80 and 0.93 for the somatic factor. Item 16 (ie, “being distracted by sounds, noise in the environment”) was subsequently removed from further analysis, as it loaded onto the somatic factor.

Jansson-Fröjmark and Norell-Clarke (2012) performed an exploratory factor analysis with the maximum likelihood ratio method followed by an oblique rotation (direct oblimin rotation) to analyze the psychometric properties of a Swedish translation of the PSAS in a large community sample. The sample consisted of 1890 participants (mean age 47 years; range 18-70) who fulfilled the criteria for insomnia but not for any other sleep disorder. The factor structure they found was not as clear-cut as expected, since some items had cross-loadings or low loadings. Overall, the authors found two factors: a cognitive and a somatic factor, accounting for 38.2% and 9.4% of the variance, respectively. Further, in order to improve the reliability and validity of the scale, items 9 (ie, “worry about falling asleep”), 11 (ie, “depressing or anxious thoughts”) and 16 (ie, “being distracted by sounds, noise in the environment”) were discarded.

Finally, a more recent study of a sample of 600 university Pakistani students (352 women) aged 18-25, using an exploratory factor analysis (method was not indicated) followed by varimax rotation, extracted two factors accounting for 51% of the total variance and determined by the scree plot. The authors found a Cronbach´s alpha of 0.89, 0.87, and 0.82 for the total PSAS, somatic arousal, and cognitive arousal, respectively (Shahzadi & Ijaz, 2014). Factor loadings >0.50 were set as a criterion for inclusion on each factor. The two factor solution revealed a clearer factor structure with no dubious items and cross-loadings. The test-retest reliability was r=0.87 (p<0.001). In that study, the PSAS was translated into the Urdu language.

The aim of the present study was to further investigate the psychometric properties of a European Portuguese version of the PSAS (PSAS-PT) in a large sample of young adults.

Method

Participants

A total of 713 medicine university students were recruited for the current study. From this initial pool of participants, 22 were excluded because of missing data. Thus, the final sample consisted of 691 participants (452 women). The included students attended the first 3 years of medical school (1st year=35.9%; 2nd year=28.7%; 3rd year=35.3%; missing=0.1%). All participants were single. It should be noted that it was previously confirmed that missing data were random (Little's MCAR test: χ^2=113,402, *df*=149, *p*=0.987).

Measures

Pre-Sleep Arousal Scale (PSAS)

The PSAS contains 16 items, each rated on a 5-point scale that describes symptoms of arousal at bedtime (Nicassio, Mendlowitz, Fussell, & Petras, 1985). Eight items evaluate cognitive arousal and eight evaluate somatic arousal. Higher scores indicate higher pre-sleep arousal.

Sleep–wake variables

Concerning sleep-wake variables, the following indicators were used (cf. Marques, Gomes, Ferreira, & Azevedo, 2016):

- *Subjective sleep quality*: "Ever since you can remember, how has your sleep quality been?" (scored 1, very good, to 5, very poor)
- *Sleep latency*: "How long does it take to you to fall asleep?" (scored 1, 1-14 minutes, to 5, ≥60 minutes)
- *Nocturnal awakenings*: "How many times do you wake up at night" (scored 1, 0 times, to 7, ≥6 times).

Sleep loss over worry

Sleep loss over worry was assessed with a single item (ie, "I lose sleep over worries" adapted from General Health Questionnaire-12) rated on a 4-point scale from 1, almost never, to 4, almost always. No specific time frame was specified. Higher scores denote greater worry-related sleep disturbance.

Ford Insomnia Response to Stress Test (FIRST)

The FIRST is a self-report scale designed to assess sleep-related "reactivity" (ie, the tendency to exhibit pronounced sleep disturbance in response to a stress challenge). Greater scores indicate higher vulnerability to stress-related sleep disturbance (Drake, Richardson, Roehrs, Scofield, & Roth, 2004). In the current study, the Portuguese version by Marques et al. was used, with a Cronbach´s alpha of 0.81.

