GRACE WINDSOR BSc Hons

AN INVESTIGATION INTO PRE-SLEEP COGNITIVE AROUSAL

Section A: What are the psychometric properties of the Pre-sleep Arousal Scale (PSAS)? A narrative review based on a systemic literature search.

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Section B: A quantitative study on sleep quality and nocturnal cognitive arousal during pregnancy: Exploring relationships with self-compassion and mindfulness

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Summary of MRP Portfolio

Section A is a narrative review based on a systematic literature search aimed to summarise and critically evaluate the quality of the Pre-Sleep Arousal Scale. The review evaluated ten studies that assessed the psychometric properties of this scale against specific criteria. The Pre-Sleep Arousal Scale was found to have promising psychometric properties, with the most robust evidence for content validity and internal consistency. Some psychometric weakness was found for factor structure, test-retest reliability, interpretability, criterion, and construct validity, which was often due to methodological flaws in the study.

Section B is an empirical investigation of nocturnal cognitive arousal as a mediator between self-compassion and sleep quality, and mindfulness and sleep quality, in a pregnant sample. Nocturnal cognitive arousal describes having an active mind before sleep, measured by the Cognitive factor of the Pre-Sleep Arousal Scale. This was found to mediate the relationship between self-compassion and sleep quality, and this mediation remained significant when mindfulness was controlled for. No relationship between mindfulness and sleep quality was found in this sample. Although nocturnal cognitive arousal was found to mediate the association between mindfulness and sleep quality; this mediation did not stay significant when self-compassion was controlled for.

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Section A

What are the psychometric properties of the Pre-sleep Arousal Scale (PSAS)? A narrative review based on a systemic literature search

Word count: 7979 (201)

Abstract

Hyperarousal is one component that has been theorized to have an important role in insomnia models, though it is a broad concept, and is challenging to measure. There is a need for reliable and valid measures of hyperarousal in insomnia models to develop the knowledge base and for clinicians to be able to measure this construct. One widely used measure that measures cognitive and somatic arousal during the pre-sleep period is the Pre-Sleep Arousal Scale. The current review aimed to identify, summarise and critically evaluate the quality of this Scale. The review identified ten relevant studies that assessed the psychometric properties of this scale and evaluated them against measurement criteria recommended by Terwee et al., (2007). The most robust evidence for the PSAS was found for content validity and internal consistency. Some psychometric weakness was found for factor structure, test-retest reliability, interpretability, criterion, and construct validity, which was often due to methodological flaws in studies. The Pre-Sleep Arousal Scale was found to have promising psychometric properties, however, further research by validation studies of higher quality is required to establish these psychometric properties with greater confidence, to increase the applicability of the PSAS in research and clinical settings.

Keywords: Pre-sleep arousal scale, Psychometric properties, Insomnia, cognitive arousal, somatic arousal

What are the psychometric properties of the Pre-sleep Arousal Scale (PSAS)? A narrative review based on a systemic literature search

Often unrecognised and underreported by clinicians, insufficient sleep is considered a global public health epidemic (Chattu et al., 2018). There are over 80 sleep disorders, the most common of which is insomnia (Mai & Buysee, 2008). Several elements are known to drive insomnia, one of which is key is hyperarousal (Riemann et al., 2010). This review will present insomnia and its aetiology before discussing the importance of hyperarousal and, ultimately, the importance of good measurement of hyperarousal.

Definition of Insomnia

Insomnia is the most prevalent sleep disorder (Mai & Buysee, 2008). According to the Diagnostic and Statistical Manual of Mental Disorders, 5th edition, revised text (DSM-5-RT), insomnia is formally diagnosed by specifying one of three symptoms: (1) difficulty falling asleep (onset insomnia); (2) an inability to maintain sleep with frequent awakenings (middle insomnia); and (3) early morning wakefulness, often with an inability to return to sleep (late insomnia). These difficulties must negatively affect social, occupational, or other important life areas and impair daily functioning. They must be present for at least three nights per week for three months, at the minimum. In addition, the individual must be unable to sleep even with ample opportunity, and another sleep disorder, mental health condition or substance usage must not otherwise explain the experience. In general, insomnia occurs in two forms: short-term and chronic insomnia. Short-term or otherwise known as episodic insomnia, lasts between one and three months. Whilst chronic insomnia can be broken down into persistent (lasting for three months or more) and recurrent (two or more

episodes in a year) (American Psychiatric Association, 2013). The prevalence of adults who encounter at least one insomnia "symptom" is estimated to be approximately 30%, found in a range of study populations globally (Roth, 2007). The prevalence of people with insomnia diagnosis in the USA and Europe populations is understood to be 6% -10% (Morin & Jarrin, 2013).

Insomnia has been found to be related to increased levels of emotional dysregulation (Galbiati et al., 2020) and can impact social, educational, and occupational functioning (Frotier-Brochu et al., 2012). Insomnia frequency has repeatedly been shown to have a close relationship with levels of depression and anxiety, even when other explanations were rigorously controlled for (Taylor et al., 2005). As well as empirical evidence for its association with preexisting depression, anxiety, and pain, insomnia has also been shown to be a risk factor for subsequent depression, anxiety, and pain (Morphy et al., 2007). Furthermore, chronic insomnia has been suggested to be an independent risk factor for and involves a complex bidirectional relationship with otherwise healthy individuals developing psychiatric disorders (Krystal, 2006). In addition to its psychological consequences, the number of hours of sleep, combined with data on six other health practices, was found to significantly predict later health and mortality (Belloc, 1973).

Insomnia is common, often persistent, and is intertwined with physical health problems and psychological distress (Morphy et al., 2007). Thus, understanding its aetiology is key to its treatment and the prevention of associated risks, which will be discussed in the next section.

Aetiology of insomnia

A major conceptual framework in sleep research is the two-process model, which discusses part of what drives insomnia. This model posits that sleep is regulated by

two processes: Process C (Circadian rhythm) and Process S (sleep homeostasis) (Borbely, 1982); see Figure 1. Process C refers to an internalised 24-hour circadian pacemaker, guided by the transition from day to night, that repeats every day, and is distinct from a sense of sleepiness, due to how long one has been awake. Process S, unlike process C, does not restart every 24 hours on its own and is a sleep-wake-dependent homeostatic process. It refers to the sleep drive, which builds up whilst one is awake, due to the increase in adenosine (a neurotransmitter which promotes the sleep drive) and once sleep has commenced the sleep drive dissipates, as sleep causes adenosine to fall rapidly. These two processes occur at the same time and interact with each other. They can either work together, which promotes good quality sleep, or against one another, which can lead to sleep disorders, such as insomnia. Insomnia may occur when these two processes are out of sync. Many insomnia treatments, (e.g., Cognitive Behavioural Therapy for Insomnia) are underpinned by this two-process model (Morin et al., 2003).

Figure 1.

Diagram of the Two-process model of sleep regulation

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Although the literature acknowledges that homeostatic and circadian processes are important in driving insomnia; hyperarousal, such as overactive psychological and neurobiological systems, is now recognised to play a huge role in both the maintenance and treatment of insomnia (Kalmbach et al., 2018). There are now many models that discuss the importance of hyperarousal as a third factor in the aetiology of insomnia (Riemann et al., 2010).

Hyperarousal

One widely accepted hypothesis in insomnia literature suggests that hyperarousal is a maintaining factor (Espie, 2007). Furthermore, insomnia literature often divides hyperarousal into cognitive or somatic/physiologic arousal, which is thought to be closely related to the vulnerability and maintenance of insomnia (Harvey, 2002; Riemann et al., 2010).

Hyperarousal models of insomnia have been proposed since the proliferation of theoretical perspectives of insomnia. Morin's model (1993) proposed that insomnia occurs and is maintained by a combination of predisposing, precipitating, and perpetuating factors. It discusses the vicious cycle of cognitive and behavioural arousal and the role of sleep-related worry in reducing the ability to sleep. Harvey's Cognitive Model (2002) draws on psychological theories (Borkovec, 1979; Morin, 1993) and states that individuals with insomnia experience uncontrollable and excessive worry and intrusive thoughts during the pre-sleep period. This model discusses how insomnia may be maintained by cognitive arousal and excessive worry about sleep. Alternatively, Espie's model of insomnia (2002) emphasizes the inability to de-arouse and states that cognitive processes are triggered in the face of wakefulness, which amplifies and sustain wakefulness. Espie's model highlights the role of conditioned arousal, in which associations are made between the bed and a

state of hyperarousal because of previous experiences of being unable to sleep, which can perpetuate insomnia.

Hyperarousal is a broad concept, and the scientific study surrounding it is expansive, making it a challenge to define and measure (Kalmbach et al., 2018). Given the significant role arousal plays, developing and psychometrically validating measures which assess it is a key area of research and clinical practice in treating insomnia. Clinicians need to be able to measure this concept to work with it. The following section will discuss one way hyperarousal has been partitioned and measured.

Definition of Pre-sleep arousal

Pre-sleep arousal is one hyperarousal element that seems crucial in understanding insomnia and would be helpful to know more about. The hyper-aroused state during the pre-sleep period is thought to disrupt the onset and maintenance of sleep (Riemann et al., 2010). This pre-sleep arousal suspends the sleep system by activating the central nervous system (Bonnet & Arand, 2010). It refers to a state-dependent level of cognitive arousal symptoms (active/racing mind before bedtime, worries, rumination) and somatic arousal symptoms (physical symptoms such as bodily tension and high heart rate).

Importance of good measurement

Good measurement ensures that results obtained from psychometric measures are trustworthy, meaningful, and useful for both research and clinical practice (Gadermann et al., 2012). Further to what has been discussed, it is necessary to measure constructs pertaining to what variables contribute to and maintain insomnia; to work towards a better understanding and prevention of its negative consequences (Buysse et al., 2006). Also, it is necessary to have adequate instruments that can be

used in both research and clinical settings across different cultural contexts (World Health Organization, 2018). The use of the PSAS in insomnia research has been encouraged by an expert panel making recommendations for standard research assessments of insomnia to address specific research questions, for example, measuring changes in arousal after interventions (Buysse et al., 2006). In addition to these recommendations, the expert panel stated that measurement strategies based on different theoretical models, such as hyperarousal, were a pressing need. They called for future research to focus on the development, reliability, and validity of measures to enable comparison between studies, grow the knowledge of insomnia, and help test hypotheses regarding its aetiology**.** Given the high priority to having good hyperarousal measures and the compelling theory underpinning pre-sleep arousal as a potential component in disrupting sleep onset and maintenance (Riemann et al., 2010), it is vital to have a good, standardized assessment of it.

Pre-sleep arousal scale

The first questionnaire to be developed that measured both cognitive and somatic manifestations of arousal before sleep, is the Pre-sleep arousal scale (PSAS) (Nicassio et al., 1985). The PSAS was developed as a measure of state-dependent cognitive and somatic arousal that happens during the period before sleep, that can impact on an individual's ability to initiate or maintain sleep (Nicassio et al., 1985). It is a subjective self-report tool with 16 items, divided into two subscales: the cognitive (8 items) and somatic subscale (8 items). The PSAS has been used in a variety of clinical and cultural populations and is now one of the most widely used subjective arousal measures in clinical practice and insomnia research (Lemyre et al., 2020).

Literature exploring pre-sleep arousal

Recent systematic reviews of pre-sleep arousal have explicitly focused on the nature of *cognitive* pre-sleep activity in adults and measures which assess it (Lemyre et al., 2020), cognitive processes related to insomnia, and psychometric properties of measures which assess it (Hiller et al., 2015). However, both reviews gave more of an overview of the psychometric properties, did not examine against specific criteria, and called for future research to validate measures of somatic arousal. Hiller et al. (2015) review also called for research to provide the clinical cut-offs of measures, to increase their clinical utility, and to explore whether clinical cut-offs could differentiate factors that maintain insomnia.

Another recent systematic review of instruments measuring insomnia identified, summarised and quality-assessed the psychometric properties of instruments against specific criteria. However, instruments assessing arousal before sleep, such as the Pre-Sleep Arousal Scale, were excluded (Ali et al., 2020). Ali et al. (2020) discussed the increasing acknowledgement of the cultural effects on insomnia and sleep behaviours in sleep research and state that comparing psychometric properties of insomnia-related instruments across different populations could be an area for future investigation.

Instruments assessing insomnia have recently been reviewed and quality assessed against psychometric criteria, yet they did not include the PSAS. Likewise, other recent reviews have provided an overview of psychometric properties of measures assessing *cognitive* pre-sleep activity but did not assess against specific criteria. Therefore, understanding the quality of the PSAS is an area for future review.

Aim of the current review

There is a pressing need for reliable and valid measures of hyperarousal in insomnia models to develop the knowledge base and effective interventions for individuals experiencing sleep difficulties. There have been reviews written about pre-sleep cognitive arousal in adults (Hiller et al., 2015; Lemyre et al., 2020) and psychometric properties of tools measuring insomnia "symptoms" (Ali et al., 2020). However, though the PSAS is used widely in the literature, to the authors' knowledge, a review has yet to examine its quality critically. Therefore, this review aimed to search the literature to identify and critically evaluate the psychometric properties of the PSAS using a quality appraisal tool as guidance.

Method

Eligibility Criteria

This review identified studies that assessed measurement properties of the PSAS. No restrictions were placed on the PSAS language version. Table 1 describes the inclusion and exclusion criteria.

Table 1.

Inclusion and exclusion criteria

Inclusion	Exclusion
The study dealt with the PSAS concept, and/or used some of the different versions of the PSAS questionnaire.	Studies that used the PSAS as an outcome variable or to evaluate intervention efficacy without assessing measurement properties.
At least one of the primary aims of the study was to assess the measurement properties of the PSAS.	Studies in which the PSAS was used in a validation study to validate another instrument.
Unpublished reports and pre-prints that had enough information available to allow for quality ratings.	Unpublished reports and pre-prints that did not have sufficient information for quality ratings.
Studies that developed the PSAS or had reported at least one measurement property as defined by Terwee et al. (2007) was (e.g., validity, reliability, interpretability) or to test the psychometric	Other reviews.

properties of the PSAS in a different culture.

Studies had to be written and available in English.

Literature Search process

Electronic literature searches were performed on 21st of December 2022, on the PychInfo, Pubmed, ASSIA, Web of science, EMBASE and Medline databases for records with the following search terms in their title or abstract; (*"Pre-sleep arousal scale"* OR *PSAS-C* OR *PSAS-S OR "Pre-sleep*"*) AND (*Insomnia* OR *"Sleep disturbance"* OR *"falling asleep"* OR *"sleep*"* OR *"cognitive arousal"* OR *"somatic arousal"* OR *"physical arousal"* OR *hyperarousal* OR *arousal* OR *"sleep problems"*)AND (*"Questionnaire*"* OR *"scale*"* OR *"measure*"* OR *"instrument*"* OR *"assessment tool"* OR *"psychomet*"* OR *"develop*"* OR *"valid*"* OR *"reliab*"* OR *self-report* OR *outcome* OR *"clinical significance"* OR *cut-offs* OR *interpretability*). Previous reviews were looked at to determine some of the search terms that were suitable for the current review. The searches included no time frame, to maximise the scope of the search. A review of unpublished reports and pre-prints was performed, including Google Scholar, which discovered further literature that was also included in the review. Lastly, forward, and backward citation searches were also conducted as recommended by Lefebvre et al. (2008) to find any further relevant studies.

Quality assessment

Translation

Studies that translated the PSAS were assessed against translation process guidelines as recommended by the WHO (2018), which can be seen in Table 2.

Table 2.

WHO guidelines for translation and adaptations of instruments

Step	Description of each step
1. Forward translation	The translator should preferably be a health care professional, equipped with interview skills. They should aim to translate the conceptual equivalent of the text, rather than a literal translation.
2. Expert panel	A bilingual expert panel should review the translated questionnaire for discrepancies between the original questionnaire and the forward translated questionnaire.
3. Back translation	An independent translator should repeat Step one, by translating the questionnaire back to its original language.
4. Pre-testing and cognitive interviewing	At least 10 respondents that represent the target population should be asked about their views on the wording of the questionnaire.
5. Final version	The final version of the questionnaire should result from the above stages being completed.
6. Documentation	An outline of the above stages should be documented in appropriate documents.

Steps 5 and 6 were removed from the quality appraisal and were not reported on, as they did not appear to be relevant to the process followed in the literature.

Measurement Properties

The psychometric properties were rated for quality using Strauss et al.'s (2016) quality criteria, which were adapted from Terwee et al.'s (2007) criteria. Terwee et al. (2007) outline quality criteria for the design, methods, and outcomes of studies on developing and evaluating health status measures. They recommend for these criteria to be used in systematic reviews to compare measurement properties of questionnaires measuring a construct and to detect shortcomings or gaps in understanding measurement properties. Terwee et al.'s (2007) criteria do not specify how to rate factor structure, the strength of correlations for construct validity, and do not include

Pearson's *r* as a measure for test-retest reliability. Strauss et al. (2016) adapted Terwee et al.'s (2007) criteria to include this information. The current review adapted the criteria further by drawing on relevant literature to specify how to rate criterion validity and content validity in relevant translation studies. How each study performed against these criteria were rated.

Following Strauss et al.'s (2016) approach, a score of two was given if a criterion was fully met, a score of one when it was partially met, and zero if it was not met. In keeping with similar reviews of insomnia related instruments (Ali et al., 2020), a criterion was not rated if a study did not discuss content in relation to an individual psychometric property or there was no evidence reported. An overall rating for each measurement property of the measure was decided on based on a modular approach, after each study was assessed against the criteria. If conflicting information was found by multiple authors for an individual psychometric property, then the overall score was based on most scores and then downgraded for the inconsistency of findings (Mokkink et al., 2018, p. 30-32). The quality criteria used to rate measurement properties are detailed in Table 3. Terwee et al.'s (2007) criteria for responsiveness were not included as these criteria were not assessed by the included studies.

Table 3.

