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**Title: Development of the Pain-Related Beliefs and Attitudes about Sleep
(PBAS) scale for the assessment and treatment of insomnia comorbid
with chronic pain.**

Subtitle: Pain-Related Beliefs and Attitudes about Sleep

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ABSTRACT

Study Objectives

Dysfunctional beliefs and attitudes about sleep is a cognitive-behavioral factor central to the development and perpetuation of insomnia. Previous works to unravel the complex interrelationship between pain and insomnia have not explored the role of inflexible beliefs about the sleep-pain interaction, possibly due to a lack of a valid instrument for doing so. The current study evaluated the psychometric and functional properties of a 10-item Pain-Related Beliefs and Attitudes about Sleep (PBAS) scale.

Methods

The PBAS scale was administered to four clinical samples of chronic pain patients with comorbid insomnia: to examine the scale's psychometric properties ($n=137$), test-retest reliability ($n=26$), sensitivity to treatment ($n=20$), and generalizability ($n=62$). All participants completed the PBAS together with validated measures of pain interference, insomnia severity, and cognitive-behavioral processes hypothesized to underpin insomnia.

Results

The PBAS scale was found to be reliable, with adequate internal consistency and temporal stability. Factor analysis suggested a 2-factor solution representing beliefs about "pain as the primary cause of insomnia" and the "inevitable consequences of insomnia on pain and coping". The PBAS total score was positively correlated with scores from the Insomnia Severity Index (ISI) scale, Dysfunctional Beliefs and Attitudes about Sleep (DBAS) scale, and the Anxiety and Preoccupation about Sleep Questionnaire (APSQ). It was a significant predictor of insomnia severity and pain interference. A significant reduction in PBAS was also observed in patients after receiving a hybrid cognitive-behavioral intervention for both pain and insomnia.

Conclusions

Pain-related sleep beliefs appear to be an integral part of chronic pain patients' insomnia experience. The PBAS is a valid and reliable instrument for evaluating the role of these beliefs in chronic pain patients.

Keywords: pain, insomnia, beliefs, assessment, scale

Current Knowledge/Study Rationale: Maladaptive beliefs about the sleep-pain interaction are possible factors perpetuating pain-related insomnia. This study examined the psychometric properties of the Pain-Related Beliefs and Attitudes about Sleep (PBAS) scale, specifically designed for the assessment and treatment of insomnia comorbid with chronic pain.

Study Impact: Thinking about the interaction between pain and sleep is an integral part of chronic pain patients' insomnia experience. Findings from the current study suggest that the PBAS is a valid and reliable tool for detecting and assessing these unhelpful beliefs, opening up new avenues for research and interventions.

1. Introduction

Sleep beliefs are featured in cognitive-behavioral theories of insomnia as a factor central to the development and perpetuation of sleep disturbances.¹⁻⁸ A key hypothesis across these theories of insomnia is that certain inflexible beliefs about sleep may exacerbate emotional responses, heighten cognitive and physiological arousal, and promote sleep practices that are paradoxically sleep interfering.^{1, 2, 5-9}

The Dysfunctional Beliefs and Attitudes about Sleep (DBAS) scale was developed as a research and clinical tool to measure these maladaptive sleep beliefs.⁶ Both the original 30-item version^{6, 10} and the abbreviated 16-item version¹¹ have shown satisfactory psychometric properties. Compared with the original version, the abbreviated version has a similar but more compact 4-factor structure, which reflects themes of thoughts concerning (i) inevitable consequences of insomnia, (ii) worry/helplessness about insomnia, (iii) unrealistic sleep expectations, and (iv) assumed effectiveness of sleep medications.

Functionally, previous research has indicated that these dysfunctional beliefs are a clinical correlate of insomnia. Holding these beliefs may be maladaptive; a high DBAS score is associated with greater insomnia severity, anxiety, and depression.¹¹ Dysfunctional beliefs may also mediate therapeutic change, in treatment studies, a reduction in DBAS has been associated with an improvement in sleep as assessed with both subjective and objective measures of sleep efficiency at post-treatment^{12, 13}. The improvement in sleep

efficiency was well maintained at up to one-year follow-up.^{12, 13} Together, these findings point to these dysfunctional beliefs as a logical treatment target.