Eysenck Personality Inventory (EPI)

The short version of the EPI (EPI-12) Eysenck & Eysenck, 1964 is a 12-item tool to assess neuroticism and extraversion dimensions. In the current study, the neuroticism (NE) scale with six items was used. Item 12 (ie, "I suffer from sleeplessness") was removed from computation of this dimension, as it might have constituted a confounding variable. For this study, the Portuguese version by Silva et al. was used, with a Cronbach´s alpha of 0.60.

Self-reported insomnia

Self-reported insomnia was assessed with item 12 from the EPI-12, which is scored from 1, almost never, to 4, almost always.

Profile of Mood States (POMS): negative and positive affect measures

The POMS (McNair, Lorr, & Droppleman, 1971) comprises 65 adjectives that describe feelings and emotions that people may experience. Each item is answered on a 5-point scale: 0, by no means, to 4, very much. The POMS comprises scales measuring six mood states: tension-anxiety, depression-rejection, fatigue-inertia, anger-hostility, vigor-activity, and friendliness. In the current study, participants made ratings over the previous month (not the previous week, as originally requested), as it wanted to evaluate affect more as a trait, rather than a transient mood state (McNair et al., 1971). The “Negative Affect” (NA) dimension was created by summing the scores from tension-anxiety, depression-rejection, and anger-hostility subscales; the “Positive Affect” dimension (PA) was derived by summing the scores on the vigor-activity and friendliness scales. Additionally, it used the fatigue-inertia subscale. For this study, the Portuguese version by Silva, Azevedo, Silva and Dias (1991) was used.

Procedure

This study was approved by the Ethics Committee and the Scientific Council of the Faculty of Medicine of the University of Coimbra. The professors were initially contacted in order to obtain authorization to administer the questionnaires to the students at the beginning/end of a class session (out of the evaluation period). The aims of the study were explained to the students, and it was emphasized that their cooperation was voluntary, and confidentiality was ensured. All participants agreed to collaborate in the study and all ethics requirements were met. The PSAS was translated from English into European Portuguese by a psychiatrist (MD/PhD) who has extensive experience in sleep medicine and on the translation of psychological assessment instruments. It was then back-translated into English by a bilingual translator without previous knowledge of the scale, and no significant discrepancies with the original version were found. Overall, the recommended guidelines on translation and adaptation of psychological instruments were followed (Hambleton, 2005).

Data analysis

To examine the factor structure of the PSAS, an exploratory factor analysis (maximum likelihood ratio) was used followed by a direct oblimin rotation. To examine internal consistency of the scale, Cronbach´s alphas were calculated. Pearson correlation coefficients were carried out to study the associations of the PSAS with concurrent measures. To compare groups, Student *t*-tests for independent samples were performed. To interpret correlation effect sizes, Pearson´s correlation coefficients were used: r=0.1 (small); r=0.3 (medium); r=0.5 (large). To study effect sizes pertaining to differences between groups, Cohen´s d was computed: d=0.2 (small); d=0.5 (medium); d=0.8 (large) (Cohen, 1988). All analyses were performed using IBM SPSS Statistics v.22.

Results

Descriptive statistics

The mean score for the total sample was 29.48 (7.73) for the total PSAS, and 19.24 (5.54) and 10.23 (3.28) for the cognitive and somatic subscales, respectively. For men, the mean score for the PSAS total was 28.80 (6.95), 18.74 (5.25) for the cognitive scale, and 10.05 (2.97) for somatic scale. For women, the score for the PSAS total was 29.48 (8.09), 19.50 (5.67) for cognitive scale, and 10.33 (3.43) for somatic scale.