Quality criteria for measurement properties of health status questionnaires

Property	Definition	Quality criteria [a]
1. Content validity	Evaluates the extent to which the items in the questionnaire comprehensively represent the concepts the questionnaire aims to measure.	As per Terwee et al.'s (2007) criteria. Studies in which a translation of the PSAS was described, were rated if a pilot study was performed after translation, recommended by Prinsen et al., (2018, p. 20). **2:** The measurement aim, target population, concepts being measured, and item selection were clearly described AND items were generated by discussion/consultation with experts and members of the target population. **1:** There was a lack of clear description of the above-mentioned elements OR only the target population was involved OR any other methodological weakness; **0:** There was no target population involved.
2. Factor structure	Assesses if the factor structure of the questionnaire has been examined and supported.	As per Stauss et al. (2016) criteria. **2:** EFA was performed, followed by CFA, in independent samples, and the factor analysis supported the suggested factor structure. Alternatively, CFA was carried out if a factor structure was already suggested theoretically AND if the factor analysis supported the suggested factor structure; **1:** Only EFA was conducted, AND the suggested factor structure was supported; **0:** Confirmatory factor analysis (CFA) or exploratory factor analysis (EFA) was conducted, and they did not support the suggested factor structure;
3. Internal consistency	Measures whether items in a (sub) scale are inter-correlated and, as a consequence, measure the same construct.	As recommended by Terwee et al.'s (2007) criteria. **2:** Factor analysis was performed on a sample size considered to be adequate. An adequate *sample size* was the number of items multiplied by seven and greater than 100 AND Cronbach's alpha for each factor had to be between 0.70 and 0.95; **1:** Factor analysis was not performed but 75% of Cronbach's alphas were in the acceptable range, between 0.70 and 0.95;

			0: No factor analysis was performed, and most of the Cronbach's alphas were not in the acceptable range;
4.	Test-retest reliability	The extent to which scores are consistent across different performances.	As per Terwee et al.'s (2007) criteria, and like Strauss et al. (2016), criteria were adapted to incorporate Barker at al., (2002) 'rules of thumb' as Terwee et al. (2007) did not consider Pearson *r* as a measure of reliability. **2:** ICC OR weighted kappa ≥ 0.70; **1:** ICC OR weighted kappa <.70 OR *r* ≥ 0.70; **0:** r < 0.70.
5.	Criterion validity	The extent to which scores on the questionnaire relate to a gold standard, or to which scores on the questionnaire can predict future outcomes of interest.	The criteria suggested by Terwee et al. (2007) did not encompass AUC (Area under the Curve) and ROC (Receiver Operating Characteristic) as measures of criterion validity. The AUC and ROC measure ability of a questionnaire to classify individuals with or without a condition. Therefore, widely used criteria by Hanley and McNeil (1982) were drawn on to aid rating. **2:** AUC > 0.8 demonstrates good predictive value; **1:** AUC > 0.7 demonstrates acceptable predictive value; **0:** AUC between 0.5 and 0.70 demonstrates poor predictive value ability.
6.	Construct validity	The degree to which scores on one instrument relate to scores on other measures, based on the theoretically derived hypothesis, concerning the concepts being measured.	Terwee et al.'s (2007) criteria were used to rate construct validity; however, they do not consider strength of correlations. Therefore, Barker et al.'s (2002) 'rules of thumb' were used to factor this in. **2:** Specific hypotheses outlined AND at least 75% of results supported these hypotheses AND two or more correlations of *r* ≥ .50 to support convergent validity; **1:** Specific hypothesis outlined AND less than 75% of results were as expected AND/OR less than two correlations of *r* ≥ .50 to support convergent validity OR any other methodological weakness; **0:** No specific hypotheses outlined, even when two correlations were at least *r* ≥.50. Strength of correlations were described in the text based on Cohen's (1988) benchmarks for effect sizes. *r* = .1-.3 were regarded small *r* = .3-.5 were regarded medium

		r = over .5 were regarded large
7. Interpreta-bility	The extent to which qualitative meaning can be attached to quantitative scores, or what differences in scores on a measure can be interpreted as.	These criteria were in line with Terwee et al.'s (2007) criteria, how differences in scale scores should be interpreted. **2:** A score of two was given where means and standard deviations (SD) scores of at least four relevant subgroups were given AND if there was an indication of how the differences in scale scores should be interpreted; **1:** Means and SD scores of less than four relevant subgroups were given and there was an indication of how the differences in scale scores should be interpreted; **0:** Doubtful design and method.
8. Floor and ceiling effects	The portion of respondents who scored the highest or lowest score possible	In line with Terwee et al., (2007) criteria: **2:** ≤ 15% of respondents scored the highest or lowest score possible. **1:** >15% of respondents scored the highest or lowest score possible. **0:** Doubtful design or method

Note. EFA = exploratory factor analysis; CFA= confirmatory factor analysis; ICC = Intraclass correlation; ROC = receiver operating characteristic; AUC = Area under the ROC Curve; [a] 2 = Criterion fully met 1 = Criterion partially met 0 = Criterion not met.

Review Structure

Initially, for the studies in which the PSAS was translated from English, an appraisal of the translation process was conducted. Then the quality of the measurement properties of the PSAS was assessed and reported. A narrative synthesis approach was used (Popay et al., 2006) to synthesise the findings informed by the quality assessment and was organised by each psychometric property across studies.

Results

Selected studies

From journal databases, 452 records were identified. The records were then reviewed in line with the Preferred Reporting Items for Systematic-reviews and Meta Analysis (PRISMA; Page et al., 2021), which can be viewed in Figure 2. Firstly, duplicates were removed. The inclusion and exclusion criteria were used to screen and remove records by titles and then abstracts, before full papers were screened. Further searches on Google Scholar and citating searching via forward and backward searching identified five more papers, three of which met the inclusion criteria. See Figure 2 for details of the systematic literature search, including the number of records that were excluded at each stage. This resulted in a total of ten papers being included in the review (see Table 4).

Figure 2.

PRISMA 2020 Flow diagram displaying the search results and screening process

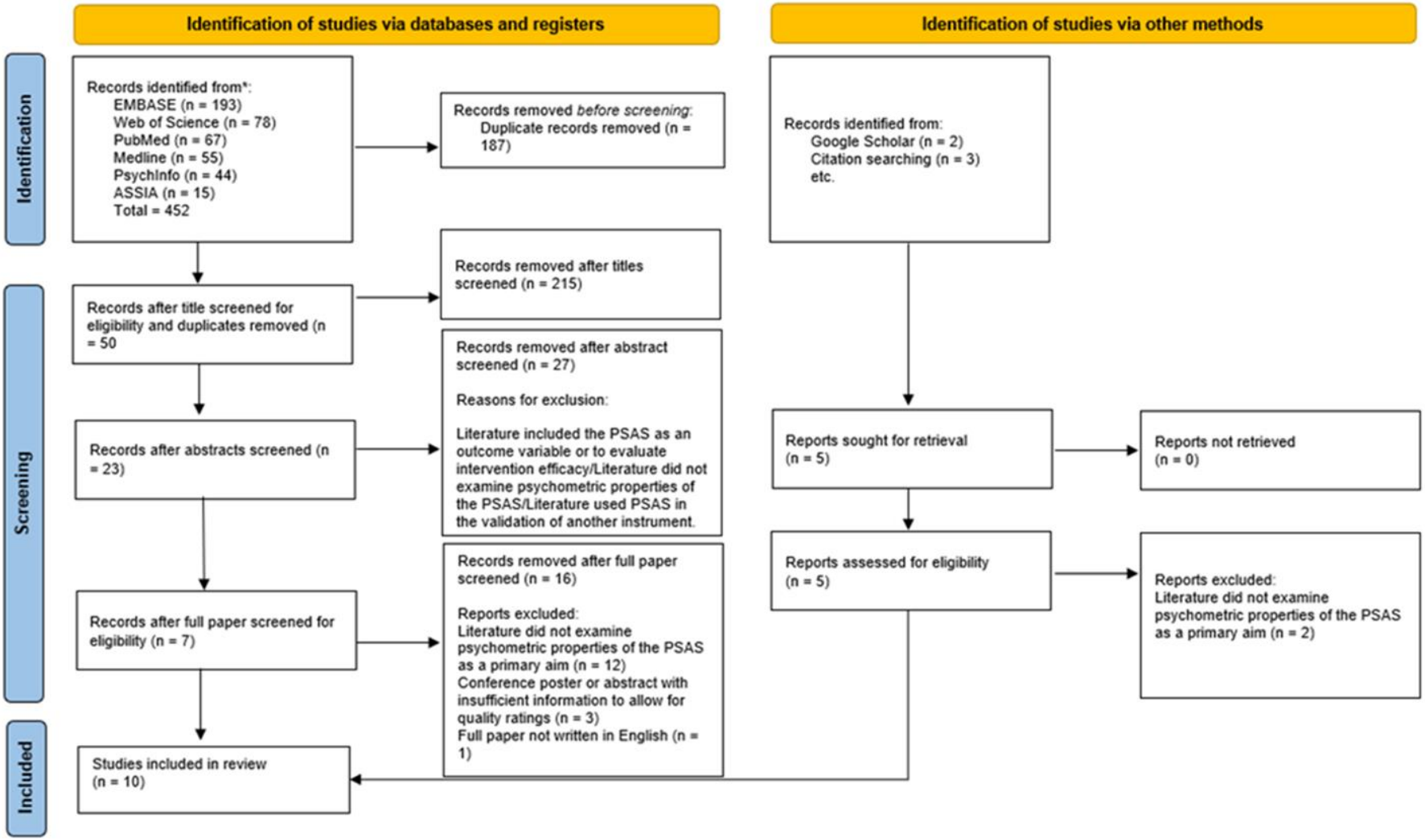

Table 4.

Overview of literature included in the Current Review

Measure acronym	Author(s) (Year)	Country	Aims	Design	Sample
PSAS	Nicassio, Mendlowitz, Fussell & Petras (1985)	USA	To develop a subjective instrument to describe individuals state of arousal as they fall asleep. And to assess this instrument's psychometric properties.	Study 1: Cross-sectional Study 2: 31 college students monitored their sleep behaviour as well as pre-sleep arousal over 10 consecutive nights. Participants divided into groups based on answers to several self-report sleep variables.	Total of 207 from three samples: One sample consisted of 147 college students (*M* = 19.33, 42.2.% female), another 30 adults with insomnia (*M* = 39.27, 46.6% female), and lastly, 30 adult normal sleepers *(M* = 35.27, 56.6% female). Ethnicity was not reported.
Swedish PSAS-13 PSAS-14	Jansson-Fröjmark, Norell-Clarke (2012)	Sweden	To examine the psychometric properties of the Pre-Sleep Arousal Scale, and answer psychometric questions regarding the internal consistency, discriminant and convergent validity as well as the scales association with sleep parameters and daytime impairment.	Cross-sectional Three sleep groups; insomnia disorder, poor sleep and normal sleep. Based on insomnia diagnostic criteria (Edinger et al., 2004).	A randomly selected sample of the general population (54.9% female; *M* = 47.1 years). 1890 participants who did not fulfil criteria for a sleep disorder other than insomnia. Representative of Swedish population on several demographic characteristics and 92.1% of participants were born in Sweden.
Urdu PSAS	Shahzadi & Ijaz (2014)	Pakistan	To translate the PSAS into Urdu and to establish psychometric properties of the scale.	Translation and validation study	600 undergraduate students in Pakistan (*M* = not reported, 58.6% female). Ethnicity not reported.
PSAS-PT	Marques, Gomes,	Portugal	Aimed to examine some of	Translation and validation study.	691 undergraduate students from medical

	Nicassio, Pinto de Azevedo (2018)		the psychometric properties of the European Portuguese version of the scale, in a large sample of young adults.	Cross-sectional. Participants were divided into an insomnia group and a non-insomnia group based on their response to an insomnia item from EPI regarding sleeplessness (Eysenck & Eysenck, 1964).	school in Portugal (*M* = not reported, 65.1% female). Ethnicity was not reported.
PSAS	Puzino, Amatrudo, Sullivan, Vgontzas & Fernandez-Mendoza (2020)	USA	To better understand the clinical utility of the PSAS – somatic subscale in a clinical sample.	Cross-sectional	248 patients with a diagnosis of chronic insomnia disorder, in the absence of any other sleep disorder, in the USA (*M* = 45; 65.3% female). Information on ethnicity, BMI, medical, psychiatric and sleep disorders was provided.
PSAS	Puzino, Frye, LaGrotte, Vgontzas & Fernandez-Mendoza (2019)	Spain	To better understand the clinical utility of the PSAS – somatic subscale.	Cross-sectional Level of sleep disturbance dependent on ISI score. 39% reported subthreshold insomnia, and 8% clinically significant insomnia.	196 young adults (mean age = 20.17 ± 1.00 years; 75% female). 196 young adults (*M* = 20.2, 75% females). Education and BMI (Body Mass Index) were reported, but not ethnicity.
PSAS	Vochem, Strobel, Maier, Spiegelhalder, Hertenstein, Riemann & Feige (2019)	Germany	To evaluate possible predictors of and determine cut-off scores for the PSAS and TMB-10.	Cross-sectional Good sleepers were determined by participants self-reports to be good sleepers, Insomnia determined according to ICD-10, and <7 on the PSQI, and <13 on BDI-II.	304 German participants. 208 were in a 'good sleepers' group' (*M* = 35, 67.3% female), and 96 in a non-organic insomnia group (*M* = 46.3, 57.29% female). No further demographic information was provided.
PSAS-J	Okajima, Ishii, Ochi & Nicassio (2020)	Japan	To develop a well-validated Japanese version of the PSAS.	Translation and validation study Participants were divided into two groups: those with insomnia and normal sleepers. Inclusion in the insomnia group was based on self-reported sleep disturbance that had	237 randomly selected individuals stratified by age and sex *(M* = 43.21, 51% female). Individuals receiving treatment for a mental, physical or sleep disorder were excluded. Ethnicity wat reported.

				been present for at least three months, at least three times per week.	
PSAS	Kalmbach, Cheng, Roth, Roth, Swanson, O'Brien, Fresco, Harb, Cuamatzi-Castelan, Reffi & Drake (2022)	USA	To determine clinically relevant cut-offs on the PSAS.	Cross-sectional analysis 19% had self-reported insomnia and 80% reported no insomnia, based on the DSM-5 insomnia disorder classification	99 pregnant women in their study (M = 29.8). Mainly non-Hispanic White (47.5%) or non-Hispanic Black (40.4%). Further information was provided on socioeconomic and perinatal information.
Turkish PSAS	Türkarslan, Çınarbaş & Nicassio (2022)	Turkey	To translate the PSAS to Turkish and to investigate its psychometric properties.	Translation and validation study Sleep disturbance was categorised based on scores of the ISI.	651 Participants recruited via social media and internet (65.28% female; mean age 26.9 ± 11.9 years) 651 participants in Turkey (*M* = 26.9, 65.28% female). Information on education, employment, marital status and socioeconomic status was provided.

Note. USA = United States of America; EPI = Eysenck Personality Inventory; ISI = Insomnia Severity Index; ICD-10 = International Classification of Diseases, Tenth Revision; PSQI = Pittsburgh Sleep Quality Index; BDI-II = Beck Depression Inventory, Second Edition; DSM-5 = Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition.

Translation of PSAS from English

Five studies translated the PSAS from English into a different language. Table 5 details the translations process of each of those studies against the WHO criteria. One paper (Shahzadi & Ijaz, 2014) reported nearly as thorough a process as the WHO recommends. Although an independent translator did not back-translate the measure and specific detail about the piloting procedure was not reported, they did refer to all four steps as recommended by WHO, and therefore appear to have conducted a relatively robust translation process. Türkarslan et al., (2022) also reported on all four steps recommended by WHO. Whilst they did not report whether a conceptual rather than literal equivalent of the text was translated, translators were not health care professionals. Also, whether the back translation process was conducted by an independent translator was not stated, yet they did report a pilot study and double-translation and reconciliation procedure, suggesting an adequate translation process. Both Marquez (2018) and Okajima (2020) did not report whether a piloting procedure was conducted, or whether the translation involved conceptual rather than literal equivalent of the text, however, they did report on three steps recommended by WHO, suggesting a satisfactory translation process. Jansson-Fröjmark (2012) only referenced two steps in the translation process recommended by WHO. They did not report key information such as the professions or the roles of the translators and did not report a pre-testing procedure with individuals from the target population.

Review of psychometric properties and their Evaluation

Quality ratings for the studies included in this review can be seen in Table 6. Further details about the psychometric properties are reported in Tables 7 and 8. The quality ratings for each psychometric property will be discussed further below.

Table 5.

Stages of translation of the PSAS

Study Author	Forward translation	Expert panel	Back translation	Pre-testing and cognitive interviewing
Jansson-Fröjmark (2012)	Reported that the measure was translated to Swedish by two bilingual translators, though their role in the research and profession was not reported. Did not report if this was a conceptual or literal translation.	Two bilingual translators were involved in the forward and back-translation of the measure, however no mention of whether they were compared for discrepancies. Their role in the research and profession was not reported.	The measure was back-translated by a bilingual translator but there was no mention whether this person was independent.	Feedback from representatives of the target population was not reported.
Shahzadi (2014)	The translators were five experts from the clinical psychology unit and English departments of Government College University. They were consulted for translation and adaptation of the measure. Then a discussion between two clinical psychologists, researcher and research supervisor, focused on conceptual equivalence of each item.	The forward translation was the focus of a group discussion with two clinical psychologists, the researcher and research supervisor, which resulted in a selection of the translation which reflected the true meaning of items.	The same five bilingual experts back translated the measure into English. Therefore, they were not independent.	The translated measure was piloted on 20 student representatives of the target population. Students completed the English version, and then the Urdu version of the measure one week later. It was noted that students did not find any difficulty in rating the items, but it was not reported how this was assessed. The correlation between the English and Urdu version was noted to be between 0.48 and 0.78.
Marquez (2018)	A psychiatrist (MD/PhD) with substantial experience in sleep medicine and the translation of psychological assessment instruments, translated the	No significant discrepancies with the original version were found.	An independent bilingual translator without previous knowledge of the scale, back-translated the measure into English.	Feedback from representatives of the target population was not reported.

	PSAS from English to European Portuguese. Whether a conceptual rather than a literal translation was aimed for, was not reported.			
Okajima (2020)	Reported the independent front-translation from English into Japanese by two clinical psychologists who worked in a sleep clinic. Whether a conceptual rather than a literal translation was aimed for, was not reported.	Suitability of the forward translation into Japanese was confirmed by a physician with expertise in sleep medicine and sleep research and three clinical psychologists. The equivalence between the original and the translated version of the scale was ensured by the back-translation procedure.	Scale was back-translated from Japanese into English by two native speakers of both English and Japanese independently. The original author reviews these two back-translations, who confirmed their acceptability.	Feedback from representatives of the target population was not reported.
Türkarslan (2022)	Reported the forward translation of the study by the researcher and senior psychology researcher. Whether a conceptual rather than a literal translation was aimed for, was not reported.	Reported that the two translations were combined by an English-Turkish scholar. How these were combined was not detailed.	Reported the application of a double-translation and reconciliation procedure, however who conducted this was not specified.	Reported that 25 participants took part in a pilot study to evaluate the translations clarity. Feedback was gathered from the pilot study, to create a final version of the scale.

Table 6.

Quality ratings for the Pre-sleep arousal scale

Measure	Study First Author (Year)	Content Validity	Factor structure	Internal Consistency	Test-retest reliability	Criterion validity	Construct validity	Interpret-ability	Floor and ceiling effects
PSAS	Nicassio (1985)	2	N/A	1	2	N/A	2	1	N/A
Swedish PSAS-13 PSAS-14	Jansson-Frojmark (2012)	N/A	1 1	2 1	N/A	N/A	0	1	N/A
Urdu PSAS	Shahzadi (2014)	2	1	2	1	N/A	0	1	N/A
PSAS-PT	Marques (2018)	N/A	1	2	N/A	N/A	0	1	N/A
PSAS	Puzino (2020)	N/A	N/A	N/A	N/A	2	2	1	N/A
PSAS	Puzino (2019)	N/A	N/A	N/A	N/A	1	0	1	N/A
PSAS	Vochem (2019)	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A
PSAS-J	Okajima (2020)	N/A	2	2	1	N/A	0	1	N/A
PSAS	Kalmbach (2022)	N/A	N/A	N/A	N/A	1	N/A	1	N/A
Turkish PSAS	Türkarslan (2022)	2	2	2	2	N/A	2	1	N/A
Overall rating		2	1	2	1	1	0	1	N/A

Note. *Based on an adapted version of the quality criteria developed by Terwee et al., (2007). Rating: 2=Criterion fully met; 1=Criterion partially met; 0=Criterion not met/insufficient data to rate criterion; N/A = No information available to establish rating.

Table 7.