The growing interest in the relationship between pain and sleep has driven the investigation of possible cognitive-behavioral mechanisms underpinning pain-related insomnia.¹⁴⁻¹⁷ This has also led to the identification of elevated DBAS scores across a range of painful conditions, such as cancer, fibromyalgia, and different types of chronic musculoskeletal, neuropathic and inflammatory pain.¹⁸⁻²¹ Not all patients with chronic pain have problems sleeping, but among those who do, the vast majority report an onset of sleep disturbance during or following the onset of pain²² and many believe that sleep disruption is a secondary symptom of pain.²³ Clinical experience and qualitative research further suggest that some patients hold firm beliefs about how their pain affects sleep and how they would struggle to manage their pain following a poor night's sleep.^{23, 24} Example thoughts are "I can never get comfortable in bed because of the pain", "The pain will wake me up predictably", and "I won't be able to cope with my pain if I don't sleep well".

These thoughts and beliefs reflect chronic pain patients' perceived cause(s) and consequence(s) of their insomnia and their assumed relationship between pain and sleep. These thoughts and beliefs have an idiopathic focus on pain and its interaction with sleep that is not covered by items of the DBAS, e.g., "I believe that insomnia is essentially a result of a chemical imbalance", "I can't ever predict whether I will have a good or poor night's

sleep“, and “Without an adequate night’s sleep, I can hardly function the next day”. Smith et al. found that chronic pain patients frequently reported pain-related thoughts during the pre-sleep period and that pre-sleep thoughts pertaining to pain were significantly associated with poorer sleep continuity¹⁵. However, the effect of these thoughts on subsequent sleep and pain management has never been empirically examined, as there is currently no instrument specifically assessing these beliefs about sleep in the context of chronic pain.

The current study evaluated the psychometric and functional properties of a 10-item Pain-Related Beliefs and Attitudes about Sleep (PBAS) scale, designed to assess pain-related dysfunctional beliefs and attitudes about sleep among people with chronic pain. Specifically, the factor structure, internal consistency, temporal stability, concurrent validity, predictive validity, sensitivity to treatment and generalizability of the scale were examined.

2. Method

2.1 Participants

Secondary analysis of data drawn from four clinical study samples informed the evaluation of the psychometric and functional properties of the PBAS scale. Each of the four studies received ethical approval from the relevant research ethics committee.

Participants in Sample 1 were 137 chronic pain patients who completed the PBAS scale and a collection of validated measures assessing sleep, pain and

psychological characteristics. Participants in Sample 2 were 26 patients who completed the PBAS scale on two occasions, one week apart, for the assessment of test-retest reliability. Participants in Sample 3 were 20 patients who completed a pilot study investigating the effectiveness of a 4-week hybrid cognitive behavioral therapy (CBT) for insomnia and chronic pain.²⁵ Sensitivity to change associated with treatment was examined by comparing responses to the PBAS collected at pre- and post-treatment assessments. Participants in Sample 4 were 60 patients who, like participants in the first sample, completed the PBAS alongside a range of validated questionnaires. Sample 4 was consisted of chronic pain patients with and without insomnia recruited from a pain clinic in Gloucestershire, UK, whereas Samples 1, 2, and 3 were chronic pain patients with insomnia recruited from pain clinics based within the city of London, UK. The difference in insomnia presentation and geographical setting provided a test of the generalizability of the findings across different demographic profiles.

The four samples were recruited using similar inclusion and exclusion criteria. Essentially, all participants were adults (aged 18 years or above) with chronic pain and recruited from hospital-based pain clinics. To be included in the study, participants needed to be literate in English, have experienced non-malignant pain for at least 6 months, and for Samples 1, 2 and 3, scored 15 or above on the Insomnia Severity Index.²⁶ Sample 4 did not require participants to have a minimum ISI score, thus further testing the generalizability of the PBAS scale to chronic pain patients that may present with subclinical threshold insomnia. Exclusion criteria were: i) receiving an injection or

operation for their pain in the last month, ii) co-morbid major psychiatric disorders, iii) hospitalized or with a life-threatening medical condition, and iv) visual/cognitive impairments that prevent questionnaire completion. The participants' demographic, pain and sleep characteristics are presented in

Table 1.

2.2 Measures

2.2.1 Pain-Related Beliefs and Attitudes about Sleep (PBAS)

The PBAS scale is a 10-item self-completed questionnaire designed to assess patients' beliefs about the interaction between pain and sleep (see **Table 2** for individual items). The items were generated based on previous research evidence and clinical interviews with patients with concurrent chronic pain and insomnia^{23,24}. They reflect the pain-related sleep beliefs and statements commonly endorsed by this population. Administered as an extension to the DBAS, efforts were made to avoid repetition of content. Only 10 items were developed and included to keep the questionnaire short, user-friendly and easy to administer and score in clinical settings. Instruction for completion is identical to the DBAS, requiring participants to rate their level of agreement with each statement between 0 'strongly disagree' and 10 'strongly agree'. The total score is based on the average score of all items, with a higher average score indicating stronger or more inflexible beliefs that pain and sleeplessness are inextricably linked. All samples completed the PBAS scale, alongside the following:

2.2.2 Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS-16)¹¹

The brief version of the DBAS contains 16 items for the assessment of general negative beliefs and attitudes about sleeplessness. DBAS-16 was used because it has proven to be as reliable and valid as the original 30-item version, but shorter and briefer thus less burdensome to complete. Participants were asked to rate their level of agreement with each statement between 0 'strongly disagree' and 10 'strongly agree', thus a higher average score is indicative of more strongly held negative beliefs about sleep. The DBAS-16 has demonstrated acceptable internal consistency (Cronbach's $\alpha \geq .77$), temporal stability ($r = .83$) over a 2-week interval and concurrent validity (correlation with Insomnia Severity Index: $r = .45$).

2.2.3 Anxiety and Preoccupation about Sleep Questionnaire (APSQ)²⁷

Sleep-related anxiety was assessed using the 10-item APSQ. Participants were asked to reference the previous month and rate their agreement to each item between 1 (not true) and 10 (very true). Higher total scores indicate greater sleep related anxiety. The APSQ has shown good internal consistency (Cronbach's $\alpha = .92$) and concurrent validity (Pittsburgh Sleep Quality Index: $r = .44$; Beck Anxiety Inventory: $r = .37$).

2.2.4 Insomnia Severity Index (ISI)²⁶

The ISI is a measure of insomnia severity. Participants were instructed to reference their sleep during the previous month and rate the 7 items between 0 (not at all) and 4 (extremely). A higher total score is indicative of more severe insomnia, with a clinical cut-off of 15 or above that has optimal sensitivity (94%) and specificity (94%). The ISI has demonstrated acceptable

internal consistency (Cronbach's $\alpha = .76\text{-.78}$; item-total $r = .36\text{-.67}$), concurrent validity (correlations with other sleep assessments ranging from 0.07 to 0.91) and high sensitivity to the effect of treatment.

For indexing pain severity and pain interference, Samples 1-3 completed the Brief Pain Inventory (BPI) and Sample 4 completed the Short Form – McGill Pain Questionnaire (SF-MPQ). Both scales are introduced below:

2.2.5 Brief Pain Inventory (BPI)²⁸

The BPI is a self-report questionnaire administered to assess the severity of pain and a measure of pain-related interference. For the pain interference subscale, The interference sub-scale assesses the extent to which pain interferes with 1) general activity; 2) mood; 3) walking ability; 4) work both inside and outside the home; 5) relations with people; 6) sleep; and 7) enjoyment of life. Participants were asked to rate the 7 items between 0 (does not interfere) and 10 (interferes completely) during the past week. A total pain interference score is calculated as the average of the 7 items. A higher average interference subscale score indicates greater interference in daily life due to pain. The BPI has been shown to have good internal consistency (Cronbach's $\alpha = .88$), concurrent validity with the Roland-Morris Disability Questionnaire ($r = .57$) and high sensitivity to the effect of treatment.²⁹ Of the 4 items assessing pain severity, the numerical rating scale of current pain rating was utilized to index present pain intensity in Samples 1-3 [0 (no pain at all) and 10 (pain as bad as you can imagine)].

2.2.6 Short Form - McGill Pain Questionnaire (SF-MPQ)³⁰

SF-MPQ consists of 15 descriptors of pain (11 sensory; 4 affective) and participants rate these on a scale of 0 (none) to 3 (severe). Pain scores are calculated from the sum of the intensity rank values of the words chosen for sensory, affective and total descriptors. The scale also includes a visual analogue scale (VAS) and present pain index (PPI). The VAS (0-10) is similar to the current pain rating scale of the BPI and was used to index present pain intensity in Sample 4. The scale has been shown to correlate very strongly with the long-form version of the McGill Pain Questionnaire and sensitive to the effect of clinical pain treatments³⁰.

2.2.7 Analysis

Statistical analyses were conducted using SPSS version 22. Comparisons of demographic details (**Table 1**) across all four samples were performed using ANOVA for continuous variables (age, body mass index, pain intensity, and insomnia severity index score) and chi-square χ^2 for categorical variables (sex, ethnicity, education level, marital status, employment status, benefits status, pain duration, and insomnia duration). All variables were visually and statistically checked for normal distribution. Factor structure, internal consistency (Cronbach's α), concurrent validity (Pearson's r), temporal stability (test-retest), sensitivity to treatment (change associated with treatment), predictive validity (stepwise linear regression), and generalizability of the scale are reported below.