Dimensionality of the PSAS

In order to explore the factor structure of the PSAS, an exploratory factor analysis (EFA) was performed. First, major relevant assumptions to conduct this technique were evaluated: 1) most of associations between items were $r>0.3$; 2) Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) was 0.881 (>0.60), and significant Bartlett´s test of sphericity ($\chi^2_{(120)}=3603.915$; $p<0.001$). Afterwards, EFA using maximum likelihood method was carried out followed by direct oblimin (Delta=0) rotation, since it was assumed that the hypothetical factors would be correlated (Field, 2013); loadings ≥0.35 were only considered. Three factors were extracted, accounting for 41.90% of the total variance. One factor overlapped with the traditional cognitive pre-sleep arousal dimension; the other two factors resulted from a division from the traditional somatic scale. Despite these findings, the extraction of only two factors were forced taking into account the original conceptualization underlying the PSAS and after the calculation of parallel analysis. The parallel analysis was run through a SPSS syntax file (O'Connor, 2000). The literature suggests that this is the more stringent method to extract factors (Horn, 1965). The results indicated that both factors explained approximately 37.74% of the total variance. The first factor comprised eight items (items 9-16) and was labeled "Cognitive Arousal"; the second factor comprised the remaining eight items (items 1-8) and was labeled "Somatic Arousal" (Table 1). The correlation between scales was 0.50.

Internal consistency

Cronbach's alpha for the total scale was $\alpha=0.85$, which is considered to be robust internal consistency. With regard to the subscales, the values were $\alpha=0.82$ and $\alpha=0.79$

for cognitive and somatic arousal, respectively (Table 1). All items were considered relevant for internal consistency of the subscales (Table 2).

Association of the PSAS with other measures

The PSAS scale and its subscales were found to be significantly correlated with sleep quality, sleep latency, nocturnal awakenings, sleep loss over worry, sleep reactivity to stress, neuroticism, positive affect, negative affect, and fatigue-inertia (Table 3). The only correlation that was not significant was between somatic arousal and positive affect. The majority of the correlations were moderate in magnitude (Cohen, 1988).

Differences between "insomnia" and "non-insomnia" groups

Based on responses to the insomnia item extracted from the EPI (ie, "I suffer from sleeplessness"), two groups were constituted: the "insomnia" group (*n*=71), which comprised participants who responded "quite often/almost always" to the item; and the "non-insomnia" group (*n*=587), which comprised participants who responded "almost never" or "quite seldom" to the item. Regarding the PSAS total score, the "insomnia" group (M=39.41; SD=8.86) scored substantially higher than the "non-insomnia" group (M=28.25; SD=6.57; $t_{79.582}=-10.268$; $p<0.001$; $d=1.62$). Pertaining to the cognitive arousal scale, the "insomnia" group scored higher (M=26.23; SD=5.74) than the "non-insomnia" group (M=18.38; SD=4.80; $t_{82.285}=-11.074$; $p<0.001$; $d=1.59$). With regard to somatic arousal scale, the "insomnia" group scored higher (M=13.16; SD=4.95) than the "non-insomnia" group (M=9.86; SD=2.86; $t_{75.731}=-5.497$; $p<0.001$; $d=1.04$).

Discussion

High levels of general arousal are a central feature of insomnia disorder (Riemann et al., 2010). The aim of the current study was to examine psychometric properties of a European Portuguese version of the PSAS (PSAS-PT), which is a well-known questionnaire designed to assess pre-sleep arousal.

Overall, the data confirmed that the PSAS-PT had very acceptable psychometric properties. Two possible factor solutions were suggested that could be examined in further research. First, it provided evidence that the classical structure constituted by cognitive arousal and physiological arousal factors is valid, and psychometrically adequate. Alternatively, a new solution emerged suggesting three plausible factors: "cognitive arousal" comprising the same eight items and the remaining two factors related to somatic arousal. That is, the difference is that the somatic arousal is divided in two factors. A similar finding was also observed in other studies (Azevedo et al., 2010; Gieselmann et al., 2012), but these three factor/component structures were ignored since the two-factor composition was shown to be more robust. It is worth noting that Kohn and Espie (2005) stated that there may be problems related to the somatic scale of the PSAS. It is possible that the somatic scale may be more suitable for assessing pre-sleep physiological arousal in patients with insomnia associated with mental disorder.