Content Validity, Factor Structure, Internal Consistency, Test–retest reliability and Criterion Validity of the PSAS

Study First Author (Year)	Content validity (recipient and expert groups consulted)	Factor structure proposed	Support for factor structure: type of analysis conducted (factor structure found)	Internal consistency: adequate sample size for factor analyses?	Internal consistency	Test-retest reliability (sample) (time between testing)	Criterion Validity
Nicassio (1985)	Recipient: Yes Expert: Yes	Not reported	Not reported	Not reported	Sample 1 α = 0.88 (cognitive) α = 0.79 (somatic). Sample 2 α = 0.76 (cognitive) α = 0.81 (somatic) Sample 3 α = 0.67 (cognitive) α = 0.84 (somatic)	ICC = 0.72 (cognitive) ICC = 0.76 (somatic) (3 weeks)	Not reported
Jansson-Frojmark (2012)	Not reported	One, two & three factor solutions evaluated	EFA (Two-factor solution found with 3 problematic items removed) EFA (Two-factor solution found with 2 problematic items removed)	Yes (*N*=1890)	PSAS-13: α = 0.85 (total score) α = 0.88 (cognitive) α = 0.72 (somatic) PSAS-14 (validated in insomnia sample) α = 0.82 (total score) α = 0.89 (cognitive) α = 0.66 (somatic)	Not reported	Not reported
Shahzadi (2014)	Recipient: yes Expert: Yes	Factor structure suggested from development study	EFA (Two factor structure found)	Yes (*N*=600)	α = 0.89 (total score) α = 0.82 (cognitive) α = 0.87 (somatic)	r=0.87 (total score) (sample = 60)	Not reported

Marques (2018)	Not reported	Factor structure suggested from development study	EFA (Three-factor structure found but ignored in favour of two-factor structure)	Yes (*N*= 691)	α = 0.85 (total score) α = 0.82 (cognitive) α = 0.79 (somatic)	Not reported	Not reported
Puzino (2020)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	**Predictive validity:** PSAS- C high sleep reactivity: (AUC = 0.82, 95% CI=0.76-0.88) Score of 24.5 best balance between sensitivity (73%) and specificity (75%). PSAS-S when predicting clinical anxiety (AUC=0.88, 95% CI = 0.83-0.93) Score of 14.8 best balance between sensitivity (85%) and specificity (80%).
Puzino (2019)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	**Predictive validity:** PSAS-C when identifying: SOL (AUC = 0.74; 95% CI = 0.65 - 0.83). ISI (AUC = 0.82; 95% CI = 0.70-0.94). PSAS-S when identifying: BAI (AUC = 0.71; 95% CI = 0.0.56- 0.85). ISI (AUC = 0.72; 95% CI = 0.55 - 0.88). PSAS-S score ≥ 12 best balance between sensitivity (65%) and specificity (65%) across ISI, BAI and SOL. However, PSAS-S score ≥ 14 greater sensitivity (86%) for clinically significant anxiety.
Vochem (2019)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Okajima (2020)	Not reported	Factor structure suggested from	EFA (Two factors) CFA (Two factors)	Yes (*N*=237)	α = 0.85(cognitive) α = 0.90 (somatic)	ICC= 0.78 (cognitive subscale) ICC= 0.67 (somatic	Not reported

		development study				subscale) (sample = 237) (3 weeks)	
Kalmbach (2022)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	**Predictive validity** PSAS-C ≥ 18 predicted: ISI: AUC = .87 (79%) sensitivity (79%) specificity) EPDS: AUC = .82 (71%) sensitivity (76%) specificity) SI: AUC = .90 (100%) sensitivity (72%) specificity) Sleep onset insomnia: AUC = .86 (90%) sensitivity (74%) specificity. PSAS-S ≥ 13 predicting: ISI: AUC = .83 (74%) sensitivity (83%) specificity) EPDS: AUC = .82 (80%) sensitivity (78%) specificity) SI: AUC = .73 (67%) sensitivity (74%) specificity) Sleep onset insomnia: AUC = .84 (70%) sensitivity (77%) specificity
Türkarslan 2022	Recipient: yes Expert: Yes	Factor structure suggested from development study	EFA (Two factors – item 8 removed from cognitive factor) CFA (Two factors)	Yes (*N*= 651)	α = 0.92 (total score) α = 0.93 (cognitive) α = 0.86 (somatic)	ICC=0.90(p<0.001) (total score) ICC=0.90(p<0.001) (cognitive subscale) ICC=0.83(p<0.001) (somatic subscale) (sample = 88) (3 weeks)	Not reported

Note. EFA = exploratory factor analysis; CFA= confirmatory factor analysis; α = Cronbach alpha; ICC = intraclass correlation coefficient; r = Pearson correlation coefficient; AUC = area under the curve; CI = confidence interval; SOL = sleep onset latency; ISI = insomnia severity index; BAI = Beck anxiety inventory; EPDS = Edinburgh postnatal depression scale; SI = Suicidal ideation.

Table 8.

Construct validity, Interpretability and Floor and ceiling effects of the PSAS

Study Author	Construct validity	Interpretability	Floor and ceiling effects
Nicassio (1985)	**Convergent Validity** PSAS (cognitive, somatic) &: MAS: r = 0.50, 0.58, respectively; CES-D: r = 0.40, 0.41, respectively; Sleep onset latency: r = 0.59, 0.29, respectively; Total sleep time: r = 0.34, 0.19, respectively; Awakenings from sleep: r = 0.35, 0.29, respectively; Listlessness during the day: r = 0.45, 0.23, respectively; PSAS-S & CSAQ somatic subscale: r = 0.52; PSAS-S & CSAQ cognitive subscale: r = 0.49; PSAS-C & CSAQ cognitive subscale: r = 0.36; PSAS-C & CSAQ somatic subscale: r = 0.06;	Insomnia (people with insomnia scored significantly higher than normal sleepers. The difference in the cognitive subscale being the most striking)	Not reported
Jansson-Frojmark (2012)	**Convergent Validity:** PSAS-13 (total, cognitive, somatic) &: APSQ: p = 0.52, 0.47, 0.43, respectively; DBAS-10: p = 0.45, 0.41, 0.38, respectively; HADS-A: p = 0.57, 0.51, 0.49, respectively; HADS-D: p = 0.44, 0.39, 0.38, respectively; Sleep onset latency: 0.33, 0.32, 0.26, respectively; wake after sleep onset: 0.31, 0.29, 0.26, respectively; Early morning awakening: 0.23, 0.21, 0.21, respectively; Total sleep time: 0.24, 0.22, 0.20, respectively; Sleep quality: 0.43, 0.38, 0.35, respectively; Daytime impairment: 0.51, 0.45, 0.44, respectively;	Insomnia (people with insomnia scored significantly higher than poor sleepers, and poor sleepers scored significantly higher than normal sleepers)	Not reported
Shahzadi (2014)	Not reported	Students (scored higher on cognitive subscale) **Cut-off scores for total PSAS** Mild Pre-sleep arousal: 0-34 Moderate Pre-sleep arousal: 35-43 Severe Pre-sleep arousal: 44-53 Very severe Pre-sleep arousal: 54-61	Not reported
Marques	**Convergent validity**	Insomnia (Self-reported insomnia sufferers scored	Not reported

(2018)	PSAS-PT (total, cognitive, somatic) &: FIRST: 0.48, 0.48, 0.33, respectively; APS: 0.45, 0.40, 0.38, respectively; EPI: 0.39, 0.38, 0.26, respectively; Sleep quality: r= 0.35, 0.33, 0.26, respectively; Sleep latency: r = 0.40, 0.44, 0.20, respectively; Nocturnal awakenings: 0.28, 0.27, 0.21, respectively; Sleep loss over worry: 0.51, 0.50, 0.35, respectively; Positive affect: -0.10, -0.10, -0.07, respectively; Negative affect: 0.41, 0.40, 0.29, respectively; Fatigue-inertia: 0.29, 0.28, 0.20, respectively;	significantly higher than self-reported non-insomnia sufferers, on the total, cognitive and somatic scales)	
Puzino (2020)	**Convergent validity** PSAS (cognitive, somatic) &: ISI: 0.37, 0.32, p≤ 0.01, respectively; FIRST: r = 0.55, 0.39, p ≤ 0.01, respectively; APS: r = 0.50, 0.50, p ≤ 0.01, respectively; DASS-D: r = 0.38, 0.56, p ≤ 0.01, respectively; DASS-A: r = 0.43, 0.79, p ≤ 0.01, respectively; PSAS-C & PSAS-S: r = 0.52, p ≤ 0.01, respectively;	**Cut-off scores:** PSAS-C: ≥ 20 (clinically significant): cognitive arousal indicated to play a clinically significant role in night-time sleep disturbance. 16-19 (marginally significant): cognitive arousal indicated to play a marginally significant role in night-time sleep disturbance. 16 or lower (absence of): absence of cognitive arousal. PSAS-S: ≥ 14 (clinically significant): a medical condition or anxiety, once the latter is ruled out, are playing a clinically significant role in night-time sleep disturbance. 12-13 (marginally significant): medical condition or anxiety, once the latter is ruled out, are playing a marginally significant role in night-time sleep disturbance. Lower than 12 (absence of): absence of a comorbid condition or clinically significant impact of anxiety on night-time sleep.	Not reported
Puzino (2019)	**Convergent validity:** PSAS (cognitive & somatic) &: ISI: r= 0.53, 0.44, p ≤ 0.01, respectively; FIRST: r = 0.35, 0.35, p ≤ 0.01, respectively; APS: r = 0.31, 0.34, p ≤ 0.01, respectively; BDI-II: r = 0.45, 0.45, p ≤ 0.01, respectively; BAI: r = 0.37, 0.58, p ≤ 0.01, respectively; PSAS-C & PSAS-S: r = 0.40, p ≤ 0.01, respectively;	**Cut-off scores:** PSAS-C score ≥ 16 as the best indicator for arousability. PSAS-C score ≥ 19 as the best indicator for SOL, ISI, BAI PSAS-S scores ≥ 12 best detected ISI and arousability PSAS-S scores ≥ 14 best detected clinically significant anxiety	Not reported

Vochem (2019)	Not reported	Gender, age, sleep quality, depression, state-trait anxiety (level of anxiety and female gender were associated with scores above cut-off on the PSAS) Distribution based cut-off scores were determined by stratifying good sleepers into six groups by age and gender, using the 95% quantile: Mean cut-off score for PSAS-S: 13.8 (12.2-15.7) Mean cut-off score for PSAS-C: 20.9 (17-23.8)	Not reported
Okajima (2020)	PSAS-J (cognitive, somatic) &: FIRST: r = 0.53, 0.38, respectively; DBAS-16: r = 0.44, 0.35, respectively; ISI: r = 0.52, 0.43, respectively;	Insomnia (people with insomnia scored significantly higher compared with normal sleepers)	Not reported
Kalmbach (2022)	Not reported	Insomnia (women with insomnia scored significantly greater compared to those without insomnia) **Cut-off scores in pregnant samples**: PSAS-S score ≥ 13 classifies high nocturnal somatic arousal. ≥ 12 to prioritize sensitivity. ≥ 14 to prioritize specificity. PSAS-C score ≥ 18 classifies high nocturnal cognitive arousal. ≥ 16 to prioritize sensitivity. ≥ 19 to prioritize specificity.	Not reported
Türkarslan (2022)	**Convergent validity: (Pearsons)** PSAS-T (cognitive) & RTSQ: r = 0.72, p ≤ 0.001; PSAS-T (somatic) & BAI-Somatic: r = 0.67, p ≤ 0.001; PSAS-T (total) & ISI: r = 0.65 p ≤ 0.001; **Divergent validity: (Pearsons)** PSAS-T (total, cognitive, somatic) & GRAS: r = 0.25, 0.28, 0.15, *p*<.001 respectively;	Insomnia (significant differences found between people with insomnia and good sleepers)	Not reported

Note. MAS = Taylor Manifest Anxiety Scale, HADS-A = Hospital Anxiety and Depression Scale - Anxiety subscale; EPDS = Edinburgh Postnatal Depression Scale; CSAQ = Cognitive-Somatic Anxiety Questionnaire; APSQ = Anxiety and Preoccupation about Sleep Questionnaire; DBAS = Dysfunctional Beliefs and Attitudes about Sleep; HADS-D = Hospital Anxiety and Depression Scale - Depression subscale; FIRST = Ford Insomnia Response to Stress Test; APS = Arousal Predisposition Scale; DASS-D = Depression Anxiety Stress Scale-Depression subscale ; DASS-A = Depression Anxiety Stress Scale-Anxiety subscale ; ISI = Insomnia Severity Index ; BDI-II = Beck Depression Inventory - Second Edition; BAI = Beck Anxiety Inventory; RTSQ = Response to Stressful Experiences Scale; GRAS = Gender Role Attitudes Scale ; SOL = Sleep Onset Latency ; SI = Suicidal Ideation; r = Pearson's correlation coefficient.

Table 9.

Tabulated summary of the PSAS psychometric properties

Measure	Content Validity	Factor structure	Internal Consistency	Test-retest reliability	Criterion validity	Construct validity	Interpretability
PSAS-16	Recipient and expert groups consulted. (*N*=3)	EFA (Two factor structure found) (*N*=3) CFA (Two factor structure found) (*N*=1)	α = 0.85-.89 (total score) α = 0.67 - .93 (cognitive) α = 0.79 - .90 (somatic) (*N* = 4)	*ICC* = 0.90 (total score) *ICC* = 0.72 -.90 (cognitive) *ICC* = 0.67 - .83 (somatic) *r* = 0.87 (total score) (*N*=4)	In a clinical sample: PSAS-C: **24.5** when predicting **sleep reactivity,** (AUC =.82). PSAS-S of **14.8** when predicting **clinical anxiety** (AUC =.88). (*N*=1) Non-clinical sample: PSAS-C **19** when identifying clinically significant **difficulty initiating sleep** (AUC = 0.74). PSAS-S of **≥12** shown to identify those with clinically significant anxiety (AUC = .71). (*N*=1) In pregnant sample: PSAS-C and PSAS-S scores that corresponded with measures of sleep onset insomnia, depression, insomnia, and suicidal ideation: PSAS-C of **≥18** and PSAS-S of **≥13** had majority in the good range (AUC > 0.8). (*N*=1) .	**Convergent Validity of the PSAS with measures of:** Anxiety; r= 0.37 - 0.67 (*N*=5) Depression; r= 0.38 - 0.45 (*N*=4) Sleep onset latency; r=0.20 – 0.59 (*N*=3) Arousal; r= 0.31 – 0.52 (*N*=4) Insomnia response to stress; r=0.33 – 0.55 (*N*=4) Insomnia; r= 0.32 – 0.65 (*N*=3) Dysfunctional beliefs about sleep; r= 35 – 0.45 (*N*=2) Other sleep indices; r= 0.19 – 0.51 (*N*=3) **Divergent validity of the PSAS with measures of:** Gender role attitudes; r =0.15 – 0.28 (*N*=1)	Insomnia sufferers scored significantly higher than normal sleepers. (*N*=6) Level of anxiety & female gender associated with scores above cut-off on the PSAS. (*N*=1) **Cut-off scores:** PSAS-C: ≥ 20 (clinically significant) 16-19 (marginally significant) 16 or lower (absence of) PSAS-S: ≥ 14 (clinically significant) 12-13 (marginally significant) Lower than 12 (absence of) (*N*=2) In pregnant samples: PSAS-S: ≥ 13 classifies high nocturnal somatic arousal. PSAS-C: ≥ 18 classifies high nocturnal cognitive arousal. (*N*=1)
PSAS-13	-	EFA (Two-factor solution found with 3 problematic	α = 0.85 (total score) α = 0.88 (cognitive) α = 0.72 (somatic) (*N*=1)	-	-	**Convergent Validity of the PSAS-13 with measures of:** Anxiety and preoccupation about sleep; p =0.43 - 0.52 Dysfunctional beliefs about sleep; p=0.38 – 0.45 Anxiety; p= 0.49 – 0.57	-

	items removed) (*N*=1)				Depression; p=38 - .44 Sleep onset latency; p= 0.26 - 0.33 Other sleep indices; p= 0.20-0.51 (*N*=1)	
PSAS-14	EFA (Two-factor solution found with 2 problematic items removed) (*N*=1)	α = 0.82 (total score) α = 0.89 (cognitive) α = 0.66 (somatic) (*N*=1)	-	-	-	-

Note. N = number of studies; EFA; exploratory Factor analysis CFA; confirmatory factor analysis r= pearson's correlation coefficient; AUC= Area under the curve; α = Cronbach alpha; ICC = intraclass correlation coefficient.

Population

Population samples ranged from 99 to 1890 participants. Samples were drawn from non-clinical, clinical and pregnant populations, across a number of cultural populations. The percentage of female participants ranged from 42.2% to 100%, and the mean age ranged from 19.33 to 47.1. Only Jansson-Frojmark and Norell-Clarke (2012) and Kalmbach et al. (2022) reported ethnicity. Participants' level of sleep disturbance was based on a range of methods, such as scores on the ISI, PSQI and self-reporting on sleep related indices. See Table 4 for further details.

Summary. Samples consisted of participants from a range of populations. In samples of individuals without sleep disturbance, with sleep disturbance, with chronic insomnia and in pregnant samples.

Content Validity

Three studies examined content validity, one of which was the original development study (Nicassio et al., 1985), and two were studies that described the translation of the PSAS and included a pilot study of the translated measure (Shahzadi & Ijaz, 2014; Türkarslan et al., 2022). Nicassio et al.'s (1985) study involved item generation by the authors through clinical observations and interviews with participants experiencing sleep disturbance that focused on the nature of patient's phenomenological experiences as they attempted to fall asleep. Based on empirical evidence in the literature (Schwartz et al., 1978) that cognitive and somatic modes of arousal can be distinguished, items were written according to manifestations of somatic (e.g., jittery, shortness of breath) and cognitive arousal (e.g. worry about problems other than sleep, can't shut off your thoughts).

The reviewers of the present study also considered whether the individual items in the PSAS (comprehensively) captured the key concepts the authors set out to measure, i.e. (cognitive and somatic dimensions of) pre-sleep arousal. Nicassio et al. (1985) clearly

described the construct of (cognitive and somatic) pre-sleep arousal and related it to theory and the origin of the dimensions of arousal. Experts were also consulted to check the validity of item content during this process; three clinical psychologists independently categorised all items of the PSAS into the two subscales and achieved 100% agreement. This study was rated 2/2 for this criterion. Shahzadi and Ijaz (2014), conducted a pilot study and collected feedback about how participants found answering items. Türkarslan et al. (2022), also gathered feedback about translation clarity after a pilot study from the representative population. Both studies were scored 2/2.

Summary. An overall rating of 2/2 was awarded because studies that addressed content validity appeared to comprehensively capture key concepts of pre-sleep arousal and experts and members of the target population were consulted. However, although the target population were involved in item generation, it was not entirely clear whether feedback was sought about clarity. For studies that translated the measure, a pilot study was involved in which feedback about clarity was sought.

Factor structure and internal consistency

Five of the studies examined factor structure, and six assessed internal consistency. Nicassio et al. (1985) did not perform a factor analysis. This original scale development study which proposed two factors for the factor structure using three clinical psychologists as experts to categorise the 16 items into two factors. As no factor analysis was conducted, this criterion was not rated. Nicassio et al. (1985) found acceptable-good internal consistency for the PSAS subscales in their samples (α = .76 to .88), except for the cognitive subscale in the 'normal sleepers' sample (α = .67). As the Cronbach's alphas were mainly within the acceptable range, yet inconsistent across samples, and a factor analysis was not performed, internal consistency was rated 1/2 for this study.