3. Results

3.1 Demographics

There were no significant differences on all demographic and clinical characteristics (reported in **Table 1**) measured between the three London samples, except that Sample 3 had a significantly greater % of female participants than Sample 2 [$\chi^2 (3, N=245) = 9.14, p < .05$].

Overall, participants in Sample 4 were older, more ethnically homogenous and had a lower level of insomnia severity, compared with Samples 1-3. A significant difference in age was found between Samples 1 and 4 [$F (3, 241) = 4.95, p < .001$]. Additionally a significant difference in insomnia severity was found between Samples 1-4, 2-4 and 3-4 [$F (3, 236), p = .000$]. A significant difference was also found for ethnicity between Samples 1-4, 2-4 and 3-4 $\chi^2 (3, N=245) = 23.07, p < .001$] and between Samples 1 and 4 for employment status $\chi^2 (3, N=245) = 13.60, p < .01$. No significant between sample differences were found for the remaining categories. See **Table 1** for ANOVA and χ^2 results.

3.2 Distribution of PBAS scores.

The mean PBAS score was 6.23 ($SD=1.99$). Visual examination of the histogram and Q-Q Plot of PBAS scores (**Figure 1**) did not indicate any significant deviations from a normal distribution or notable outliers [Skewness = -0.19 ($SE = 0.21$); Kurtosis = 0.34 ($SE = 0.41$)].

3.3 Content validity

A principal component analysis (PCA) was conducted with orthogonal rotation (varimax), following satisfactory results from the Kaiser-Meyer-Olkin (KMO) test (0.81) and Bartlett's test of sphericity ($p = .001$) verifying sampling adequacy (i.e., suitability of data for structure detection). The KMO statistic indicates the proportion of variance in the data that are attributable to underlying factors. KMO values greater than 0.80 are considered good and suggest that a factor analysis is potentially useful for understanding the data structure. The Bartlett's test evaluates the data's appropriateness for PCA by checking whether or not the correlation matrix concerned is an identity matrix, in which variables are noncollinear and unsuitable for structure detection. A rejection of the null hypothesis (i.e., identity matrix) signifies that there is a relationship between the variables³¹. The 10 items loaded on 2 factors, both of which had eigenvalues over Kaiser's criterion of 1. These two factors combined explained 58.8% of the total variance.

Table 2 shows items 1-5 loading on the first factor, accounting for 29.15% of the item variance. Factor 1 was labeled “**pain as the primary cause of insomnia**”. Items 6-10 loaded most strongly on the second factor, accounting for 29.66% of the item variance. Factor 2 was labeled “**inevitable consequences of insomnia on pain and coping**”.

3.4 Internal consistency

The internal consistency of the PBAS was measured with Cronbach's α and item-total correlation. As evident in **Table 2**, the Cronbach's α coefficients for

both the full scale ($\alpha = .84$) and the subscales (Factor 1 $\alpha = .82$ and Factor 2 $\alpha = .81$) were high, demonstrating good internal consistency. Item-total correlations were moderate to strong, ranging from .46 to .63.

3.5 Concurrent validity

Intercorrelations of the PBAS score with the scores of the DBAS-16, APSQ and ISI were examined to establish concurrent validity (**Table 3**). In Sample 1 ($n= 137$), there were positive correlations between PBAS and DBAS-16 ($r = .65, p < .001$), APSQ ($r = .57, p < .001$), and ISI ($r = .37, p < .001$). A similar pattern of relationships was observed in Sample 4 ($n= 57$), where positive correlations were again found for PBAS with DBAS-16 ($r = .57, p < .001$), APSQ ($r = .45, p < .001$), and ISI ($r = .64, p < .001$).

3.6 Temporal stability of the PBAS

Twenty-six participants completed the PBAS twice, with a one-week interval between administrations. A Pearson correlation coefficient calculated between the two PBAS scores showed a significant correlation, $r = .91, p < .0001$, indicating a high level of test-retest reliability and temporal stability.

PBAS scores decreased slightly from the first (mean = 6.87, SE = 0.39) to the second (mean = 6.79, SE = 0.41) administration, however, a paired t-test revealed that this was not a significant decrease, $t(25) = 0.44, p = .66$. The temporal stability of PBAS scale compared well with that of the DBAS-16, which also showed a significant correlation between scores, $r = .94, p < .0001$. However, a paired t-test revealed that DBAS-16 mean scores dropped from

the first (mean = 6.0, SE = 0.42) to the second (mean = 5.63, SE = 0.42) administration. The drop in DBAS-16 was small but significant, $t(25) = 2.45, p <.05.$

3.7 Sensitivity to treatment

The responses of 20 participants receiving a 4-week course of hybrid CBT for sleep and pain management as part of a pilot study were analyzed, in order to determine the sensitivity of the PBAS for detecting reduction in dysfunctional pain-related sleep beliefs after treatment.

