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Differential Predictors of Nighttime and Daytime Sleep Complaints in Older Adults with Comorbid Insomnia and Osteoarthritis Pain

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Abstract

Objectives—Osteoarthritis (OA) is extremely common in older adults, affecting 50% of people aged 65 or older, and more than half of older adults with OA complain of significantly disturbed sleep. This study compared predictors of nighttime sleep complaints and daytime sleep-related consequences as measured by the Insomnia Severity Index (ISI) and Pittsburgh Sleep Quality Index (PSQI) in older adults with comorbid OA pain and insomnia.

Methods—A secondary analysis of baseline data from a large longitudinal randomized controlled trial. Multivariate regression analyses were performed to test two sets of predictive models.

Results—367 older adults (mean age 72.9 ± 8.2 years; female 78.5%) with OA and insomnia were included in this analysis. In Model 1, fatigue and depression predicted daytime sleep-related consequences for both ISI and PSQI. When measures of sleep and pain beliefs/attitudes were added (Model 2), fatigue, and sleep and pain beliefs/attitudes predicted nighttime sleep complaints for both ISI and PSQI; depression was no longer a significant predictor of ISI daytime consequences, but remained in the model for PSQI daytime consequences.

Conclusions—This study found both similarities and differences in factors predicting nighttime sleep complaints and daytime sleep-related consequences. Individual beliefs/attitudes about sleep and pain were stronger predictors of sleep difficulties than were depression and pain. Fatigue was the strongest and most consistent predictor associated with both nighttime sleep complaints and daytime sleep-related consequences regardless of the scale used to measure these concepts.

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Keywords

Sleep; Insomnia; Fatigue; Beliefs; Attitudes; Depression; Pain; Osteoarthritis

INTRODUCTION

Osteoarthritis (OA) is extremely common in older adults, affecting 50% of people aged 65 or older, more than half of all older adults with OA complain of significantly disturbed sleep, making OA-related insomnia the most common comorbid form of insomnia in older adults.^{1,2} The assessment and diagnosis of chronic insomnia involves two components: nighttime sleep complaints and daytime sleep-related consequences, as specified by the 3rd edition of International Classification of Sleep Disorders (ICSD-3) and the Diagnostic and Statistical Manual for Mental Disorders (DSM-5).^{3,4} While questionnaires commonly used in the evaluation of insomnia, such as the Insomnia Severity Index (ISI) and Pittsburgh Sleep Quality Index (PSQI), typically inquire about both the nature of nighttime sleep and daytime function, these measures are usually reported in the literature as total scores and rarely are their nighttime and daytime components examined separately.

Studies have shown poor nighttime sleep is associated with medical comorbidity,⁵ depression,^{6,7} fatigue,⁸ and pain.⁹ However, in the case of individuals with OA pain, little is known about how these correlates interact with demographic characteristics or beliefs and attitudes about sleep and pain, or whether they are also important predictors of daytime sleep-related complaints. The current study addresses this gap by comparing predictors of ISI and PSQI subscales for nighttime sleep complaints and daytime sleep-related consequences in a large cohort of community dwelling older adults with comorbid OA and insomnia. We hypothesized that demographic, mood, and physical predictors for nighttime complaints would be similar for both the ISI and PSQI, predictors for daytime complaints would also be similar across both scales, but that predictors for nighttime compared to daytime complaints would differ within both scales. We then sought to determine whether addition of variables measuring sleep and pain beliefs/attitudes would alter the nature of the original predictive relationships.

METHODS

Participants and Procedures

This was a cross sectional study employing secondary analyses of baseline data from a large randomized controlled trial (R01 AG031126).¹⁰ The study sample was composed of 367 older adults, age 60 or above, who enrolled in a study comparing three group interventions for treating insomnia and osteoarthritis pain. Participants were recruited from Kaiser-Permanente of Washington, formerly Group Health Cooperative (GHC), a large health maintenance organization in Seattle, Washington. Sample characteristics were comparable to other nonparticipating older adult GHC members with OA and insomnia symptoms.¹¹

Inclusion/Exclusion Criteria—Between 2008 and 2010, the team contacted 8,057 GHC members aged 60 or above who had an electronic medical record OA diagnosis associated

with a health care visit in the past 3 years. Members with the following conditions identified in the last three years were excluded prior to initial screening: rheumatoid arthritis; obstructive sleep apnea, periodic leg movement disorder, restless leg syndrome, sleep–wake cycle disturbance, rapid eye movement behavior disorder; dementia or receiving cholinesterase inhibitors; Parkinson's disease; cancer diagnosis in the past year and receiving chemotherapy or radiation therapy in the past year; inpatient treatment for congestive heart failure within the prior 6 months.¹² Eligible members were mailed a screening questionnaire which asked about frequency and interference level of their OA pain over the past three months and the frequency and severity of their sleep problems. Eligibility for participation was based upon responses to pain and sleep items on the questionnaires.¹¹ Participants all met research diagnostic criteria for chronic insomnia,¹³ and had significant arthritis pain as defined by Grade II, III, or IV on the Graded Chronic Pain Scale (GCPS).¹⁴