Jansson-Frojmark et al. (2012) conducted an Exploratory Factor Analysis (EFA) on an adequate sample size, which yielded a two-factor solution in the entire sample. However, three items on the cognitive arousal factor were found to be problematic. One and three-factor solutions were also evaluated; however, both were found to be problematic and discarded. Therefore, the authors explored whether excluding the three problematic items would improve the factor solution. Items removed individually did not affect the factor solution; however, it was improved when all three were removed from the factor analysis together. The authors termed this version the PSAS-13, validated in the entire sample. In the insomnia sample, EFA yielded a two-factor solution for the PSAS, cognitive and somatic arousal; however, items two and 16 were problematic. The one and three-factor solutions were also evaluated in this sample; however, due to the cross- and low-loadings were also discarded. The factor solution was improved when the author conducted a further factor analysis with items two and 16 removed. The authors termed this version the PSAS-14, validated in the insomnia sample. As they did not conduct a CFA, 1/2 was given for the factor structure of the PSAS-13 and PSAS-14. Jansson-Frojmark and Norell-Clarke (2012) found acceptable-good internal consistency for the PSAS-13 total score and subscales but higher in the cognitive subscale in an adequate sample size (α =.72 to .89). This criterion was rated 2/2. In the insomnia sample, good internal consistency was found for the total score and cognitive subscale of the PSAS-14 (α = .82 to .89); however, a low internal consistency for the somatic subscale (α = .66). Therefore, this was scored 1/2.

Shahzadi and Ijaz (2014) conducted an EFA on an adequate sample size and revealed a two-factor solution. High internal consistency was found for the scale and each subscale (α = .82 to .89). A score of 1/2 was achieved for the factor structure, as the EFA supported one of the suggested factor solutions; however, no CFA was conducted.

Marques et al. (2018) performed an EFA on an adequate sample size, which indicated that the PSAS-PT comprised a two-factor solution. From the EFA, two possible factor solutions were found; evidence showed that the classical structure comprising of the cognitive and somatic arousal structures were psychometrically adequate. The new factor solution proposed three factors; the original cognitive arousal factor and two factors related to the original somatic arousal factor. However, as the two-factor structure was shown to be more robust, the authors chose to ignore the three-factor structure. As only EFA (and not CFA) was performed, a score of 1/2 was given for this criterion. Cronbach's alphas were calculated for each subscale separately and found acceptable-good internal consistency for the PSAS total score and subscales (α = .79 to .85). Therefore, this study was given 2/2.

Okajima et al. (2020) performed an EFA and CFA on an adequate sample size. From the EFA, the two-factor solution from the original PSAS was found, that is, and the CFA supported the two-factor model. The PSAS-J also showed good internal consistency, and Cronbach's alphas were calculated per dimension (α = .85 & .89). Therefore, this study was rated 2/2 for factor structure and internal consistency.

Türkarslan et al. (2022) conducted an EFA and CFA using an adequate sample size. EFA revealed a two-factor structure consistent with the original factors; however, they found that item 8 (being distracted by sounds and noise in the environment) did not have an adequate factor loading to be included in the PSAS-C. After removing this item, the authors conducted a CFA of the PSAS with 15 items, supporting a two-factor model. Therefore, this criterion was rated 2/2. This study also fully met the criterion for internal consistency as Cronbach's alphas were calculated for each subscale separately and showed good internal consistency (α = .86 to .93). Vochem et al. (2019). Puzino et al. (2019) and Puzino et al. (2020) did not evaluate internal consistency or factor structure and were not rated on these criteria.

Summary. The overall rating was 1/2 for factor structure and 2/2 for internal consistency. Two studies did fully meet the criterion factor structure but were downgraded due to inconsistency. Although the same factors were mainly found across studies (cognitive and somatic subscale), the lower ratings were mostly due to study quality, such as, studies only conducting EFA and not CFA. Lower ratings for internal consistency resulted from inadequate *αs.* For example, in one study, only one of the subscales (cognitive) was inadequate, and in the study that suggested the PSAS-14, the somatic subscale was inadequate.

Reliability

Four studies assessed test-retest reliability. Nicassio et al. (1985) found adequate reliability for both cognitive and somatic subscales (*ICC* = .72 & .76) and was rated 2/2. Shahzadi and Ijaz (2014) found adequate test-retest reliability (r = 0.87), however, they did not calculate ICC or weighted Kappa. Therefore, was rated 1/2. Okajima et al. (2020) found the cognitive subscale to have acceptable reliability (*ICC* = .78), whilst the somatic scale showed moderate reliability (*ICC* = .67). Due to the lower reliability of the somatic subscale, the PSAS-J was rated 1/2 on this criterion. Türkarslan et al. (2022) found the PSAS total score and the cognitive subscale to have excellent reliability and the somatic subscale to have good reliability (*ICC* = .90 to .83), and therefore was rated 2/2 for this criterion. Five studies did not assess test-retest reliability and therefore not rated on this criterion.

Summary. While all four studies reported at least acceptable test-retest reliability (or approaching .70), two studies were rated 1/2 based on poor study quality (due to the ICC or weighted Kappa not being calculated, or ICC just below .70), which resulted in an overall rating of 1/2.

Criterion validity

Puzino et al. (2020) calculated the AUC to determine clinically useful predictive values of the PSAS-S & PSAS-C with criterion variables; sleep reactivity and clinical anxiety in a clinical sample. For the PSAS-C a score of 24.5 was given for predicting sleep reactivity, which was in the good range (*AUC* =.82) for sensitivity (73%) specificity (75%), but as predicted, not for clinical anxiety (*AUC* = .64). A score of 14.8 on the PSAS-S was found to show good balance when predicting clinical anxiety, between sensitivity (85%) specificity (80%) which was in the good range (*AUC* =.88). Therefore, this criterion was rated 2/2.

Puzino et al. (2019) also calculated the AUC to determine clinically useful predictive values of the PSAS subscales with criterion variables such as clinically significant difficulty initiating sleep, insomnia, arousability and anxiety in a non-clinical sample. A PSAS-S of ≥12 was shown to have the best balance when identifying those with clinically significant anxiety with sensitivity (65%) and specificity (65%) (*AUC* = .71). A score of 19 on the PSAS-C was shown to have the best balance when identifying clinically significant difficulty initiating sleep (*AUC* = 0.74). Therefore, this study was given a score of 1/2.

Kalmbach et al., (2022) calculated the AUC to identify clinically relevant cut-offs on the PSAS-C and PSAS-S in a pregnant sample, that corresponded with measures of sleep onset insomnia, depression, insomnia, and suicidal ideation. PSAS-C score of ≥18 and PSAS-S score of ≥13 had majority in the good range (AUC > 0.8), except for PSAS-S with suicidal ideation, which was acceptable (*AUC* = .73). Therefore, this study was rated 1/2 for criterion validity.

Summary. The overall rating for criterion validity was 1/2. The predictive validity of the PSAS and its subscales were found acceptable in predicting measures of anxiety, depression and sleep related criterion variables in a clinical, non-clinical and pregnant sample.

Construct validity

Eight studies addressed construct validity. Nicassio et al., (1985), compared the PSAS and subscales with measures of anxiety, depression, and sleep difficulty indices. Both subscales were strongly correlated with anxiety and moderately correlated with depression. The somatic and cognitive subscales were relating to the respective subscales on a measure of anxiety, which indicated that the PSAS subscales were in fact measuring different components of arousal. Significant correlations were found between the PSAS and all sleep measures. The strongest correlation was with sleep onset latency. Discriminant validity was also supported as the PSAS was more strongly associated with concurrent sleep disturbance than measures of anxiety and depression. This study was rated a score of 2/2, as the authors outlined specific hypotheses, and found significant correlations in the expected directions, of which two were $r \geq .50$, supporting convergent validity of the PSAS.

Jansson-Frojmark and Norell-Clarke (2012), evaluated the construct validity of the PSAS by examining its discriminant and convergent validity with related measures, and its association with sleep parameters and daytime impairment. They found the PSAS-13 to be significantly related to, yet also relatively distinct from anxiety, depression, sleep related worry and beliefs. That is, the PSAS-13 was significantly related to sleep related worry on a moderate level, to dysfunctional beliefs about sleep at a fair level, anxiety on a moderate to good level, and depression on a fair level. In addition, the PSAS-13 was found to be moderately correlated with sleep parameters key to insomnia. However, cognitive arousal was more strongly related to sleep parameters than somatic arousal. Finally, the PSAS-13 was related to daytime impairment on a fair to moderate level. Although more than two of these correlations were $r \geq .50$, and authors concluded that most correlations were in the 'expected' direction, they did not state specific hypotheses and consequently this study was rated 0/2.

Marques et al., (2018) found the PSAS-PT to be significantly correlated with arousability, sleep quality, sleep latency, sleep loss over worry, nocturnal awakenings, sleep reactivity to stress, fatigue inertia, negative affect, and neuroticism. Most of which were moderate correlations in the 'expected' direction. Only positive affect was negatively associated with PSAS, meaning lower levels of arousal were associated with higher levels of positive affect. This correlation was significant for the total score and the cognitive, but not the somatic subscale. As no specific hypotheses were stated and the authors only made vague reference to correlations trending in the 'expected direction', this criterion was rated 0/2.

Congruent with hypotheses, Puzino et al. (2020) found that the somatic subscale had a large positive correlation with clinical anxiety and was the strongest clinical factor associated with it (greater than the association with arousability). Two correlations were $r \geq .50$, and therefore a rating of 2/2 was given for construct validity. Puzino et al., (2019) examined the construct and discriminant validity of the PSAS. The cognitive subscale was found to have a strong correlation with insomnia severity and a moderate correlation with depression. Whilst the somatic subscale was shown to have moderate correlations with depression and insomnia severity, and a strong correlation with anxiety. As specific hypotheses were not stated, this criterion was given a score of 0/2.

Okajima et al., (2020) tested concurrent and discriminant validity of the PSAS-J. The authors found significant positive correlations to the insomnia related scales (insomnia severity, sleep reactivity to stress, dysfunctional beliefs and attitudes about sleep). There were all moderate correlations, two of which were $r \geq .50$. They found that higher PSAS-J scores predicted worsening insomnia symptoms and concluded that the PSAS-J was distinct from other measures of beliefs about sleep and sleep reactivity to stress. However, specific hypotheses were not outlined by the authors, only vague predictions were given about the PSAS-J measuring different factors to measures of sleep reactivity to stress and dysfunctional

beliefs and attitudes about sleep, and whether they converged to each other, being indicative of discriminant validity. Therefore, this study was given a score of 0/2.

Türkarslan et al., (2022) assessed convergent, divergent and discriminant validity. They found the cognitive subscale to be strongly correlated with ruminative thinking, whilst the somatic subscale was found to be strongly correlated with somatic anxiety. Finally, the total PSAS score was found to be strongly correlated with insomnia severity. Divergent validity was found to be acceptable as although the PSAS-T was not expected to be significantly correlated with Gender Role Attitudes, small but significantly positive correlations were found. The authors formulated hypothesis and three quarters of correlations were in the expected direction, with at least two being $r \geq .50$. Therefore, this study was given a rating of 2/2.

Summary. The overall score for construct validity was 0/2. Despite three studies fully meeting this criterion, it was downgraded due to inconsistency. Terwee et al. (2007) require authors to stipulate hypotheses and consequently five studies attracted a score of 0 because the authors failed to do so. However, the correlations reported in these studies do seem to be in keeping with the wider literature on the association between pre-sleep arousal and anxiety, depression, sleep indices and insomnia. Furthermore, most of the studies attracting a score of 0/2 did find correlations to be $r \geq .50$.

Interpretability

All included studies addressed the criterion interpretability. Nicassio et al. (1985) conducted subgroup analysis showing that those with insomnia scored significantly higher on both cognitive and somatic subscales than those without insomnia. However, they did not indicate what level of change on the scale might be needed to show a difference in insomnia, therefore was rated 1/2. Jansson-Frojmark and Norell-Clarke (2012), provided mean scores of subgroup differences based on levels of sleep disturbance, showing that people with insomnia

scored significantly higher than poor sleepers, who in turn had significantly elevated scores than normal sleepers. Yet gave no indication of what differences in scale scores might be interpreted as and was therefore rated as 1/2. Shahzadi and Ijaz (2013) did not analyse subgroups, and limited means and SDs to students' scores on the two subscales but considered how scale scores might be interpreted and cut-off scores were provided, based on percentile analysis. Therefore, it was rated 1/2. Marques et al., (2018) limited group differences to insomnia and non-insomnia groups and did not indicate what level of change on the scale might be needed to detect insomnia. And therefore, was rated 1/2 for this criterion.

Puzino et al., (2019) and Puzino et al., (2020) did not provide subgroup differences; however, the authors did suggest what cut-off scores of the PSAS might predict clinically meaningful outcomes in a non-clinical (Puzino et al., 2019) and clinical sample (Puzino et al., 2020). Therefore, these studies were rated 1/2. Vochem et al., (2019) provided subgroup differences by age and gender in two groups (good sleepers and those with insomnia) and found that females with insomnia were more likely to have PSAS scores above the cut-off. The authors also determined distribution-based cut-off scores which indicated what levels of change on PSAS could be interpreted as and was therefore rated 2/2. Okajima et al., (2020) partially met this criterion, as again, they limited subgroup analyses to those with and without insomnia and indicated that the PSAS-J could discriminate between those with a pathological and a non-pathological pre-sleep arousal status but did not indicate what levels of change on the scale might indicate this difference. Türkarslan et al., (2022) also only reported differences between people with insomnia and good sleepers, and again did not indicate how these score differences might be interpreted. Therefore, was rated 1/2. Kalmbach et al., (2022) did indicate how scale scores might be interpreted in pregnant samples and identified empirically derived cut-offs for clinically significant nocturnal cognitive and somatic arousal,

although they only provided means and SD of those with and without insomnia. Therefore, gained a score of 1/2.

Summary. The overall score for interpretability was 1/2. Whilst one study fully met this criterion, and the PSAS has been shown to differentiate those with and without insomnia, with some indication of how to interpret scores of the PSAS in different cultural and clinical contexts, most of the studies only partially supported interpretability, due to providing information on less than four relevant subgroups, or not indicating what level of change might be interpreted to mean.

Discussion

Psychometric properties of the PSAS were described in ten studies included in this review, consisting of a development study, four validation and five cultural adaptation studies. In most studies, a definition of the sample was given, such as mean age, gender, quality of sleep or insomnia, including how participants were partitioned by sleep quality. However, only a few studies described ethnicity. The samples comprised clinical, non-clinical, undergraduate students, adults, and pregnant participants across many cultural populations. One study with a substantial sample of participants (N =1890) conducted in Sweden represented several demographic parameters by the authors compared to public register data reflecting the population (Jansson-Frojmark & Norell-Clarke, 2012).

Translation procedures

Of the five studies that translated the PSAS to a language other than English, two studies referenced all four steps recommended by WHO. Shahzadi & Ijaz's (2014) translation process appeared to be the most rigorous, and this study also showed robust evidence for content validity and internal consistency. However, they conducted a less robust measure of test-retest reliability and factor analysis and did not state specific hypotheses for construct validity. On the other hand, Türkarslan et al. (2022) demonstrated robust psychometric

properties, such as fully meeting the criterion for all properties assessed, except interpretability.

Psychometric properties

The most reported psychometric properties in this literature were interpretability and construct validity, and the least was criterion and content validity. The most robust psychometric properties were content validity and internal consistency. Three studies reported content validity of the PSAS; the original development study included experts and people with sleep disturbance in its development, and the two papers that included a pilot in the translation process of the measure gathered feedback from the target population. Six studies reported internal consistency, and the reported α for most of the totals and subscales was good, being >.70. Except for a single subscale in Nicassio et al. (1985) study and in the shortened PSAS-14 (Jansson-Frojmark & Norell-Clarke, 2012). However, all other studies of the PSAS with 16 items and its subscales demonstrated good internal consistency.

Psychometric weakness was also found for the PSAS. Specifically, factor structure, test-retest reliability, interpretability, criterion, and construct validity. Four studies reported test-retest reliability, and the majority of acceptable test-retest reliability was reported ($ICC \geq 0.70$ or $r \geq 0.70$), except for a single subscale in one study (Okajima et al., 2020). However, r was not considered the most robust measure of reliability by Terwee et al. (2007). Therefore, the lower overall rating did not necessarily reflect poor test-retest of the PSAS but rather lower study quality, resulting in less confidence in these results. Eight studies reported construct validity and a lower rating was given mainly due to authors failing to state specific hypotheses, although most correlations were adequate ($r \geq 0.50$). Three studies examined criterion validity. The PSAS-C demonstrated at least acceptable validity in predicting sleep reactivity and clinically significant difficulty initiating sleep, and the PSAS-S showed at least acceptable validity in predicting clinical anxiety. All studies reported on interpretability,

demonstrating that the PSAS showed robust ability to discriminate between those with and without insomnia, however, did not report enough subgroups analysis to fully meet Terwee et al., (2007) criteria. Lastly, for factor structure, most studies identified both the two-factor structure proposed in the original development study. However, many did not conduct CFA, which Strauss et al. (2016) consider the most robust analysis. Notably, however, the studies that performed CFA also supported the two-factor structure.

As the overall rating of each psychometric property was based on most ratings, and properties were downgraded for inconsistency, some properties attracted an overall rating of 1 or 0. However, despite the lower ratings, each property had at least one study that fully met the criteria suggested by Terwee et al. (2007). Furthermore, one study demonstrated a good translation process and fully met all the psychometric properties it set out to address, except interpretability (Türkarslan et al., 2022). Whilst this study is a pre-print and conclusions should be drawn tentatively, it does indicate the potential of the PSAS to demonstrate robust psychometric properties if the methodological quality of future studies is improved.

The psychometric properties of this commonly used measure are promising. However, regarding test-retest reliability, interpretability, factor structure, construct and criterion validity, further studies of higher quality are required to establish these properties with greater confidence.

Strengths and limitations

Recent reviews of sleep related measures called for research to compare psychometric properties of insomnia-related measures across different populations due to increasing awareness of cultural effects on insomnia (Ali et al., 2020). Therefore, a strength of this review is that it has shown the PSAS to have validity across different populations. Psychometric theory discusses the benefit to cross-cultural validity of a scale (WHO, 2018)

and the PSAS has been shown to perform in a similar way and is applicable across different cultures.

A limitation of the current review is that Terwee et al. (2007) criteria were arguably stringent, for example, concerning construct validity. Authors stipulating hypotheses are considered important by these criteria. Consequently, four studies attracted a score of 0, suggesting that support for the construct validity of the PSAS was not found. However, this was due to the authors needing to stipulate hypotheses rather than the inadequate correlations between related constructs. Reviewers could have stipulated hypotheses to compare all the results against in the absence of specific hypotheses stated by study authors, as recommended by Prinsen et al. (2018). However, this was decided against, as reviewers felt that using a single set of criteria was best for coherence and consistency across papers.

Furthermore, several studies included in the present review had the same author as the original study, which may be a potential source of bias (Furlan et al., 2009). However, other studies were included from a range of authors. Another limitation was that this review included a pre-print study that still needed to be peer-reviewed. Ideally, only published articles would have been included; however, the authors did not want to privilege published articles. Also, the inclusion of unpublished reports and pre-prints has been recommended for use in reviews of psychometric testing of instruments (Aromataris & Munn, 2020).