The hybrid CBT was effective in reducing ISI scores of insomnia severity from pre-treatment ($M = 20.3, SE = 0.73$) to below the clinical threshold at post-treatment ($M = 7.75, SE = 1.48$), $t(19) = 9.39, p < .05, r = .90$. The hybrid CBT was also associated with a significant reduction in BPI pain interference score from pre-treatment ($M = 7.06, SE = 0.22$) to post-treatment ($M = 4.09, SE = 0.38$), $t(19) = 8.99, p < .05, r = .90$.

Pre-treatment endorsement of dysfunctional beliefs and attitudes from the treatment sample was similar to that given by Sample 1 (PBAS $M = 6.23$, DBAS-16 $M = 4.67$). PBAS scores showed a significant reduction in this sample, from pre-treatment ($M = 6.29, SE = 0.31$) to post-treatment ($M = 3.33, SE = 0.39$), $t(19) = 6.94, p < .0001, r = .85$. A similar significant reduction following treatment was also observed for DBAS-16 scores from $4.73 (SE = 0.33)$ to $2.26 (SE = 0.33)$, $t(19) = 6.8, p < .0001, r = .84$.

Of relevance, pre-to-post-treatment reductions in the PBAS scores were significantly correlated with pre-to-post-treatment reductions in DBAS-16 ($r = .85$, $p < .0001$), BPI pain interference ($r = .58$, $p < .01$) and ISI ($r = .57$, $p < .01$).

3.8 PBAS was the strongest predictor of Insomnia Severity (ISI) among chronic pain patients.

Linear regression analyses were performed to determine whether PBAS was a predictor of insomnia severity. The stepwise method was used to enter all potential predictors (PBAS, BPI/SF-MPQ pain intensity, DBAS-16, and APSQ) to the regression models, to identify a combination of predictors that account for the most variance in the predicted variable. Since the correlations among the potential predictors were all less than 0.80, multicollinearity was not assumed to be of major concern in the multiple regression analyses. Further tests to explore if the data met the assumption of collinearity indicated that multicollinearity was not a concern, VIF values were 1.72 or less and Tolerance statistics all greater than 0.58.³¹ As it is often recommended to carry out some form of validation analysis when stepwise regression is used³¹, we have two samples with which we can cross-validate the regression model predicting ISI scores.

For Sample 1 (**Table 4**), PBAS scores was selected first into the model, significantly predicting insomnia severity individually [$F(1,135) = 21.49$, $\beta = 0.37$, $p <.001$], accounting for 14% of the variance. PBAS scores also jointly predicted insomnia severity with pain intensity in the second model and with

pain intensity and APSQ in the third model. The addition of pain intensity and APSQ in the model increased the percentage variance explained to 19% and 21% respectively.

A similar regression analysis (**Table 5**) was carried out in Sample 4 to cross-validate the predictive model. In this second analysis, PBAS was again a significant predictor of insomnia severity individually [$F(1,54) = 35.55, p < .001$], accounting for 40% of the variance, and jointly with pain intensity in the second model and with pain intensity and APSQ in the third model. The addition of pain intensity and APSQ in the model increased the percentage of variance explained to 53% and 60% respectively. In both samples, DBAS-16 did not emerge as a significant predictor of insomnia severity.

3.9. PBAS strengthened the prediction of pain interference (BPI) among chronic pain patients

Using Sample 1 data (**Table 4**), a further stepwise regression was conducted with BPI pain intensity, PBAS, DBAS-16, and APSQ entered as potential predictors of pain interference (BPI pain interference score). Pain Intensity scores was selected first into the model as a significant predictor of pain interference [$F(1,135) = 38.62, \beta = 0.47, p <.001$] accounting for 22% of the variance. The addition of PBAS [$F(1,134) = 27.47, p <.001$] to the predictive model increased the percentage variance explained to 28%. DBAS-16 ($t = -0.96, p = .34$) and APSQ ($t = -0.30, p = .74$) were not significant predictors of pain interference.