The Cronbach´s alpha (α=0.85) for the total score was similar to other studies (α=0.89, Azevedo et al., 2014; α=0.88, Nicassio et al., 1985; and α=0.89, Shahzadi and Ijaz, 2014). The current results concerning cognitive and somatic subscales (0.82 and 0.79, respectively) were in accordance with the ones observed by Jansson-Fröjmark and Norell-Clarke (2012); specifically, the cognitive arousal scale had greater internal consistency than the somatic scales (α=0.88 vs α=0.72). Interestingly, the correlation found in the current study between subscales (r=0.50) was identical to the original study by Nicassio et al. (1985) (r=0.51). Notwithstanding, the internal consistency findings in the current study were lower than the ones found by Azevedo et al. (2010) with an identical sample. It is important to note that the chosen method for establishing factor validity is crucial for the interpretation of the data. The PCA is a method which, by default, can explain more variance than other techniques such as maximum likelihood ratio or principle axis method. Unlike PCA, these are factor analysis techniques that consider only shared variance for analysis purposes (Field, 2013).

The correlations between the PSAS and other variables trended in the expected direction. That is, higher levels of arousal were associated with poorer sleep quality and more sleep latency, sleep awakenings, sleep loss over worries, sleep reactivity to stress, neuroticism, negative affect, and fatigue-inertia. In contrast, lower levels of arousal were associated with higher levels of positive affect. An interesting observation is that the correlations values were identical for both PSAS total score and PSAS-cognitive arousal. This seems to suggest that the PSAS is a more appropriate measure to address cognitive arousal than the somatic dimension.

As would be expected, the individuals who scored higher on the insomnia item from the EPI had arousal scores than those who scored lower on that item. In addition, it is important to note that the differences concerning both general arousal and subscales were large in magnitude (Cohen, 1988).

However, despite these promising and encouraging results, some limitations should be mentioned. First, the current sample comprised young undergraduate university students, thus, limiting the potential generalizability the findings to other populations. Second, important psychometric properties such as temporal stability were not examined. Third, a single item, rather than a comprehensive measure, was used to measure insomnia and comprise insomnia and non-insomnia groups.

Importantly, future research should conduct confirmatory factor analyses to test the goodness of fit of the two-factor and three-factor solutions, specifically. Moreover, perhaps new psychometrics (eg, item response theory (IRT)) may help in the refining of the PSAS, and even a shorter and more discriminative version than Jansson-Fröjmark and Norell-Clarke (2012) may be suggested.

As is the case with the PSAS, psychometric analyses of commonly used measures in sleep/insomnia research are lacking. Some examples are the Arousal Predisposition Scale (APS), the Dysfunctional Beliefs and Attitudes About Sleep (DBAS), the Glasgow Sleep Effort Scale (GSES), among others. Greater research attention should be devoted to this important issue.

In conclusion, the PSAS-PT presents strong psychometric properties, which reinforce its use in research and applied settings. Additional research in different ethnic and cultural groups will shed further light on its utility.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

References

Azevedo MH, Maia B, Marques M, Bos S, Nogueira V, Soares MJ, et al. Psychometric properties of the Portuguese version of the Pre-Sleep Arousal Scale. Journal of Sleep Research 2010;19(Suppl. 2):e157.

Azevedo MH, Silva C, Dias M. O “Perfil de Estados de Humor”: Adaptação à População Portuguesa. Psiquiatria Clínica 1991;12:187-93.

Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd Ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.

Drake C, Richardson G, Roehrs T, Scofield H, Roth T. Vulnerability to stress-related sleep disturbance and hyperarousal. Sleep 2004;27(2):285-91.

Espie C, Broomfield N, MacMahon K, Macphee L, Taylor L. The attention-intention-effort pathway in the development of psychophysiologic insomnia: a theoretical review. Sleep Medicine Reviews 2006;10(21):5-45. http://dx.doi.org/10.1016/j.smrv.2006.03.002

Eysenck HJ, Eysenck SG. Manual of the Eysenck Personality Inventory. London, UK: University of London Press; 1964.