Implications for clinical practice and future research

In addition to future validation studies needing to establish further confidence in the psychometric properties of the PSAS, measurement properties recommended by Terwee et al. (2007) that were not addressed in the literature could be the focus of future research, such as responsiveness, agreement and floor and ceiling effects. Building on the findings from the current review, future research might want to focus on the PSAS sensitivity to change to examine its ability to be used as a pre-and post-intervention outcome measure to evaluate the

effectiveness of interventions. Longitudinal studies could be conducted to measure the responsiveness of the PSAS to measure changes over time.

Hyperarousal is a complex construct, and the research implications of the findings of this review that the PSAS has promising psychometric properties is important as this adds confidence in this measure being used in future research to understand this sleep-related construct better and to grow the knowledge base around it. Moreover, given the theoretical underpinnings of the hugely important and psychological role hyperarousal has been theorised to play in insomnia (Harvey, 2002), there is a high priority for clinicians to have well-validated and standardised sleep-related constructs, such as measures capturing hyperarousal. The PSAS could be used clinically, both therapeutically and in screening packs. If using this measure therapeutically, it can be used to see whether it is sensitive to change or as part of the therapeutic process to inform formulations. In addition, the PSAS could be useful in clinical practice to flag difficulties, for example, in services where resources and clinician time are limited, including screening questionnaires could help identify sleep or hyperarousal challenges, freeing clinicians time to be used in other ways. Also, cognitive behavioural therapy for insomnia (CBTi) is a well evidenced intervention for sleep difficulties, and there is a need to have a good measure of hyperarousal to be used routinely in services as part of psychological interventions.

Conclusion

This review aimed to identify, quality assess and synthesise findings about the psychometric properties of the PSAS. This scale has been used in research to measure the trait tendency for cognitive and somatic arousal before falling asleep. Studies reported robust psychometric properties for the PSAS, such as content validity and internal consistency. In addition, at least reasonable support was reported for factor structure, test-retest reliability, interpretability,

criterion, and construct validity. These findings were mostly consistent across different populations; however, methodological flaws mainly prevented the PSAS from attracting higher ratings on some properties. The most significant of which was many authors not stating specific hypotheses about the construct validity of the PSAS, leading to lower quality ratings, despite demonstrating adequate correlations with related constructs. Poorly reported properties, such as responsiveness and floor and ceiling effects, also need exploration. Findings from this review suggest that this commonly used measure has promising quality, but future research into validation studies of higher quality are required to provide further confidence in its psychometric properties. In addition to highlighting some promising psychometric properties, this review has shed some light on where the edges of understanding lie concerning the quality of the PSAS and what research is needed to further increase confidence in its robustness and clinical utility.

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Section B

A quantitative study on sleep quality and nocturnal cognitive arousal during pregnancy: Exploring relationships with self-compassion and mindfulness

Word count: 7159 (429)

For submission to Mindfulness

Abstract

Objectives: Sleep disturbance is highly prevalent during pregnancy, and ruminating while trying to fall asleep has been linked to insomnia. Mindfulness has been shown to protect against nocturnal cognitive arousal. The theory suggests that self-compassion might also be protective; however, it has not been tested empirically. This study aimed to start exploring associations between self-compassion, nocturnal cognitive arousal and sleep during pregnancy and comparing this pathway to mindfulness.

Methods: In a cross-sectional design, 203 pregnant people (53% in the second trimester) completed the Five Facets of Mindfulness Scale, the Self-Compassion Scale, the Insomnia Severity Index and the Pre-Sleep Arousal Scale-Cognitive factor. Mediation analysis using a bootstrapping approach was used to analyze the data.

Results: Lower self-compassion was associated with poorer sleep quality and nocturnal cognitive arousal was found to mediate this association, with the indirect effect having a confidence interval of (-.231, -.085), and remained significant when mindfulness was controlled for. No relationship between mindfulness and sleep quality was found in this sample. Nocturnal cognitive arousal was found to mediate the association between mindfulness and sleep quality, with the indirect effect having a confidence interval of (-.137, -.040). However, did not remain significant when self-compassion was controlled for.

Conclusions: Nocturnal cognitive arousal may mediate the association between self-compassion and mindfulness with sleep quality. Also, there may be something distinct about self-compassion that is predictive of sleep quality, over and above the overlap with mindfulness. Future longitudinal studies confirming this finding may suggest that nocturnal cognitive arousal could be targeted to improve sleep quality. Cultivating self-compassion and mindfulness may protect against nocturnal cognitive arousal during pregnancy.

Key words: Sleep; Pregnancy; Self-compassion; Mindfulness; Cognitive arousal.

A quantitative study on sleep quality and nocturnal cognitive arousal during pregnancy: Exploring relationships with self-compassion and mindfulness

Sleep problems are pervasive during pregnancy and the first postpartum year (Yang et al., 2020). Sleep quality and high cognitive arousal are two constructs that could predict future perinatal depression in this population (Kalmbach et al., 2021). Therefore, in addition to the clear benefits of treating insomnia and high levels of cognitive arousal alone, improving these might also play an important role in preventing and treating perinatal depression, which is another challenge that can arise during the perinatal period (Kalmbach et al., 2021). This introduction discusses the literature on the relationships between these constructs before discussing constructs which may protect against sleep disturbances in pregnancy, such as mindfulness and self-compassion.

Sleep in the Perinatal Period

The perinatal period is when an individual becomes pregnant and up to a year after giving birth. Over half of perinatal women have been found to meet the criteria for insomnia, significantly higher than the general population (Dorheim et al., 2012). Furthermore, sleep disturbances have been found to increase as pregnancy progresses, with the highest levels most likely to occur in the third trimester (Sedov, 2021). A recent systematic review of published epidemiological studies found that insomnia was prevalent in 42.4% of women in their third trimester of pregnancy (Salari et al., 2021). Sleep problems have often been attributed to physical factors such as discomfort or waking in the night, foetus growth, hormonal changes (Bourjeily, 2009; Wong et al., 2022), restless legs syndrome and acid reflux (Chen at al., 2018; Khan & Carter, 2021). Sleep-disordered breathing is also common during pregnancy and linked with obstructive sleep apnoea, when breathing stops and starts

during sleep (Pien et al., 2014). However, there has been less focus on sleep problems caused by cognitive factors such as stress and rumination for women in this period in the literature. Constant physical changes to an individual's body during pregnancy, such as a growing foetus and hormonal changes, may play a big role in relation to sleep disturbance during this period. However, the current study focused on psychological variables related to sleep disturbance during pregnancy, as these are more amenable to intervention, unlike the less controllable physical changes that are an inevitable part of a progressing pregnancy.

Rumination

Evidence has started to link rumination to sleep disturbance in the general population (Pillai & Drake, 2015) and, more recently, in the perinatal population (Kalmbach et al., 2020). Although rumination may be elevated in pregnancy, the literature on ruminative thinking during this period is still in the early stages (Kalmbach et al., 2020). Rumination has been defined as a passive process of repetitively focusing attention on negative effect or the self (Pillai & Drake, 2015). For example, when people are worried and anxious, they may have repetitive negative thoughts about adverse events (Brosschot et al., 2006). Specifically, during pregnancy, this worry and rumination may be about their infant's future (Vafapoor et al., 2018), maternal and foetal outcomes (Bayrampour et al., 2016) or fear of childbirth (Huizink et al., 2017). Rumination (i.e., repetitive negative thinking) is a common emotion regulation strategy for many people with insomnia (Pillai & Drake, 2015). It has been suggested in the literature that repetitive negative thoughts and rumination may have a negative role in sleep quality during pregnancy (Vafapoor et al., 2018). Vafapoor et al. (2018) found that higher repetitive negative thoughts during pregnancy were associated with poorer sleep quality, and emotion dysregulation indirectly affected sleep quality through repetitive negative thoughts. The authors explained their findings due to pregnant women's concerns about the absence of a clear picture of their infants' circumstances after birth,

leading to cognitive and physiological arousal, thereby reducing sleep quality. Furthermore, women may experience repetitive negative thoughts about how much sleep they are getting (Harvey, 2002), possibly as a result of sleep disturbances due to physical issues being a significant factor, as previously mentioned.

Cognitive model of Insomnia

Harvey's (2002) 'Cognitive model of insomnia' suggests that this repetitive negative thought (i.e., worry and rumination) leads to emotional arousals and sleep disturbances. This theory proposes that individuals suffering with insomnia tend to worry about their sleep and about the consequences of not getting enough. This negative cognitive activity triggers emotional distress and autonomic arousal. And selective attention towards internal and external threats to sleep is triggered. According to this model, both factors then trick the individual into overestimating the perceived deficit in sleep, resulting in persistence of sleep disturbances. As there are higher rates of sleep disturbance in pregnancy, possibly due to physical factors and repetitive negative thoughts, pregnant people may be more likely to worry or ruminate on their sleep, which according to Harvey's (2002) theory, may further perpetuate sleep difficulties.

Insomnia and Depression in the Perinatal Period

Rates of depression and suicidal ideation in the perinatal period also exceed the general population (Kalmbach et al., 2020). Though insomnia has been evidenced to be a strong risk factor for depression (Franzen et al., 2008), the role insomnia plays in depression in perinatal women has been inconsistent in the literature (Marques et al., 2011). However, recent evidence from Kalmbach et al. (2021) study found a toxic cycle between insomnia and nocturnal rumination (nocturnal cognitive arousal and perinatal focused rumination) in women in mid-to-late pregnancy; and this cycle predicted future depression. Consistent with findings from the general population (Batterham et al., 2012), Kalmbach et al. (2021) found

the effects of insomnia on depression in perinatal women to be statistically mediated by nocturnal cognitive arousal. Furthermore, this study found that nocturnal cognitive arousal may affect sleep quality in pregnancy. The authors suggest that targeting constructs such as insomnia and cognitive arousal may be key in treating and preventing perinatal depression. Pregnant women prefer non-pharmacological treatments, such as talking therapy over medication for depression (Battle et al., 2013) and sleep problems (Twigg et a., 2016). Therefore, the present study focused on insomnia and cognitive arousal and what may protect pregnant people against them.

Mindfulness

Mindfulness has been a central concept in Buddhist teachings for over two millennia. It is defined in Buddhism as a practice that involves focusing on the mindfulness of breath and bodily sensations, to develop increased awareness and understanding of the nature of mind. In contrast to repetitive negative thought, in which the wandering mind focuses on past wrongs (rumination) and concerns about the future (worry), mindfulness focuses on paying attention on purpose in the present moment and non-judgmental awareness of thoughts (Kabat-Zinn, 1994). And mindfulness has been found to be incompatible with rumination (Segal et al., 2018). In a recent study, Kalmbach et al, (2020) found that everyday mindfulness and nocturnal cognitive arousal had a strong inverse relationship, and both constructs were independently associated with insomnia during pregnancy. They concluded that women could potentially be protected against insomnia and depression by mindfulness, because nocturnal cognitive arousal could be antithetical with everyday mindfulness.

Self-compassion

Another construct that is associated with sleep quality is self-compassion (Brown et al., 2021). Neff (2003) defined self-compassion as “being kind and understanding to oneself in instances of pain or failure, rather than being harshly self-critical”. The Three Circle model

used in Compassion focused therapy developed by Gilbert (2009) depicts three interconnected affect regulation systems (see Figure 3). This model posits that well-being may be impacted when one's threat and drive systems are overactivated and the soothing system is underdeveloped. Likewise, physiological and psychological arousal (together called hyperarousal), described in Harvey's (2002) model of insomnia, is associated with an overactive threat system and an underdeveloped soothing system. Therefore, developing one's soothing parasympathetic system via self-compassion practices (Kirby et al., 2017) might improve sleep.

Figure 3.

Three types of affect regulation systems (Gilbert, 2009)

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Furthermore, a link has started to be drawn between self-compassion and rumination in the general population (Raes, 2010) and between self-compassion and sleep quality in the pregnancy literature, though there is still a gap in understanding (Marques et al., 2016). Marques et al. (2016) study found that pregnant women who were better sleepers had higher

self-compassion scores. They concluded that it might be important to develop self-compassion to improve sleep during pregnancy or reduce the impact of insomnia. Additionally, a reduction in perinatal depression has been associated with self-compassion, which was found to be one of the significant change processes (Townshend & Caltabiano, 2019). Pereira et al. (2020) found that mindfulness and self-compassion dimensions, particularly acting with awareness, observing, and describing and nonjudging of experience, are protective correlates of antenatal depressive "symptoms". One subscale of the scale of the measure they used to look at depressive "symptoms" was sleep difficulties, and they found that factors of both mindfulness and self-compassion predicted sleep difficulties. Therefore, the present study aimed to expand on this to examine the extent to which mindfulness and self-compassion may be protective against poor sleep quality in pregnancy.

Rationale and Aims

In summary, although a full representation of the scope of the current research could not be stated here due to its broad nature, to put it succinctly, the association between mindfulness and sleep has been well evidenced in the general literature, whilst the relationship between self-compassion and sleep quality is less well evidenced. However, there is still a good amount of research in that area. Also, the recent literature has established the association between cognitive arousal and sleep difficulties in pregnancy and the potential link with future depression. Therefore, the present study investigated whether the association that has been found between mindfulness, nocturnal rumination and sleep quality during pregnancy might also be found between self-compassion and these constructs. Similarly, whether the association between self-compassion, rumination and sleep quality observed in the general population (Butz & Stahlberg, 2018) is replicated during pregnancy.

In light of the evidence, the novel aspect of the current project is the consideration of the association of both mindfulness and self-compassion with nocturnal cognitive arousal and

sleep quality during pregnancy. Specifically, of those two constructs (mindfulness and self-compassion), the association between self-compassion and nocturnal cognitive arousal is the most novel element. The rationale for investigating this is to identify whether mindfulness and self-compassion may be factors that could intercept the toxic cycle between cognitive arousal and insomnia, thereby potentially preventing perinatal depression (Kalmbach et al., 2021), with this study intended as a precursor to a possible intervention study. Furthermore, investigating both mindfulness and self-compassion may help identify which aspects of awareness seem protective and are worth cultivating to help with sleep problems during pregnancy.

Hypotheses

In light of these aims, five a priori hypothesis will be tested:

Hypothesis 1. Nocturnal cognitive arousal was expected to have a negative association with sleep quality, mindfulness, and self-compassion during pregnancy.

Hypothesis 2. Sleep quality was expected to have a positive association with self-compassion and mindfulness during pregnancy.

Hypothesis 3. Nocturnal cognitive arousal was expected to statistically mediate the relationship between self-compassion and sleep quality during pregnancy.

Hypothesis 4. Nocturnal cognitive arousal was expected to statistically mediate the relationship between mindfulness and sleep quality during pregnancy.

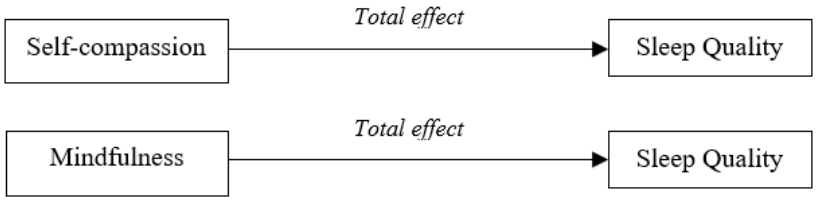
Hypothesis 5. Mindfulness and self-compassion were expected to make independent contributions to this mediation relationship.

The conceptual models for these hypothesized relationships can be seen in Figure 4.

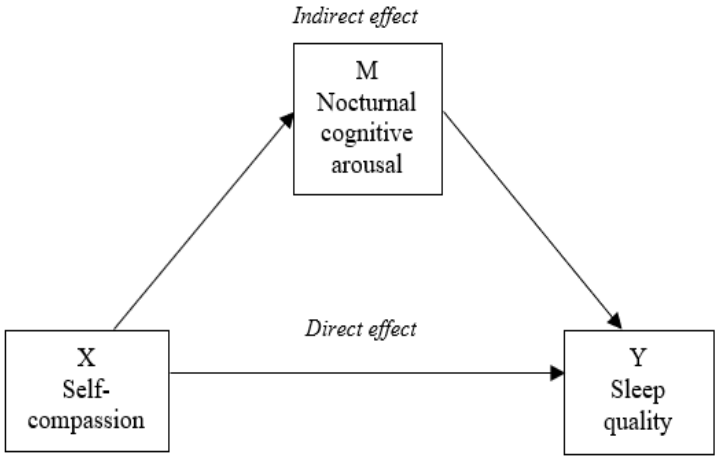
Figure 4.

Conceptual models for the hypothesized relationships

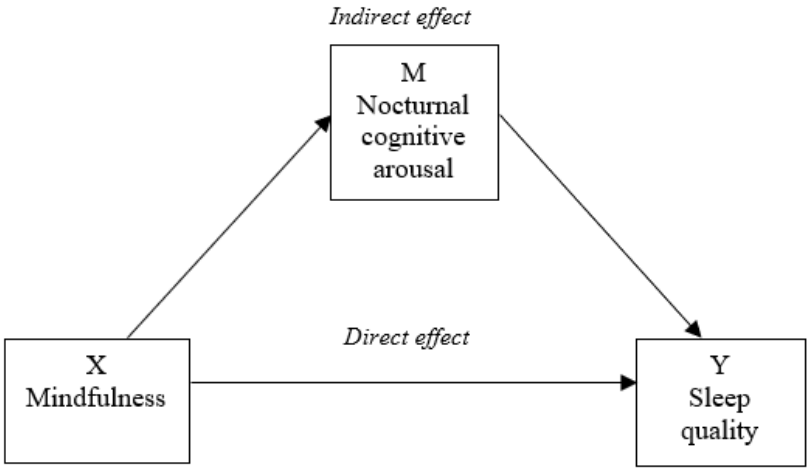
Hypothesis 2. Total effects



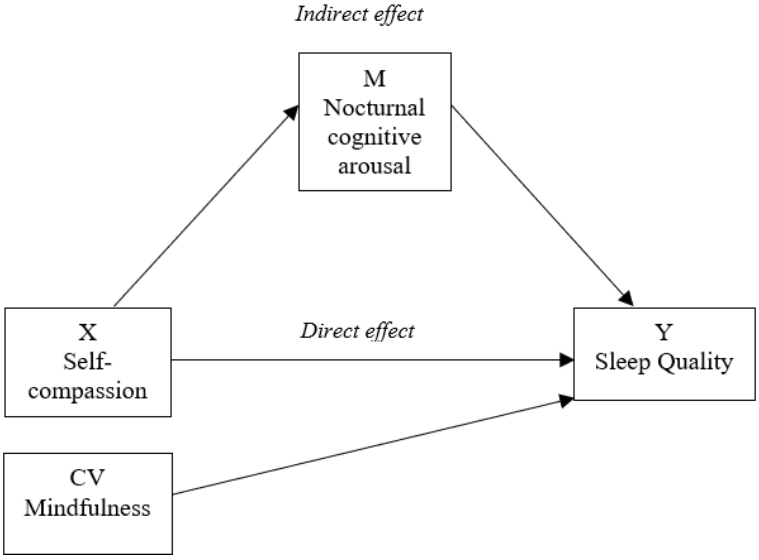
Hypothesis 1 and 3. Direct and indirect effects

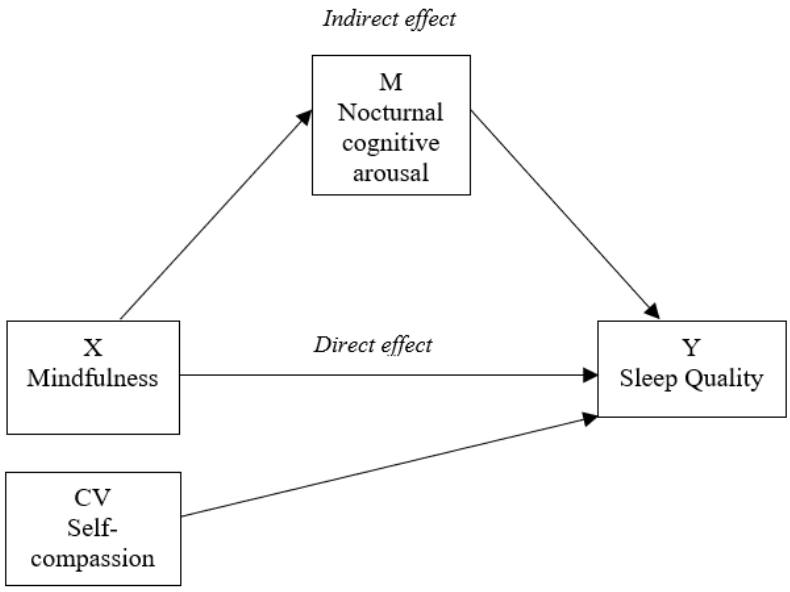


Hypothesis 1 and 4. Direct and indirect effects



Hypothesis 5. Mediation models with covariate





Note. Conceptual models depict the total effect, indirect and direct effects between the variables. X refers to the independent variable, Y refers to the dependent variable, M refers to the mediator, CV refers to the covariate.