4. Discussion

Maladaptive beliefs about the sleep-pain interaction are possible factors perpetuating pain-related insomnia. In this paper, we examined the psychometric properties of the PBAS for the assessment of these beliefs among chronic pain patients. The scale showed good reliability with adequate internal consistency and temporal stability and the total score of the PBAS correlated with established measures of insomnia severity. With scale items specifically designed to tap into the patients' perceived interaction between sleep and pain, the PBAS outperformed the DBAS and emerged as the best predictor of insomnia severity. It also independently added to the prediction of pain interference, above and beyond the expected effect of pain intensity. Importantly, the scale was sensitive to treatment; significant reduction in PBAS was observed in chronic pain patients following a course of hybrid CBT for pain and insomnia. Reduction in PBAS was also correlated with improvements in insomnia severity and pain interference.

The development of the PBAS was motivated by the findings of Smith et al.¹⁵,¹⁶, which demonstrated that the focus and content of sleep-related cognitions were different between 'primary' insomnia and insomnia co-morbid with chronic pain. Modeling on the DBAS, the PBAS contains items that capture unhelpful beliefs about sleep that are prevalent among chronic pain patients. The two emerging factors from the PBAS scale are "pain as the primary cause of insomnia" and the "inevitable consequences of insomnia on pain and coping", reflecting a negative view of the bidirectional association between pain and sleep. The development of such view is not ungrounded, considering

that poor sleep is usually a marker for worsened physiological and psychological pain-related outcomes³². Poor sleep also contributes to the exacerbation of pain processes in both healthy and chronic pain individuals^{33, 34}. The concern here is that inflexible thinking about the sleep-pain interaction may exacerbate emotional responses to sleep disturbance, accentuate pre-sleep cognitive and physiological arousal, and promote maladaptive sleep practices and pain coping strategies.

In the context of 'primary' insomnia, it has been known for some time that dysfunctional beliefs about sleep - as measured with DBAS - contribute to the development and maintenance of insomnia symptoms.³ Specifically, cognitive processes of worry and holding negative dysfunctional beliefs about sleep are significant predictors of persistent insomnia symptoms over a period of 18 months.³⁵ The development of PBAS offers a tool to examine the extent to which rigid thinking about the pain-sleep relationship contributes to the manifestation of insomnia in clinical groups for which pain is a constant or recurrent feature (e.g., fibromyalgia, arthritis, temporal mandibular joint disorder, cancer etc.).

The PBAS scale showed moderate to strong correlations with DBAS and APSQ, suggesting that there are likely overlaps in terms of the psychological factors at play in the maintenance of primary insomnia and pain-related insomnia. However, functionally speaking, the PBAS was a better predictor of insomnia severity and pain interference among chronic pain patients with comorbid insomnia. This provides evidence for the specificity of the scale and

highlights pain-focused sleep beliefs, as assessed by PBAS, as potential cognitive treatment targets when addressing pain-related insomnia. Psychological treatments for chronic pain have predominantly focused on pain management. Although sleep hygiene advice is routinely given as part of the standard treatment, emphasis on sleep is light and not enough time and effort are devoted to helping patients understand the pain-sleep interaction and addressing the cognitive-behavioral factors perpetuating their insomnia. Not surprisingly, outcome data have shown that completion of pain management programs does not always result in improved sleep.³⁶ In developing a new hybrid CBT that aims to tackle pain and sleep simultaneously, special attention has been given to addressing patients' unhelpful beliefs about pain, sleep and the interaction of the two.²⁵ The PBAS was successful at detecting changes in these pain-related sleep beliefs following a course of this hybrid CBT. Of particular clinical relevance, those patients who showed a reduction in PBAS scores were also those who demonstrated greater reduction in insomnia symptoms and pain interference. The PBAS is potentially a useful clinical tool for guiding and assessing progress of insomnia treatment among pain patients.

The development of the PBAS followed the recommended procedure of scale development.^{37, 38} Data from four independent samples of chronic pain patients were collected to examine its score distribution, structural dimension, internal consistency, temporal stability, criterion validity, sensitivity to treatment, and generalizability. The four samples were of different sizes recruited from different clinics. Samples 1, 2 and 3 were chronic pain patients

with clinical levels of co-morbid insomnia, whereas Sample 4 consisted of a mix of chronic pain patients with and without clinical insomnia. Such difference in participant composition and insomnia severity might also explain why DBAS was not found to be a significant predictor of ISI. In other words, when compared with the PBAS, DBAS may not address the prominent cognitive feature among pain patients with sub-clinical and clinical levels of insomnia. Further research administering the PBAS in heterogeneous community samples of chronic pain individuals would help determine to what extent the scale distinguishes good-sleeping from poor-sleeping pain individuals. There is also potential for reducing the number of scale items in order to cut administration times short but still maintain the necessary psychometric properties of the full scale. Additional treatment studies with bigger sample sizes and longer follow-ups are required to further establish the scale's sensitivity to treatment-associated changes in pain-related sleep beliefs. Apart from assessing the association of changes in PBAS with self-reported improvement in sleep, it would also be interesting to clarify whether changes in PBAS are associated with changes in objective sleep and pain outcomes. This would lend support to the hypothesized role of dysfunctional beliefs about sleep and pain interaction in the development and maintenance of pain-related insomnia and its contribution to subsequent pain interference.