Field A. Discovering Statistics using IBM SPSS Statistics. 4th ed. London: Sage Publications; 2013.

Gieselmann A, de Jong-Meyer R, Pietrowsky R. Kognitive und körperliche Erregung in der Phase vor dem Einschlafen: Die deutsche Version der Pre-Sleep-Arousal Scale (PSAS). Zeitschrift für Klinische Psychologie und Psychotherapie 2012;41:73-80. doi: 10.1026/1616-3443/a000134

Hambleton RK. Issues, designs, and technical guidelines for adapting tests into multiple languages and cultures. In: Hambleton RK, Merenda P, Spielberger C, editors. Adapting educational and psychological tests for crosscultural assessment. Mahwah, NJ: Lawrence Erlbaum; 2005, p. 3-38.

Horn, J. A rationale and test for the number of factors in factor analysis. Psychometrika 1965;30(2):179-85. doi:10.1007/BF02289447

Jansson-Fröjmark M, Norell-Clarke A. Psychometric properties of the Pre-Sleep Arousal Scale in a large community sample. Journal of Psychosomatic Research 2012;72(2):103-10. doi:10.1016/j.jpsychores.2011.10.005

Kohn L, Espie C. Sensitivity and specificity of measures of the insomnia experience: A comparative study of psychophysiologic insomnia, insomnia associated with mental disorder and good sleepers. Sleep 2005;28(1):104-12.

Marques D, Gomes A, Clemente V, Santos J, Castelo-Branco M. Hyperarousal and failure to inhibit wakefulness in primary insomnia: “Birds of a feather”? Sleep and Biological Rhythms 2015;13(3):219-28. doi:10.1111/sbr.12115

Marques D, Gomes A, Ferreira M, Azevedo MH. Don’t worry, Sleep well: Predictors of sleep loss over worry. Sleep and Biological Rhythms 2016;14(3):309-18. doi:10.1007/s41105-016-0060-z

Marques D, Gomes A, Drake C, Roth T, Azevedo MH. Assessing stress-induced sleep reactivity in college students: The European Portuguese version of the Ford Insomnia Response to Stress Test (FIRST). Behavioral Sleep Medicine 2016. doi:10.1080/15402002.2016.1210151

McNair DM, Lorr M, Droppleman LF. Edits Manual for the Profile of Mood States. San Diego: Educational and Industrial Testing Service; 1971.

Nicassio PM, Mendlowitz DR, Fussell JJ, Petras L. The phenomenology of the pre-sleep state: The development of the pre-sleep arousal scale. Behaviour Research Therapy 1985;23(3):263-71. doi:10.1016/0005-7967(85)90004-X

O’Connor BP. SPSS and SAS programs for determining the number of components using parallel analysis and velicer’s MAP test. Behavior Research Methods, Instruments, & Computers 2000;32(3):396-402. doi:10.3758/BF03200807

Ong J, Arnedt T, Gehrman P. Insomnia diagnosis, assessment, ad evaluation. In: Kryger M, Roth T, Dement W, editors. Principles and Practice of Sleep Medicine. 6th ed. Missouri: Elsevier Saunders; 2016, pp. 785-93.

Riemann D, Spiegelhalder K, Feige B, Voderholzer U, Berger M, Perlis M, et al. The hyperarousal model of insomnia: A review of the concept and its evidence. Sleep Medicine Reviews 2010;14(1):19-31. doi:10.1016/j.smrv.2009.04.002

Silva CF, Azevedo MH, Dias MR. Estudo Padronizado do Trabalho por Turnos. Versão Experimental. Instituto de Psicologia Médica da Faculdade de Medicina, Universidade de Coimbra; 1994.

Table 1. Factorial solution for the Pre-Sleep Arousal Scale-Portuguese version.