Method

Design

This study had a cross-sectional design, which entailed the completion of online self-report questionnaires assessing sleep quality, mindfulness, self-compassion and nocturnal cognitive arousal at one point in time. Due to its cross-sectional nature, this study was not intended to establish causality between variables; instead, regression analyses were used to investigate the significance level of association between variables. This study intended to investigate the variables predicting sleep quality during pregnancy, and therefore, the term ‘predictor’ does not imply causation but refers to this statistical relationship.

Expert by experience involvement

During the study design, several people who were both pregnant or had been pregnant previously were consulted, and these discussions considerably informed how the study was

conducted. For example, the suitability and sensitivity of the demographics questions and debrief sheet wording to this population were discussed.

Participants

The present study aimed to collect data from over 118 participants (discussed further in data analysis). The data from 203 participants (190 female, 6 non-binary, 4 transgenders, 3 preferred not to say) were included in this study. In total 278 participants responded to the online questionnaire, however, 36 were removed due to incomplete data on at least one of the measures. Thirty-three were removed due to not living in the UK and six were removed due to having a body mass index (BMI) before pregnancy of 35 or above. Exclusion criteria is discussed further in the procedure. Most participants were in the 30-39 (51.2%) and 21-29 (45.3%) age groups, and participants were predominantly white (84.7%). Over half of the participants were in their second trimester of pregnancy (53%), with 27.1% in the first and 19.7% in the third trimester. The participants were predominantly married (82.3%) and had not given birth previously (67.5%). Nearly a third of participants (27.6%) had experienced previous perinatal loss and over half (58.6%) had been told by a professional that they were experiencing a high-risk pregnancy.

Participants were recruited from all three trimesters of pregnancy. It was assumed from the literature that the second and third trimesters would be the main areas of sleep disruption. However, from our data, we have shown that it is quite homogenized across these three groups. So, from a sampling perspective, it felt important to include the first trimester in the recruitment to see if there was a difference between these groups. However, no significant difference was found (See Appendix L). Further demographic information can be seen in Table 9.

Table 10.

Sample demographics

Variables		*N*	%
Total		203	100
Trimester	First	55	27.1 %
(Gestational week)	(Conception – 5 weeks)	9	
	(6 -11 weeks)	46	
	Second	108	53%
	(12 -18 weeks)	73	
	(19 – 23 weeks)	35	
	Third	40	19.7%
	(24 – 31 weeks)	18	
	(32 – 40 weeks)	22	
Gender	Female	190	93.5%
	Non-binary	6	3%
	Transgender	4	2 %
	Preferred not to say	3	1.5%
Age	18 – 20	4	2%
	21 – 29	92	45.3%
	30 – 39	104	51.2%
	40 – 49	3	1.5%
	50 – 59	2	1%
	60+	2	1%
Ethnicity	White	172	84.7%
	Asian/Asian British	17	8.4%
	Black/African/Caribbean/Black British	7	3.4%
	Mixed/Multiple ethnic groups	7	3.4%
Highest education achievement	Less than high school diploma	3	1.5%
	High school degree or equivalent	31	15.3%
	Bachelor's degree (e.g., BA, BS)	103	50.7%
	Master's degree (e.g., MA, MS, MEd)	51	25.1%
	Doctorate (PhD, EdD)	13	6.4%
	Prefer not to say	2	1%
Relationship status	Married	167	82.3%
	In a domestic partnership	23	11.3%
	Divorced	5	2.5%
	Single	7	3.45%
	Widowed	1	0.5%
Obstetric information	Given birth previously		
	Yes	66	32.5%
	No	137	67.5%
	Previous perinatal loss		
	Yes	56	27.6%
	No	147	72.4%
	High risk pregnancy		
	Yes	119	58.6%
	No	84	41.4%

Measures

The variables being examined in this study were measured using the following self-report measures. See Appendix F to J for copies of these questionnaires, and details regarding permission of use.

Sleep Quality

The Insomnia Severity Index (ISI; Bastien, Vallieres & Morin, 2001) is a 7-item self-report measure which assesses the nature and severity of respondents' sleep problems e.g., "problems waking up to early". Respondents rate questions according to how each applies to them over the past two weeks. The ratings are on a 5-point Likert scale from 0 (none/very satisfied/not at all) to 4 (very severe/very dissatisfied/very much). Scores ranged from 0-28, with higher scores indicating higher severity. A cut-off score of ≥10 is used to detect insomnia cases in community samples (Morin et al., 2011) and both ≥10 and ≥11 have been advised in pregnant samples (Kalmbach et al., 2022).

The ISI was selected as it has been shown to have good psychometric properties (Morin et al., 2011) and good validity and reliability in pregnant samples (i.e., α >.70). For example, Kalmbach et al. (2020) found this measure to have high internal consistency in pregnant samples (α = 0.90). In the current study, the ISI had high internal consistency (α = 0.87).

Nocturnal cognitive arousal

The Pre-sleep Arousal Scale – Cognitive Factor (Nicassio et al., 1985) is an 8-item self-report scale measuring trait tendency for cognitive arousal while attempting to fall asleep, e.g., "Worry about problems other than sleep". Higher scores reflect greater nocturnal cognitive arousal. The range of scores is from 8 to 40, and a PSAS-C score of ≥ 18 has been recommended for use in the pregnant population to reflect clinically significant nocturnal

cognitive arousal (Kalmbach et al., 2022). The PSAS-C has been shown to have promising psychometric quality, as discussed in section A of this report. Whilst some psychometric properties show reasonable quality, it was shown to have strengths in terms of content validity and internal consistency. This measure has been used extensively in a general population (Lemyre et al., 2020) and Kalmbach et al., (2020) found this scale to have a high Cronbach's alpha of 0.89 in a pregnant sample. Internal consistency was high in the current study (α = 0.86). This measure was chosen to allow comparison with other studies that focused on ruminating at night during pregnancy. The terms nocturnal rumination and nocturnal cognitive arousal are used interchangeably; and this measure has been used as an indicator of nocturnal cognitive arousal.

Self-compassion

The Self-Compassion Scale (Neff, 2003) is a 26-item self-report measure of levels of self-compassion, e.g., "When times are really difficult, I tend to be tough on myself". Respondents rate items on a 5-point Likert scale from 1 (almost never) to 5 (almost always). It comprises six subscales: self-kindness, self-judgment, common humanity, isolation, over-identification and mindfulness. To calculate the total score, negative subscales items (self-judgment, isolation, and over-identification) were reverse scored before totaling. In the present study, the total SCS score was calculated without the mindfulness subscale due to the overlap with mindfulness as a construct, which was measured by another scale, and the total score was used as opposed to the total mean. Higher scores can be interpreted as higher levels of self-compassion. The SCS has been found to have good reliability and validity across various contexts and populations (Neff, 2016), and Neff, (2003) found it to have good test-retest reliability (.85 to .93) and internal consistency (α =.92). It has been used in pregnant samples (Townshend & Caltabiano, 2019), and the total SCS score and SCS without the mindfulness subscale demonstrated good internal consistency in the current sample (α =

0.80).

Mindfulness

The Five Facets of Mindfulness Questionnaire is a 39-item self-report measure (Baer et al., 2006) of the trait-like tendency to be mindful in daily life. It encompasses five facets: observing (e.g. “When I’m walking, I deliberately notice the sensations of my body moving”), describing (e.g., “I can easily put my beliefs, opinions, and expectations into words”), acting with awareness (e.g. “I am easily distracted”), non-judging (e.g., “I tell myself I shouldn’t be feeling the way I’m feeling”) and non-reactivity (e.g. “I watch my feelings without getting lost in them”). Respondents rate items on what is ‘generally true’ for them on a five-point Likert scale from 1 (never or rarely true) to 5 (very often or always true). The total was calculated once negatively worded statements were reverse coded. Total scores range from 39 to 195, and higher scores indicate greater levels of trait mindfulness.

Evidence of the FFMQ’s psychometric properties has been shown (Shallcross et al., 2020; Baer et al., 2008), and support for good construct validity (Christopher et al., 2012) and internal consistency. For example, previous studies found Cronbach’s alphas ranging from .75 to .88 for individual scales in a study focusing on mindfulness and sleep (Xie et al., 2023). The FFMQ has also been shown to have good validity and reliability in pregnant samples (Kantrowitz-Gordon, 2017) and showed good internal consistency in the current study ($\alpha = 0.73$).

Demographics

Participants were asked demographic questions and questions about variables identified in the literature to be related to the perinatal period (Kalmbach et al., 2019). These included age, gender, ethnicity, education, relationship status, gestational age/pregnancy trimester, BMI and obstetric information. Prenatal sleep disparities are related to obesity (Kalmbach et al.,

2019), and sleep-disordered breathing and obstructive sleep apnoea are elevated during pregnancy (Pien et al., 2014). Due to these theoretical links, this potentially confounding variable was controlled in the current study by removing participants with a BMI score ≥ 35 before the data was analysed. This aligns with criteria utilised by other studies measuring sleep in the pregnant population (Kalmbach et al., 2019) and reflects criteria taken from the commonly used sleep apnoea screener, STOP-bang questionnaire (Chung et al., 2016).

Procedure and Ethical issues

The Ethics Panel, at Salomons Institute for Applied Psychology, Canterbury Christ Church University approved this study (Appendix A). A convenience sampling strategy was used, with this study advertised on social media platforms and online forums for pregnant people using a virtual advertising poster (see Appendix B). This virtual poster included vital information about the study, the main inclusion criteria, and a hyperlink to an anonymous survey using the platform Qualtrics. This hyperlink led to an information sheet about the study (Appendix C), which included more detailed information, including the nature of the questions in the survey. Before agreeing to participate, participants were asked to consider issues or questions that may arise or cause distress due to completing the survey. Participants were informed that they could withdraw at any time and that a debrief sheet with contact information of suggested organisations for support to manage any concerns that may have been raised, was available either at the end of the survey or if they withdrew early. Participants were then taken to the consent form (Appendix D), which required participants to give consent to take part in the study before they were taken to a socio-demographic questionnaire (Appendix E), study questionnaires (Appendix F - C) and finally, the debrief sheet (Appendix K). The inclusion criteria were that participants had to be pregnant, over 18 years old and currently living in the UK.

At the end of this survey, participants were offered the option to enter a prize drawer

for one of four available £25 Amazon vouchers and to receive a summary of the study outcome (Appendix M). For this, participants were directed to a separate survey to provide contact details, and they were made aware that this information would be kept separately from their questionnaire answers.

Statistical Analysis and Statistical power

The Statistics Package for the Social Sciences (SPSS, Version 29) was used to perform descriptive, correlational and mediation analyses. The associations between measures were established using Pearson correlation analysis to address Hypothesis 1. Descriptive statistics were used to examine the measures' mean, SDs and internal consistency (Cronbach's alpha) and to explore the demographics of the sample. The minimum acceptable Cronbach's alphas value given by Bland and Altman (1997) of 0.70 was utilised. Haye's (2018) bootstrapping approach to mediation analysis, using the PROCESS macro for SPSS, was performed. Five thousand bootstrap samples were generated, and bias-corrected 95% confidence intervals were calculated. PROCESS was employed as it is a robust approach that did not require assumptions around the normality of the distribution and homoscedasticity (Hayes, 2018, pp. 125-126). The data was checked for multicollinearity using Pearson's correlation coefficients and presented in a correlation matrix. A correlation of 0.9 or above was considered a potential multicollinearity problem (Fields, 2018, p. 491). Mindfulness and self-compassion were added into separate mediations as predictors, with sleep quality as the response and nocturnal cognitive arousal as the mediator, to address Hypotheses 2, 3 and 4. Follow-up analyses were conducted to address Hypothesis 5 by repeating these mediations but with the alternate predictor added as a covariate.

The study aimed to collect data from a minimum of 118 participants. This was based on estimating the number of participants needed for a mediation analysis due to the effect sizes between the study variables in the literature. The association between mindfulness and

nocturnal cognitive arousal has been reported as r = -.61, and between nocturnal cognitive arousal and sleep quality as r = -.65 in pregnant populations (Kalmbach et al., 2020), whilst the association between self-compassion and nocturnal cognitive arousal has been less evidenced. In a model with one mediator, and to account for the unclear effect size of self-compassion, an H effect size (0.26) along with a large (L) effect size (0.59) was anticipated for the paths. Therefore, the sample size needed to obtain a power of .8 is N=118 (Fritz & Mackinnon, 2007).

Results

Descriptive statistics

Table 10 shows the means, SD, correlations, and Cronbach's alphas of all the measures. Means scores and SD of all measures were comparable to scores in other pregnant (Kalmbach et al., 2021; Kantrowitz-Gordon, 2017) and non-pregnant samples (Neff & McGehee, 20**10)**. The mean score for the current sample was above the cut-off for the ISI and the PSAS-C, indicating clinical insomnia and high nocturnal cognitive arousal (Kalmbach et al., 2022). As no Pearson's correlation coefficients were above 0.9, multicollinearity was not considered an issue (Fields, 2018, p. 491). Lastly, all study measures showed acceptable Cronbach's alphas (Bland & Altman, 1997). The ISI, SCS and PSAS-C were above 0.80, indicating high internal consistency.

Correlation Analysis

The first Hypothesis was investigated using Pearson's correlation analyses. Spearman's correlation coefficients were also explored; however, a notable difference between findings was not found. Therefore, the authors reported Pearson's correlation coefficient. Two-tailed Pearson's correlation coefficients are shown between all variables in Table 10. The bivariate correlations with sleep quality were significant except for the mindfulness scores.

Mediation analysis

The language from the mediation literature was adopted to describe the mediation analyses, such as the indirect, direct, and total effects (Hayes, 2018). Therefore, the term ‘effect’ is used as a statistical term, rather than implying causation.

Hypothesis 1. Nocturnal cognitive arousal was expected to have a negative association with sleep quality, mindfulness, and self-compassion during pregnancy.

Nocturnal cognitive arousal was found to have a significant association with sleep quality, mindfulness and self-compassion in this sample (see Table 2). The relationships were all found to be negative. Indicating that higher levels of nocturnal cognitive arousal were associated with poorer sleep quality, lower levels of self-compassion, and finally, lower levels of mindfulness. A positive value was reported between sleep quality and nocturnal cognitive arousal in Table 10. However, as higher scores on the sleep quality measure (ISI) indicate poorer sleep quality, this represents a negative statistical association. Therefore, Hypothesis 1 was supported.

Hypothesis 2. Sleep quality was expected to have a positive association with self-compassion and mindfulness during pregnancy.

In keeping with Hypothesis 2, a 95% confidence interval for the ‘total effect’ in the mediation model was completely negative (-.280, -.137), indicating that greater levels of self-compassion were significantly associated with greater sleep quality (i.e., lower ISI scores). This model can be seen in Figure 5. However, greater levels of mindfulness were not significantly associated with greater sleep quality, as indicated by a 95% confidence interval for the ‘total effect’ in the mediation model that included zero (-.095, .035). This model can be seen in Figure 4. As higher scores on the ISI indicate poorer sleep quality, and higher scores on the measures for self-compassion and mindfulness indicate greater levels of these constructs, the relationships in Table 10 show a negative value, for a positive statistical association. Therefore, Hypothesis 2 was in part supported by a significant positive association found between sleep quality and self-compassion.

Hypothesis 3. Nocturnal cognitive arousal was expected to statistically mediate the relationship between self-compassion and sleep quality during pregnancy.

In accord with Hypothesis 3, when nocturnal cognitive arousal was included as a mediator of the association between self-compassion and sleep quality, the mediating pathway was significant, as indicated by a 95% bootstrapped confidence for its indirect effect that did not include zero (-.231, -.085). This suggests that lower levels of self-compassion were associated with higher levels of nocturnal cognitive arousal, which was in turn associated with poorer sleep quality (i.e., higher ISI scores). The "direct effect", which refers to the part of the association between self-compassion and sleep quality that was not mediated by nocturnal cognitive arousal, was not significant in this mediation, as evidence by a 95% confidence interval which crossed zero (-.121, .004). As the direct effect was not significant, once the mediator was included, everything in this analysis can be explained by this indirect pathway, through the statistical mediator. In other words, the association between self-compassion and sleep quality in this sample, is explained by the association with nocturnal cognitive arousal. This model can be seen in Figure 7.

Hypothesis 4. Nocturnal cognitive arousal was expected to statistically mediate the relationship between mindfulness and sleep quality during pregnancy.

Regarding Hypothesis 4, when nocturnal cognitive arousal was included as the mediator of the association between mindfulness and sleep quality, the mediating pathway was significant, shown by a 95% bootstrapped confidence for its indirect effect that did not include zero (-.137, -.040). Suggesting that lower levels of mindfulness were associated with higher levels of nocturnal cognitive arousal, which was in turn associated with poorer sleep quality (i.e., lower ISI scores). Further to the indirect effect, there was a significant "direct effect" between mindfulness and sleep quality, according to the confidence interval, which did not span zero (.0082, .1064). The part of the mindfulness and sleep quality association that was not mediated by nocturnal cognitive arousal, is represented by this "direct effect". In

sum, the direct association between mindfulness and sleep quality, combined with the indirect association between them via nocturnal cognitive arousal, constitutes the total mindfulness and sleep quality association. Although there was no total effect, there was a significant direct effect in one direction and a significant indirect effect in the opposite direction, which will be returned to in more detail in the discussion. This model can be seen in Figure 6.

Hypothesis 5. Mindfulness and self-compassion were expected to make independent contributions to this mediation relationship.

To investigate whether mindfulness and self-compassion made independent contributions to this statistical mediation, these analyses were repeated, with the alternate independent variable as a covariate in the mediation (i.e., either controlling for mindfulness when self-compassion was predicting sleep quality or controlling for self-compassion when mindfulness was predicting sleep quality), to see if the total, indirect and direct effects were significant.