5. Conclusion

Excessive cognitive arousal is a cardinal feature of both primary and pain-related insomnia.³⁹ Thinking about the interaction between pain and sleep is an integral part of chronic pain patients' insomnia experience, and the findings

of the present study suggest that the PBAS is a valid and reliable instrument to detect and assess unhelpful beliefs about the sleep-pain interaction. Theoretically, it elaborates the concept of dysfunctional sleep beliefs within the context of chronic pain and allows the effect of these beliefs on sleep and pain management to be empirically examined. Clinically, it provides a tool to identify dysfunctional thoughts that require cognitive therapy and can be used as a measure of treatment progress when treating chronic pain patients with comorbid insomnia.

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Table 1. Participant Characteristics by Sample

	Sample 1 (n = 137)	Sample 2 (n = 26)	Sample 3 (n = 20)	Sample 4 (n = 62)	Test statistics #	Between- samples differences
Age (yrs.)	46.0 (11.3)	50.1 (10.5)	48.5 (8.9)	52.3 (11.1)	$F (3,241) = 4.95^{**}$	1-4
Body mass index	27.8 (6.1)	27.7 (5.8)	28.8 (5.6)	27.6 (7.1)	$F (3,232) = 0.17$	n/a
Sex (Female %)	75.9	53.8	90.0	67.7	$\chi^2 (3,N=245) = 9.14^*$	2-3
Ethnicity (Caucasian %)	72.3	80.8	65.0	100	$\chi^2 (3,N=245) = 23.07^{***}$	1-4, 2-4, 3-4
Education (Degree %)	21.2	8.0	30.0	22.6	$\chi^2 (3,N=245) = 3.63$	n/a
Marital status (Married %)	48.2	50.0	55.0	66.1	$\chi^2 (3,N=245) = 5.68$	n/a
Employment status (Unemployed or on sick leave %)	40.1	48.0	65.0	66.1	$\chi^2 (3,N=245) = 13.60^{**}$	1-4
Benefit status (Receiving benefit %)	53.3	50	70	58.1	$\chi^2 (3,N=245) = 2.48$	n/a
Pain duration (yrs.)	8	4.3	6.1	8	$\chi^2 (3,N=243) = 5.59$	n/a
Pain intensity (0-10 rating)	5.7 (2.6)	6.1 (2.3)	6.1 (1.8)	5.1 (2.3)	$F (3,240) = 1.43$	n/a
Insomnia duration (yrs.)	5	4	6	4.5	$\chi^2 (3,N=227) = 6.38$	n/a
Insomnia severity (ISI)	20.4 (3.9)	20.4 (3.6)	20.3 (3.3)	14.4 (8.0)	$F (3,236) = 2.01^{***}$	1-4, 2-4, 3-4

Notes

Means are presented with standard deviations in parentheses, except for pain and insomnia duration where medians are presented instead. Cases with missing data were excluded from the analysis on a test-by-test basis, and hence the different sample sizes.

0-10 rating: The 0-10 pain rating scale of the Brief Pain Inventory (Samples 1-3) and Short Form – McGill Pain Questionnaire (Sample 4) was used to assess pain intensity. ISI: Insomnia Severity Index total score.

F values for one-way ANOVAs are reported for significant between sample-differences for continuous data categories. Bonferroni tests post-hoc analyses were used to follow up significant results of One-way ANOVA, except when the assumption of homogeneity was not assumed Dunnett's T3 post-hoc tests were used. χ^2 for chi square tests are reported for between-samples differences for categorical data with the critical p-value set to 0.01 to control for multiple comparisons.