Items	**I**	**II**
15. Thoughts keep racing through your head	0.88	
14. Can't shut off your thoughts	0.84	
12. Worry about problems other than sleep	0.59	
16. Being distracted by sounds, noise in the environment (eg, ticking of the clock, house noises, traffic)	0.52	
13. Being mentally alert, active	0.52	
11. Depressing or anxious thoughts	0.46	
10. Review or ponder events of the day	0.38	
9. Worry about falling asleep	0.37	
4. A tight, tense feeling in your muscles		0.75
1. Heart racing, pounding, or beating irregularly		0.65
2. A jittery, nervous feeling in your body		0.61
3. Shortness of breath or labored breathing		0.61
7. Perspiration in the palms of your hands or other parts of your body		0.55
6. Have stomach upset (knot or nervous feeling, heartburn, nausea, etc)		0.49
8. Dry feeling in your mouth or throat		0.42
5. Cold feeling in your hands, feet or your body		0.39
Cronbach´s alpha	0.82	0.79
Eigenvalue	5.280	1.961
Variance explained (%)	21.19	8.54
Total variance explained (%)	37.74	

Note. Only factor loadings ≥0.35 were considered.
Extraction Method: Maximum Likelihood; Rotation: Direct Oblimin (Delta=0).
I = Cognitive Arousal; II = Somatic Arousal

Table 2. Corrected item-total correlations and Cronbach´s alpha if item was excluded.

	Corrected item-total correlation	Alpha if item excluded
Somatic Arousal scale		
1. Heart racing, pounding, or beating irregularly	0.596	0.758
2. A jittery, nervous feeling in your body	0.600	0.758
3. Shortness of breath or labored breathing	0.512	0.778
4. A tight, tense feeling in your muscles	0.623	0.758
5. Cold feeling in your hands, feet or your body	0.382	0.798
6. Have stomach upset (knot or nervous feeling, heartburn, nausea, etc)	0.473	0.779
7. Perspiration in the palms of your hands or other parts of your body	0.502	0.776
8. Dry feeling in your mouth or throat	0.448	0.783
Cognitive Arousal scale		
9. Worry about falling asleep	0.450	0.812
10. Review or ponder events of the day	0.467	0.809
11. Depressing or anxious thoughts	0.547	0.798
12. Worry about problems other than sleep	0.551	0.798
13. Being mentally alert, active	0.495	0.805
14. Can't shut off your thoughts	0.680	0.777
15. Thoughts keep racing through your head	0.697	0.776
16. Being distracted by sounds, noise in the environment (eg, ticking of the clock, house noises, traffic)	0.436	0.813

Table 3. Correlation matrix among the Pre-Sleep Arousal Scale scores and other measures.

	PSAS-total *r*	PSAS-cognitive *r*	PSAS-somatic *r*
Sleep quality	0.35**	0.33**	0.26**
Sleep latency	0.40**	0.44**	0.20**
Nocturnal awakenings	0.28**	0.27**	0.21**
Sleep loss over worry	0.51**	0.50**	0.35**
Sleep reactivity to stress (FIRST)	0.48**	0.48**	0.33**
Arousability (APS)	0.45**	0.40**	0.38**
Neuroticism (EPI)	0.39**	0.38**	0.26**
Positive affect (POMS)	–0.10*	–0.10*	–0.07
Negative affect (POMS)	0.41**	0.40**	0.29**
Fatigue-inertia (POMS)	0.29**	0.28**	0.20**

FIRST, Ford Insomnia Response to stress Test; APS, Arousal Predisposition Scale; EPI, Eysenck Personality Inventory; POMS, Profile of Mood States; PSAS, Pre-Sleep Arousal Scale

* $p<0.01$
** $p<0.001$

Highlights:

- The Pre-Sleep Arousal Scale (PSAS) is one of the most commonly used scales in sleep medicine.
- Evidence on psychometric properties of the PSAS is lacking.
- A Portuguese version of the PSAS showed adequate reliability and validity.