When nocturnal cognitive arousal was included as a mediator of the association between self-compassion and sleep quality, with mindfulness included as a covariate, the mediating pathway remained significant, as shown by a 95% bootstrapped confidence for its indirect effect that did not include zero (-.223, -.069). The total effects also remained significant, with confidence intervals not crossing zero (-.306, -.152), however, unlike the previous model, the "direct effect" was significant (-.155, -.028). The indirect, direct and total effects of this model, as well as the strengths of the paths can be seen in Figure 7.

When nocturnal cognitive arousal was included as a mediator of the association between mindfulness and sleep quality, with self-compassion included as a covariate, the mediating pathway was not significant, as indicated by a 95% bootstrapped confidence for its indirect effect that crossed zero (-.078, .009). The "total effect" was also not significant, with

confidence intervals crossing zero (-.020, .110), however, the “direct effect” was significant, with confidence intervals spanning zero (.029, .130). Therefore, when self-compassion was added as a covariate in this mediation, the pattern between these variables changed, such that there was now no significant total effect, or indirect effect, but there was a significant direct effect. This will be returned to in more detail in the discussion. The indirect, direct, and total effects of this model, as well as the strengths of the paths can be seen in Figure 8.

Table 11.

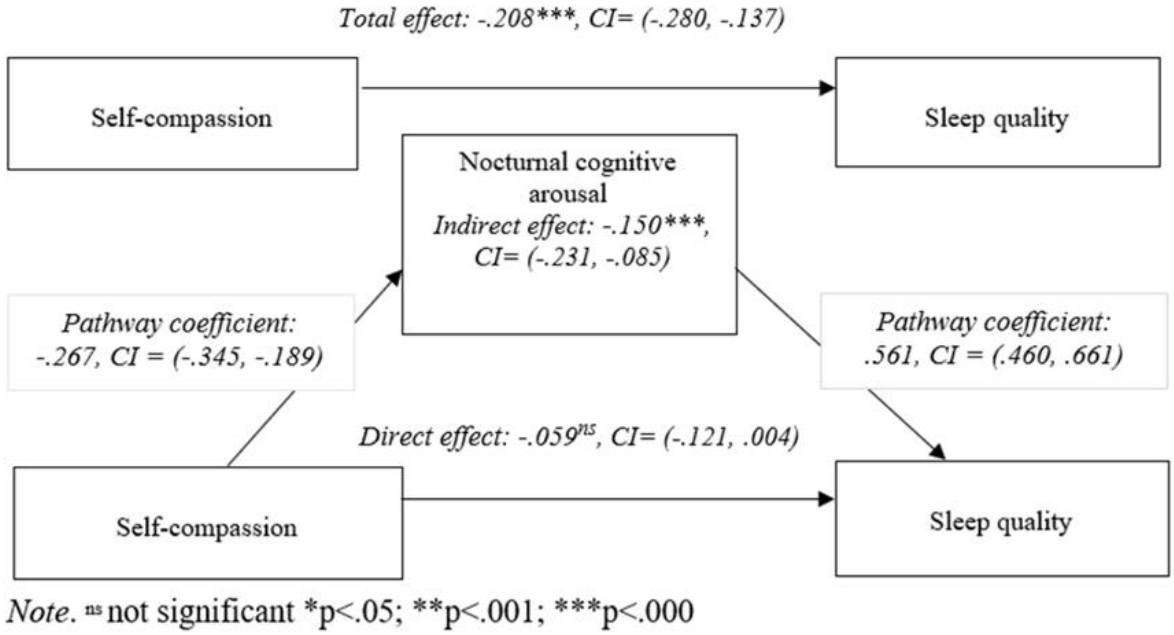
Descriptive Statistics and Pearson's Correlations of Variables

	Sleep quality[1] (0-28)	(a) Self-compassion[2] (26-130)	(b) Self-compassion (without mindfulness subscale)[3] (22-110)	(c) Mindfulness[4] (39-195)	(d) Nocturnal cognitive arousal[5] (8-40)
(a) Self-compassion[2]	-.322**	-	-	-	-
(b) Self-compassion (without mindfulness subscale)[3]	-.376**	.977**	-	-	-
(c) Mindfulness[4]	-.064	.444**	.386**	-	-
(d) Nocturnal cognitive arousal[5]	.674**	-.369**	-.430**	-.264**	-
Means (SD)	12.62(5.005)	79.37(9.936)	66.75(9.045)	121.85(10.73)	21.83(5.62)
Cronbach's Alphas	0.87	0.80	0.80	0.73	0.86

Note. $N = 203$; **p<.001; *SD* = Standard Deviation; [1]Insomnia Severity Index; [2]Self-Compassion Scale; [3]Self-Compassion Scale without Mindfulness subscale; [4]The Five Facet Mindfulness Questionnaire; [5] Pre-sleep Arousal Scale-Cognitive factor.

Figure 5.

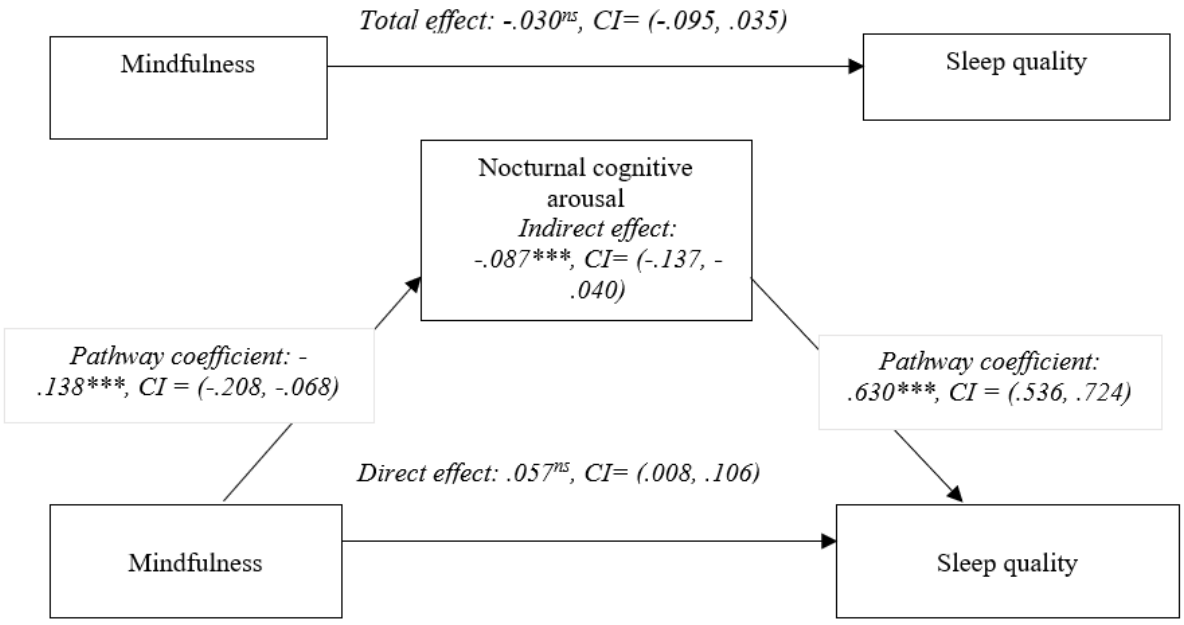
Mediation Model for Nocturnal Cognitive Arousal as a Mediator for Self-Compassion and Sleep Quality Relationship in a Statistical Diagram



Note. ns not significant *p<.05; **p<.001; ***p<.000

Figure 6.

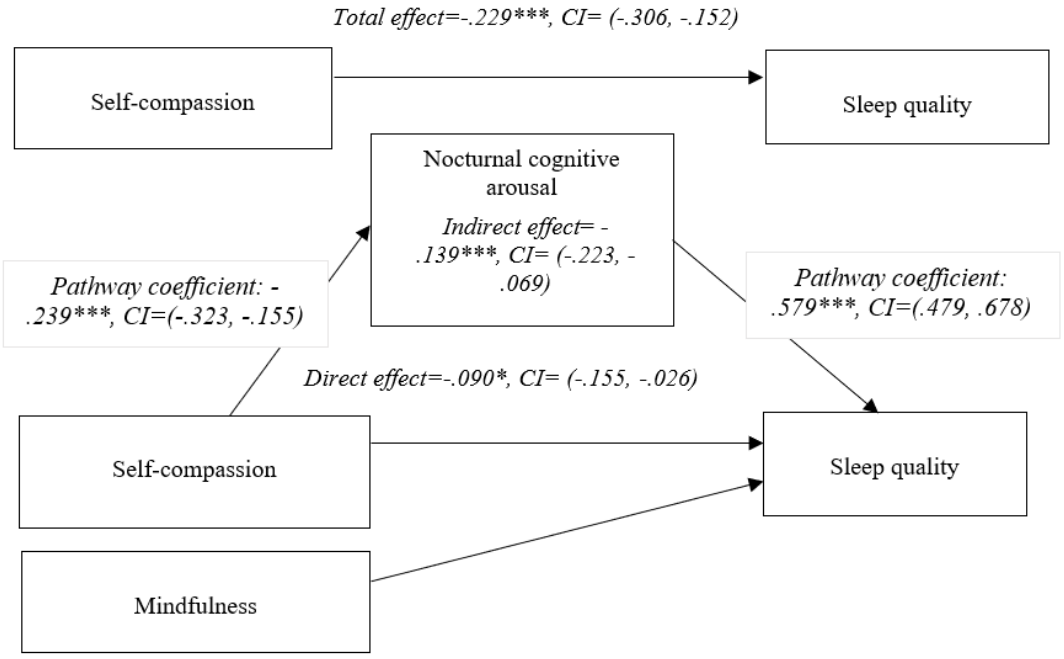
Mediation Model for Nocturnal Cognitive Arousal as a Mediator for Mindfulness and Sleep Quality Relationship in a Statistical Diagram



Note. ns not significant *p<.05; **p<.001; ***p<.000

Figure 7.

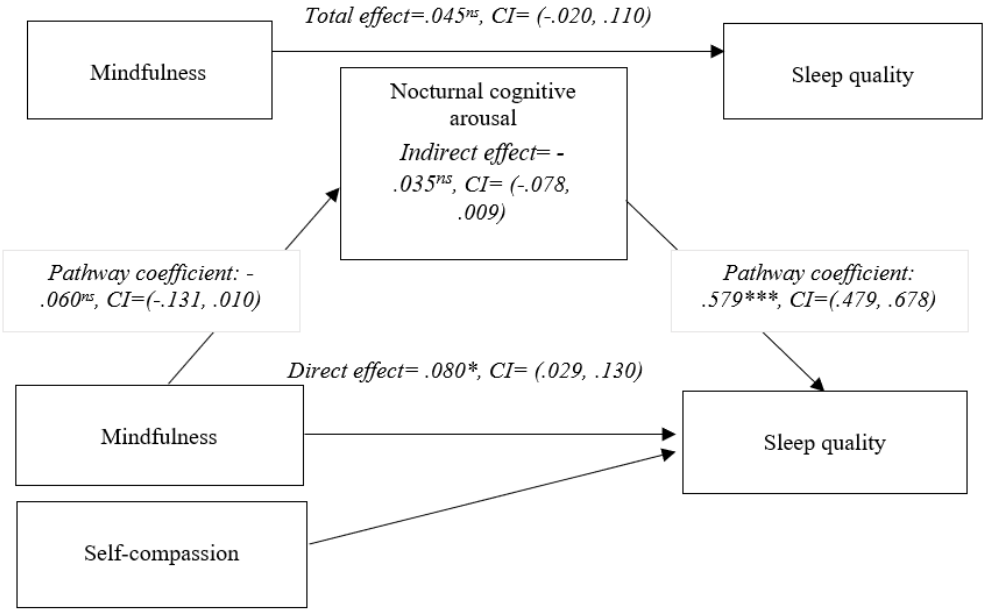
Mediation Model for Self-Compassion, Nocturnal Cognitive Arousal, and Sleep Quality, with Mindfulness added as a Covariate



Note. ns not significant *p<.05; **p<.001; ***p<.000

Figure 8.

Mediation Model for Mindfulness, Nocturnal Cognitive Arousal and Sleep Quality, with Self-Compassion added as a Covariate



Note. ns not significant *p<.05; **p<.001; ***p<.000

Discussion

This study investigated the role of nocturnal cognitive arousal, self-compassion, and mindfulness in sleep quality during pregnancy. The present study findings supported Hypothesis 1, that higher levels of mindfulness were associated with lower levels of nocturnal cognitive arousal, consistent with previous studies that found a similar association in pregnancy (Kalmbach et al., 2020). Also, in line with Hypothesis 1 is the finding that higher levels of self-compassion were associated with lower levels of nocturnal cognitive arousal, consistent with previous studies examining similar associations in a student population (Raes, 2010), and to the author's knowledge, is evidenced for the first time in this study in the pregnant population. Lastly, the finding that higher levels of nocturnal cognitive arousal were associated with poorer sleep quality, supported what has been consistently demonstrated in previous research on this association in pregnancy (Kalmbach et al., 2020).

Results indicated higher levels of self-compassion were associated with better self-reported sleep quality (supporting Hypothesis 2), in line with previous research examining this association in a student population (Brown et al., 2021) and the pregnant population (Marques et al., 2016). However, Hypothesis 2 was only partly supported, as the present study did not replicate findings to reveal evidence of a significant association between mindfulness and sleep quality (Kalmbach et al., 2020). This might be explained by the measure of mindfulness used in the current study capturing a slightly different construct to previous studies. The FFMQ has been examined and reported to be a robust measure with comparable psychometric properties to the Cognitive and Affective Mindfulness Scale – Revised (CAMS-R), a measure which has been used to measure mindfulness in previous findings (Baer et

al., 2006). However, the CAMS-R measures everyday mindfulness, whilst the FFMQ measures trait mindfulness. Therefore, future research might need to test this finding with a measure of everyday mindfulness.

Furthermore, a possible impact of a significant number of participants experiencing high-risk pregnancies in this sample is that these individuals may be experiencing their bodies as threatening. Increased body awareness may have a negative impact due to increased awareness or focus on the risks associated with pregnancy. Failure to find a relationship between mindfulness and sleep quality in this sample, may reflect a lack of a relationship in this population. Specifically, a higher proportion of participants with high-risk pregnancies compared with previous similar studies, may indicate a possible limitation of mindfulness with this particular population. This could indicate that theory in relation to this may be flawed or incomplete. As the John Kabat-Zinn's definition of mindfulness is about "anchoring your attention on purpose without judgement in the present moment", it might be that future research may want to explore the idea of anchoring attention to something other than the body, to reduce ruminative cycles in pregnancy.

Results showing that nocturnal cognitive arousal statistically mediated the association between self-compassion and sleep quality, supported Hypothesis 3. This finding was consistent with other studies that found a similar association in a student population (Butz & Stahlberg, 2018), but was a novel finding in the current study in a pregnant population.

Hypothesis 4 was supported by the findings that nocturnal cognitive arousal statistically mediated the association between mindfulness and sleep quality. This is consistent with similar findings to Kalmbach et al. (2020), who suggested from their findings that ruminating at night during pregnancy was associated with insomnia, and

mindfulness might protect against this. However, there was a significant direct effect counteracting this mediation effect in the opposite direction, such that lower mindfulness predicted higher nocturnal cognitive arousal, which in turn predicted lower sleep quality, and therefore overall, there was no significant total effect, or in other words, no overall statistical relationship between mindfulness and sleep quality. As per Fritz et al. (2012), one possible explanation for this is that there is a significant indirect pathway between mindfulness and sleep quality through nocturnal cognitive arousal as hypothesized; however, there is another process that is happening between these constructs, possibly via some other mediating variables that have not been measured in this study, acting in the opposite direction. Thus, there is no overall statistical relationship between these two variables.

Self-compassion and mindfulness were found to separately predict sleep quality, as they both had a statistically mediated pathway through nocturnal cognitive arousal. However, mindfulness and self-compassion are highly correlated (in this data, they were significantly correlated) and an overlap exists between them. Therefore, Hypothesis 5 explored this to ask, beyond this overlap, to what extent did they contribute independently. When mindfulness was controlled for in the mediation between self-compassion and other variables, the indirect, direct, and total effects were significant, suggesting that the self-compassion scale added something in addition to mindfulness. Whereas, when self-compassion was controlled for in the mediation between mindfulness and other variables, there was not a significant total or indirect effect of mindfulness but a significant direct effect. As there was a significant direct effect, some form of suppression may be happening (Paulhus et al., 2004). However, it is unclear what explains this pattern of results, and it would be helpful for this to be replicated to check if this is just a spurious finding.

Despite this potentially spurious finding, these results suggest that the mindfulness scale did not add any additional predictive value because there was no total and indirect effect of mindfulness when we controlled for self-compassion. In other words, self-compassion appears to be statistically the important component in this sample because mindfulness and self-compassion overlap; however, there seems to be, overall, nothing unique about mindfulness that is added beyond self-compassion.

Considering these findings in relation to theory, lower levels of self-compassion and mindfulness were associated with higher nocturnal cognitive arousal, including participants worrying about "problems other than sleep", potentially about pregnancy-related concerns (Vafapoor et al., 2018), and "worry about falling asleep", consistent with Harvey's (2002) model of insomnia. In turn, higher nocturnal cognitive arousal was associated with poorer sleep quality. This might be due to pregnancy-related rumination, or more opportunity for cognitive arousal when lying awake at night due to heightened sleep disturbance in pregnancy (Kalmbach et al., 2021), possibly because of increased physical and hormonal factors that keep pregnant people awake. This reflects Gilbert's (2009) Three Circle Model, as higher levels of nocturnal cognitive arousal potentially represent an overactive threat system in pregnancy, whilst lower levels of self-compassion and mindfulness may represent an underactive soothing system. This imbalance of the regulation systems would impact on sleep quality. Therefore, enhancing self-compassion or mindfulness may theoretically boost the soothing system, to balance these three affect regulation systems, or serve to prevent the threat system from becoming activated at all (Gilbert, 2009).

Whilst the findings of statistical mediation can be an important element in indicating that a construct plays a causal role, it is not enough to be conclusive, and does not prove there is a mediation relationship (Kazdin, 2007). Therefore, we can hypothesize that nocturnal cognitive arousal mediates the association between self-compassion and mindfulness with sleep quality in pregnancy, however, other steps need to be considered and investigated, such as these findings could be replicated longitudinally to test these hypotheses and whether associations are similar temporally.

Strengths and Limitations

The strength of the present study is that it is well powered (Fritz & MacKinnon, 2007) and theoretically driven. This study was built on existing empirical research, and the scales used to measure the constructs are standardized measures that have been used in this population previously (Kalmbach et al., 2020; Kantrowitz-Gordon, 2017; Townshend & Caltabiano, 2019).

The limitations of this study are that due to the cross-sectional design, how the measures assess the constructs in this study relate to each other over time cannot be deduced, as mentioned above. Furthermore, there may be limitations to the sample from which these findings were drawn. Participants were recruited through online platforms and relied on a self-report method of data collection. As this method is voluntary and relies on individuals accurately reporting their information, these aspects may reduce the reliability of the data (Paulhus & Vazire, 2007). Another limitation is the potential impact of common method variance due to using one data collection method of multiple variables (Podsakoff et al., 2003). Common method variance can present spurious relationships, suppress, or inflate the indirect effects observed between variables, resulting in inaccurate conclusions about the underlying

mechanisms of constructs (Podsakoff et al., 2003). To overcome these issues, future research about the relationship between these constructs could take a triangulation design (Denzin, 1970) such as asking qualitative questions in addition to self-report measures to explore individual's experiences in relation to these constructs, or through discussions with partners.