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 2. The 10 items of the Pain-Related Beliefs and Attitudes about Sleep (PBAS) and their psychometric properties based on Sample 1 (n= 137)

Items	M	SD	Item-total Correlations	Factor loadings (Rotated solution)	
				Factor 1: Pain as the primary cause of insomnia	Factor 2: Inevitable consequences of insomnia on pain and coping
1. My insomnia is largely a result of the pain and there is nothing I can do about it.	6.47	3.05	0.55	0.79	0.17
2. With the pain, I can never get myself comfortable in bed.	7.50	2.59	0.53	0.82	0.12
3. The pain is always there when you try to have a good night's sleep.	7.31	2.63	0.46	0.78	0.05
4. When I am in pain, I simply can't get to sleep no matter how hard I try.	6.94	2.65	0.55	0.64	0.31
5. I know I can't sleep through the night because the pain will wake me up.	6.42	3.11	0.57	0.64	0.32
6. I get very annoyed when the pain wakes me up.	6.39	3.19	0.49	0.18	0.64
7. Not sleeping well is going to make my pain worse the next day.	5.01	3.37	0.55	0.06	0.83
8. I won't be able to cope with the pain if I don't sleep well.	4.68	3.40	0.63	0.11	0.88
9. Unless I get rid of the pain, I won't sleep well.	5.98	3.38	0.55	0.26	0.65
10. The insomnia is taking away one of my few respite from pain.	5.56	3.31	0.53	0.24	0.65
Eigenvalue	-	-	-	2.92	2.97
Variance accounted for (R2)	-	-	-	29.15	29.66
Internal consistency (α) of items in bold type	0.84	-	-	0.82	0.81
Mean score (SD) of items in bold type	6.23 (2.00)	-	-	6.93 (2.14)	5.53 (2.51)

Table 3. Intercorrelations of scores on PBAS, DBAS-16, APSQ, and ISI in Samples 1 and 4

	Sample 1 (n=137)				Sample 4 (n=57 [#])			
	PBAS	DBAS-16	APSQ	ISI	PBAS	DBAS-16	APSQ	ISI
PBAS	-				-			
DBAS-16	0.65***	-			0.57***	-		
APSQ	0.57***	0.66***	-		0.45***	0.71***	-	
ISI	0.37***	0.37***	0.35***	-	0.64***	0.46**	0.53***	-

PBAS = Pain-Related Beliefs and Attitudes about Sleep. DBAS-16 = Dysfunctional Beliefs and Attitude about Sleep Scale 16-item version. APSQ = Anxiety and Preoccupation about Sleep Questionnaire. ISI = Insomnia Severity Index.

#Missing data due to incomplete response from chronic pain patients without insomnia

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4. Summary of stepwise multiple regression analysis predicting insomnia severity and pain interference in Sample 1 (n = 137)

Predicted Variable	Predictors	F	R	R ²	Adjusted R ²	ΔR ²	B	SE B	β	t	
ISI	Model 1 Predictor: PBAS	21.49**	0.37	0.14	0.13	0.14	0.72	0.16	0.37	4.64**	
	Model 2 Predictors: PBAS +	16.40**	0.44	0.20	0.19	0.06		0.60	0.16	0.31	3.82**
	BPI Pain Intensity						0.38	0.12	0.25	3.14*	
	Model 3 Predictors: PBAS +	13.12**	0.48	0.23	0.21	0.03		0.36	0.18	0.18	1.93*
	BPI Pain Intensity						0.39	0.12	0.26	3.26**	
	APSQ						0.04	0.02	0.22	2.33*	
BPI Pain Interference	Model 1 Predictor: BPI Pain intensity	38.62**	0.42	0.22	0.22	0.22	2.46	0.40	0.47	6.21**	
	Model 2 Predictors: BPI Pain Intensity +	27.47**	0.29	0.28	0.07	0.07		2.10	0.39	0.40	5.35**
	PBAS						1.82	0.51	0.27	3.59**	

*p < .05 **p < .001

Table 5. Summary of stepwise multiple regression analysis predicting insomnia severity in Sample 4 (N = 56)

Predicted Variable	Predictors	F	R	R ²	Adjusted R ²	ΔR ²	B	SE B	β	t
ISI										
Model 1										
Predictor:										
	PBAS	35.55**	0.63	0.40	0.39	0.40	2.09	0.35	0.63	5.96**
Model 2										
Predictors:										
	PBAS +	30.10**	0.73	0.53	0.51	0.14		1.56	0.33	0.47
	SF-MPQ Pain Intensity						0.13	0.04	0.40	3.91**
Model 3										
Predictors:										
	PBAS +	25.81**	0.77	0.60	0.58	0.07		1.14	0.35	0.35
	SF-MPQ Pain Intensity						0.13	0.03	0.40	4.15**
	APSQ						0.09	0.03	0.29	2.93*

* $p < .05$ ** $p < .001$

Figure 1. Histogram (left) and Q-Q Plot (right) of the distribution of PBAS scores in Sample 1