Furthermore, the study sample was majority white and married, and over half of participants reported experiencing a high risk pregnancy. These characteristics are higher than what has been reported of the UK pregnant population (Office for National Statistics, 2020) and therefore, generalizability is limited. Future research with a more diverse sample is needed. Lastly, there were some limitations with regard to the psychometric properties of the PSAS-C used to measure nocturnal cognitive arousal, addressed in Section A of this report. Whilst it showed reasonable psychometric properties, findings should be interpreted in light of these limitations.

Future research

In addition to replicating the associations found in this study, further steps need to be investigated, such as breaking down the components of both self-compassion and mindfulness to examine what overlaps between them, and what is unique about each of their predictive value. Also, future research could experimentally examine the impact of increasing self-compassion or mindfulness during pregnancy on sleep quality, to help clarify the causal relationships between these constructs. Furthermore, future studies might want to measure objective as well as self-report measures of sleep in pregnancy, to offer more of a thorough picture of sleep quality and how sleep changes during this period. Lastly, future research might want to replicate these findings in populations other than the perinatal population, to test whether these

associations between self-compassion, mindfulness, nocturnal cognitive arousal and sleep quality are universal or unique to pregnancy.

Practice implications

Given the findings, and holding them tentatively, the implications arising out of this study may be applied with perinatal mental health and service development in mind. The NHS long term plan highlights the importance of early intervention and prevention of mental health difficulties in perinatal mental health and highlights the importance of addressing sleep problems during pregnancy (NHS Long Term Plan, 2019, p. 59). Addressing sleep disturbance in pregnancy is paramount due to its high prevalence and the seriousness of its consequences. Sleep disturbance may be a risk factor for postpartum depression and anxiety (Kalmbach et al., 2021) which in turn may increase the risk of postnatal psychosis (Munk-Olsen et al., 2006). Therefore, the findings of the current study that self-compassion in addition to mindfulness may be aspects of awareness that could be potentially protective, have important implications for early intervention and prevention of later perinatal mental health difficulties.

One of the NHS values states that service users have the right to be treated with respect and dignity, and to have their individual preferences considered. Research has shown that pregnant women prefer talking therapy over medication (Twigg et a., 2016), and therefore identifying non-pharmacological interventions as well as what target to improve sleep quality in this population is of great value.

Finally, clinicians who specialize in sleep or work in perinatal mental health teams might want to be aware of self-compassion in addition to mindfulness approaches for pregnant people with sleep difficulties. Specifically, clinicians may be encouraged to ask a question about the level of self-compassion as well as

mindfulness, or possibly use a self-compassion measure, if pregnant people report sleep disturbance or cognitive hyperarousal at night, impacting their sleep.

Moreover, the findings from this report suggest that self-compassion may be a more powerful component for sleep difficulties in pregnancy, particularly those experiencing a high-risk pregnancy. Clinical psychologists working for this client group may benefit from using self-compassion-based approaches, which would require more training for clinicians, adopting group-based approaches and continual professional development opportunities. Alternatively, mindfulness interventions could be applied clinically by adapting the intervention to anchor awareness on a different part of the body or using sound or imagery.

Conclusion

To conclude, nocturnal cognitive arousal was a statistical mediator of the association between self-compassion and sleep quality, and this mediation remained significant when mindfulness was controlled for. Nocturnal cognitive arousal was a statistical mediator of the association between mindfulness and sleep quality; however, this mediation did not remain significant when self-compassion was controlled for. The hypotheses were met in the vast majority of cases. However, there was one mediation where a strange pattern of findings was observed, and it was unclear why this was the case. Given that this is a potentially surprising finding and occurs once in these findings, it would be helpful to be replicated to check whether something underlying is happening. Overall, the findings suggest that lower levels of mindfulness and self-compassion were associated with higher levels of nocturnal cognitive arousal, which was, in turn, associated with poorer sleep quality. Also, there may be something distinct about self-compassion and mindfulness that is predictive of sleep quality, over

and above the overlap between them. There is something unique that the self-compassion scale appears to be tapping, other than mindfulness, but potentially not that the mindfulness scale is tapping in addition to self-compassion.

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Appendix of supporting material

Appendix A

Ethical approval

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Appendix B

Study advertisement

Appendix C

Information sheet

Information about the research

A quantitative study on nocturnal rumination and sleep quality in pregnancy: Exploring relationships with self-compassion and mindfulness.

What is the purpose of the study? We would like to hear from pregnant women or people about their sleep during pregnancy. Difficulty with sleep quality is often experienced during pregnancy. We are interested in finding out how sleep is affected and what characteristics may be protective of sleep problems. You are invited to complete some questions about these topics in this survey to meet the aims.

Can I take part? To participate in the study, you need to be a pregnant woman or person living in the UK and over 18. It is up to you to decide whether to join the study. Taking part is simple and can be done on a phone, tablet or laptop.

What will happen to me if I take part? If you are interested in taking part, you will be asked to give consent on the next page. You are free to withdraw at any time without giving a reason. You will then be asked some sociodemographic information about your age, gender identity, education, relationship status, BMI before pregnancy, ethnicity and obstetric information. You will then be asked to complete a series of questionnaires online about your sleep quality, rumination at night, everyday mindfulness and self-compassion. Altogether the questionnaires should take no longer than 20 minutes to complete, but you may complete them more quickly than this.

Will my answers be kept private? Your participation in this study will be anonymous as we will not ask for your name or any other information that can be used to identify you. As a result, none of the researchers will know who you are.

Do I have to take part? It is up to you to decide whether to join the study. You are free to withdraw at any time.

What are the possible disadvantages and risks of taking part? Though we do not anticipate this survey to cause significant distress, we will be asking you to think about your experience of your sleep quality and your level of mindfulness, self-compassion and rumination, which may raise some questions for you that you may find distressing. If you feel this may occur, please do think about whether you want to take part in this study. You are able to withdraw from the study at any time by just leaving the website. A 'Debrief sheet' is available on this website if at any time you feel distressed and would like some support or would like some suggestions for how to manage your concerns. This might support you in managing any difficult thoughts or feelings that you may have after completing the questionnaires. It will also signpost you to where you can access additional support.

What are the possible benefits of taking part? Sleep difficulties are common in pregnancy, and so far, there is little known about what could help with this. Your responses to this study will improve our understanding of the experience of sleep problems in pregnancy and will help us to understand more about what elements may protect against sleep difficulties. We cannot promise the study will help you directly, but the information we get from this study may help to improve the treatment for pregnant women or people experiencing sleep problems. As a thank you for taking part, you will have the option of being entered into a prize draw with the chance to win one of four available £25 Amazon vouchers.

What if there is a problem? If you have a concern about any aspect of this study, you should ask to speak to me and I will do my best to address your concerns. You can contact me by leaving a message on the 24-hour voicemail phone number 01227 927070. Please leave a contact number and say that the message is for me [Grace Windsor], and I will get back to you as soon as possible. If you remain dissatisfied and wish to complain formally, you can do this by contacting Dr Fergal Jones, Clinical Psychology Programme Research Director, Salomons Institute for Applied Psychology –fergal.jones@canterbury.ac.uk. If you have any further questions about the study you may contact the Principle Investigator, Grace Windsor at gw318@canterbury.ac.uk. If you have any concerns or a complaint about any aspect of this study, you may email the Chief investigator Holly Milling at holly.milling@canterbury.ac.uk. Researchers can be contacted at any time, should you feel that you need further support as a result of this research project.

Will information from or about me from taking part in the study be kept confidential? We will follow legal and ethical practice and all information about you will be handled in confidence.

- Data will be collected online via this website.
- The data collected will be stored securely. Your data will be anonymous and coded, and your email address will be kept separate to your data.
- The data may be retained for use in future studies.
- Authorised persons such as researchers, sponsors, regulatory authorities & R&D audit will have access to view data that include your identity (for monitoring of the quality of the research).
- The data collected will be retained for 10 years and will be disposed of securely.
- The only time when I would be obliged to pass on information from you to a third party would be if, as a result of something you told me, I were to become concerned about your safety or the safety of someone else. All information which is collected from or about you during the research will be kept strictly confidential. You have the right to check the accuracy of data held about you and correct any errors.

What will happen if I don't want to carry on with the study? You can withdraw your participation in this survey at any time without consequences, and you can do this by leaving the web page at any time during the survey. Once you have contributed information to the survey and clicked "submit", that information cannot be withdrawn

from this study.

What will happen to the results of the research study?

· The results of this study may be published. If this is the case participants will not be identified in any report/publication.

· The results of this study will be made available to participants in a letter by email, should you select this option.

· Your answers to questionnaires may be used in published reports.

· There is an intention that the data will be available for use in other studies.

· Canterbury Christ Church University is sponsoring and funding this research.

Who has reviewed the study? This study has been reviewed and given favourable opinion by Salomons Ethics Panel, Salomons Institute for Applied Psychology, Canterbury Christ Church University.

Thank you

Thank you for taking time to read this information sheet and for considering volunteering for this research.

I'm Interested! What's Next?

Please click next to complete the consent form if you would like to participate. You will then be taken to the online survey.

Appendix D

Consent form

CONSENT FORM

A quantitative study on nocturnal rumination and sleep quality in pregnant women: Exploring relationships with self-compassion and mindfulness.

I have read and understood the information sheet for the above study. I have had the opportunity to consider the information and ask any questions I would like to.

- I confirm that I have read and understood the study information sheet for the above study
- I confirm that I am currently pregnant
- I live in the UK
- I am over 18 years old
- I understand that my participation in this study is voluntary and that I am not obliged to give consent
- I understand that if I do not give consent to take part, there will be no consequences
- I understand that I can withdraw my participation in this survey at any time without consequences, and I can do this by leaving the web page at any time during the survey
- I understand that once I have contributed information to the survey and clicked "submit", that information cannot be withdrawn from this study
- I understand that all contributions I make to this study will be anonymous
- I agree that the anonymised findings from this study will be included in the researcher's thesis and possibly published in a research journal
- I agree for my anonymous data to be used in further research studies
- I understand that data collected during the study may be looked at by the lead supervisor [Dr Holly Milling and Dr Kirsty Carmichael] or regulatory authorities where it is relevant to my taking part in this research
- I give permission for these individuals to have access to my data
- I agree to take part in the above study

I understand that by checking the below box, I am confirming all of the above statements are true, and I consent to take part in this study:

○ Yes I consent

Appendix E

Socio- demographic questionnaire

Demographics

We would like to gather some information about you before we start the survey. These responses will be kept anonymous.

Which category below includes your age?

- ○ 17 or younger
- ○ 18-20
- ○ 21-29
- ○ 30-39
- ○ 40-49
- ○ 50-59
- ○ 60 or older

What gender do you identify as?

- ○ Female
- ○ Non-binary
- ○ Transgender
- ○ Prefer not to say

Which category below best describes your ethnicity?

- ○ White
- ○ Mixed/Multiple ethnic groups
- ○ Asian/Asian British
- ○ Black/African/Caribbean/Black British
- ○ Other

Are you currently living in the UK?

- ○ No
- ○ Yes

What is the highest level of school you have completed or the highest degree you have received?

- ◯ Less than high school diploma
- ◯ High school degree or equivalent
- ◯ Bachelor's degree (e.g. BA, BS)
- ◯ Master's degress (e.g. MA, MS, MEd)
- ◯ Doctorate (PhD, EdD)
- ◯ Other
- ◯ Prefer not to say

What is your relationship status?

- ◯ Single (never married)
- ◯ Married
- ◯ In a domestic partnership
- ◯ Divorced
- ◯ Widowed
- ◯ Prefer not to say

Obstetrics:

What is your gestational week?

- ◯ First Trimester - Conception - 5 weeks
- ◯ First Trimester - 6 - 11 weeks
- ◯ Second Trimester - 12 - 18 weeks
- ◯ Second Trimester - 19 - 23 weeks
- ◯ Third Trimester - 24 - 31 weeks
- ◯ Third Trimester - 32 - 40 weeks

What was your Body Mass Index (BMI) before pregnancy?

If you are unsure, you can calculate your BMI before pregnancy here:
https://www.nhs.uk/live-well/healthy-weight/bmi-calculator/

- ◯ 18 or less
- ◯ 19-24
- ◯ 25-29
- ◯ 30-34
- ◯ 35+

Demographic Questions about pregnancy loss:

Have you given birth previously?

- ◯ No
- ◯ Yes

Have you previously experienced perinatal loss, such as a miscarriage, termination or stillbirth?

- ○ No
- ○ Yes

Have you been told that you are experiencing a high-risk pregnancy by a medical professional?

If any one of the following applies to you, your pregnancy may be considered high risk:

Current pregnancy:

· You are pregnant with twins or triplets

· You are known to have any of the following: gestational diabetes, high blood, pressure, a low-lying placenta, a raised BMI, a growth restricted baby, a breech baby, too much or too little water around the baby, anaemia or an infection (e.g. group B strep)

Previous pregnancy:

· Previous caesarean

· Previous post- partum haemorrhage (heavy bleeding after birth, requiring treatment such as a blood transfusion)

· Previous shoulder dystocia (difficulty in delivery the shoulders)

· Previous pre-eclampsia requiring pre-term birth (before 37 weeks)

· Previous eclampsia

· Previous retained placenta

· Previous stillbirth

Long term conditions:

· Diabetes,

· Heart disease,

· Kidney disease,

· History of high blood pressure or stroke,

· Asthma,

· Cystic fibrosis,

· Sickle cell disease,

· Clotting or bleeding disorders,

· Hyperthyroid,

· Current infections (for example HIV, hepatitis B or C, toxoplasmosis),

· Liver disease,

· Epilepsy,

· Mental health conditions requiring inpatient care.

This list is provided as a guide only. It must not be used as a substitute for professional medical care by a qualified doctor or other health care professional. Always check with your doctor if you have any concerns about your condition or treatment.

- ○ No
- ○ Yes

Appendix F

Five Facets of Mindfulness Scale*

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Appendix G

Self-Compassion Scale

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Appendix H

Pre-Sleep Arousal Scale – Cognitive Factor

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Appendix I

Permission to use the PSAS

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Appendix J

Permission to use the Insomnia Severity Index

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Appendix K

Debrief Sheet

Debrief sheet

Title of project: A study on nocturnal rumination and sleep quality in pregnancy: Exploring relationships with self-compassion and mindfulness.

Researcher: Grace Windsor

Thank you for taking part in this study. The sheet will provide you will full details of the study in which you participated. The study aimed to investigate the nature of the relationships between sleep quality, rumination, self-compassion and mindfulness in pregnancy. We know that poorer sleep quality is experienced in pregnancy, particularly later in pregnancy. And we were interested in exploring whether self-compassion and mindfulness may be protective against sleep problems.

Further support:
It has not been anticipated that serious distress would result from the present research. However, the questions you answered in this study may raise some questions or highlight an aspect of your experience of pregnancy that you are struggling with. Therefore, please see below some links to areas where you can reach support, such as support on how to sleep well in pregnancy, support for pregnancy and new parents, and support with mindfulness, such as mindfulness groups.

Sleep:
Sleepio https://www.sleepio.com
Sleep apps: Pzizz https://www.nhs.uk/apps-library/pzizz/
Sleep station https://www.sleepstation.org.uk/

Mental Health support:
Samaritans – Call 116 123 - https://www.samaritans.org/
Mind - https://www.mind.org.uk/

Support for pregnancy loss:
Miscarriage Association - https://www.miscarriageassociation.org.uk/
Cruse Bereavement - https://www.cruse.org.uk/

Pregnant families and new parents:
Best Beginnings - https://www.bestbeginnings.org.uk/charities-uk-support

Mindfulness:
Mindfulness groups: https://blgmind.org.uk/mindful-mums/
Free mindfulness apps: Headspace, Calm, Aura, Mylife Meditation, Smiling Mind

Poor sleep could be linked to mental health issues, if the survey has highlighted any difficulties where you feel you need further support, we suggest discussing these concerns further with your GP or midwife.

Thank you again for taking part in this study.

Continue to be taken to the prize drawer.

Appendix L

Table of means and standard deviations across trimester

Sleep quality, self-compassion, mindfulness, nocturnal cognitive arousal and perinatal focused rumination means and standard deviations across the three trimesters of pregnancy

		Sleep quality (0-28)	Self-compassion (26-130)	Self-compassion (without mindfulness subscale) (22-110)	Mindfulness (39-195)	Nocturnal cognitive arousal (8-40)
First trimester (N=55)	Mean	12.58	79.98	67.49	119.76	21.42
	Std. Deviation	4.991	5.870	5.869	7.984	5.789
Second trimester (N=108)	Mean	12.93	79.22	66.59	120.59	22.81
	Std. Deviation	4.953	8.955	8.386	9.521	4.973
Third Trimester (N=40)	Mean	11.85	78.92	66.17	128.10	19.72
	Std. Deviation	5.201	15.582	13.489	14.45	6.449
Overall (N=203)	Mean	12.62	79.37	66.75	121.85	21.83
	Std. Deviation	5.005	9.936	9.045	10.73	5.62

Note.

Appendix M

Study summary for ethics and study participants

A quantitative study on sleep quality and nocturnal cognitive arousal during pregnancy: Exploring relationships with self-compassion and mindfulness

Study findings

Dear study participant,

Thank you for your participation in this study. Your help was much appreciated. As a reminder, this study involved completing some questions on an online survey about your experience of sleep quality, self-compassion, and mindfulness during pregnancy. Thanks to people like you for contributing valuable time; we collected data from 203 people in total.

This study investigated the sleep quality that people experience during pregnancy. Sleep problems are highly prevalent during pregnancy and have been linked with having an active mind while trying to fall asleep. An individual's level of mindfulness has been shown to be linked with an active mind before sleep. In line with previous research, this study found that individuals with lower levels of mindfulness had more of an active mind when trying to fall asleep and, in turn, had worse sleep quality. Another concept that was investigated in this study was self-compassion. Like the results found from investigating mindfulness, those people who reported having lower levels of self-compassion also reported more of an active mind when trying to fall asleep and, in turn, reported poorer sleep quality.

Due to the similarity between the characteristics of mindfulness and self-compassion, a tentative further analysis was conducted to investigate whether their association with sleep quality and an active mind at night was independent of each other. These results found that there may be something unique about self-compassion over and above its similarity with mindfulness. However, whether mindfulness was unique over and above its similarity with self-compassion was unclear.

To summarise, the results of this study indicated that during pregnancy, having an active mind whilst trying to fall asleep at night may play a role in the relationship between an individual's level of self-compassion and mindfulness and experience of sleep quality. Improving self-compassion and mindfulness might help to reduce worrying and ruminating at night and improve sleep quality. It is important to be aware that these variables were measured at one point in time only, and therefore how they relate to each other causally cannot be concluded. Additional research studies are needed to build on these findings and develop further understanding of the relationships between these variables.

Thank you again for taking part in this study. Please do not hesitate to contact me should you have any further questions (gw318@canterbury.ac.uk).

Yours sincerely,

Grace Windsor

Appendix N

Journal submission guidelines for Mindfulness

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