Measures

Demographic Variables—Demographic characteristics included in the analysis were age, sex, education, marital status, and comorbidities as measured by Charlson Comorbidity Index (CCI). The CCI is a 19-item assessment tool that predicts 10-year survival based on a range of 19 comorbid medical conditions (e.g. myocardial infarction, diabetes). Each condition is assigned a weighted score, depending on the risk of dying associated with each condition. The possible scores range is 0 to 37. Higher total score indicates increased comorbidity and mortality.^{15,16}

Sleep Measures—The Insomnia Severity Index (ISI) is a validated 7-item (0–4) questionnaire that measures global insomnia severity; total scores range from 0 to 28, with higher scores indicating more severe insomnia.^{17,18} The ISI has good internal consistency ($\alpha=0.90$), sensitivity (86%), and specificity (87%), and has been shown to be sensitive to change with intervention.^{17,18} Confirmatory factor analyses showed three primary factor loadings with general categories of items 1, 2 and 3 (nighttime sleep difficulties), item 4 (sleep dissatisfaction) and items 5, 6 and 7 (daytime impact of insomnia).^{19–22}

The Pittsburgh Sleep Quality Index (PSQI) is a well-established tool that rates self-reported sleep quality and disturbances over the past month.²³ The PSQI includes 19 items that measure seven components of sleep: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Each domain is weighted equally on a 0–3 scale, contributing to a total PSQI score that ranges between 0–21; higher scores indicate worse sleep quality. PSQI has good internal consistency ($r=0.8$),²⁴ and test-retest reliability ($r=0.81–0.86$).²⁵

Nighttime vs. Daytime Sleep Comparisons: For purposes of this study, nighttime sleep complaints and daytime sleep-related consequences were examined separately for both the ISI and the PSQI.

For the ISI, items 1–4 were combined to create a nighttime sleep complaints subscale, based on previous factor analyses studies.^{19–22} These four ISI items ask respondents to rate current (over the past two weeks) severity of “*difficulty falling asleep*”, “*difficulty staying asleep*”,

“problems waking up too early”, and “How satisfied/dissatisfied are you with your current sleep pattern” with a total possible subscale score of 0 – 16.

For the PSQI, the sleep quality component (item 6) was used to assess nighttime sleep quality (*“During the past month, how would you rate your sleep quality overall?”*), for a total possible subscale score of 0 – 3.

Daytime functioning was measured using the ISI by combining items 5–7, for a total possible subscale score of 0 – 12. Included ISI items were: *“How noticeable to others do you think your sleep problem is in terms of impairing the quality of your life”, “How worried/distressed are you about your current sleep problem”, and “To what extent do you consider your sleep problem to interfere with your daily functioning (e.g. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, etc.) currently?”* These items were suggested to index sleep dissatisfaction and daytime impact of insomnia based on previous factor analyses studies.^{19–22}

For the PSQI, the daytime functioning component (items 8–9) was used to measure sleep-related daytime consequences, with a total possible score of 0 – 6. The two PSQI daytime function items are: *“During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?”* and *“During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?”*

Depression, Fatigue, Pain, and Beliefs/Attitudes towards Sleep and Pain—The Geriatric Depression Scale (GDS) is a 30-item depression questionnaire for older persons with yes/no ratings. Total scores range from 0 to 30; scores of 11–13 indicate mild depression while 14 or greater indicates moderate to severe depression.²⁶

The Flinders Fatigue Scale (FFS) is a 7-item questionnaire measuring fatigue. The FFS has a score range of 0–31; higher scores indicate higher levels of fatigue. The FFS has strong internal reliability and validity,²⁷ and has been used to measure fatigue in sleep studies in older adults.²⁸ For purposes of this study, we analyzed data using both the full FFS, and a modified version without the single sleep-related FFS item *“How much was your fatigue caused by poor sleep?”* to avoid any potential sleep-dependent effects. The modified 6-item scale had a range of 0–27. **Results presented in this study are based on the revised FFS, with the sleep-related item removed.**

The Graded Chronic Pain Scale (GCPS) was used as a screening tool as well as a baseline measure to assess pain severity. The GCPS asked participants to rate the number of days each participant had experienced OA pain and their average pain level in the past month. The scale also assesses the degree to which pain interferes with daily activities, and the number of days that pain kept people from their usual activities. To be eligible to participate in this study, participants reported Grade II–IV arthritis pain (average pain intensity ratings of 5 or greater on a 0–10 rating scale, or significant pain-related activity limitation). The total scores of the scale were used in the analyses.¹²

The Dysfunctional Beliefs and Attitudes About Sleep scale (DBAS) was used as a measure of how subjects think and feel about their sleep.²⁹ The 10-item DBAS scale was used, with a possible score of 0–100; higher scores indicate more dysfunctional beliefs about insomnia.^{29,30}

The Pain Catastrophizing Scale (PCS) was used as a measure describing different thoughts and feelings that individuals may experience when they are in pain. This 13-item scale has a possible range 0–52, with higher scores indicating greater catastrophizing.³¹

Statistical Analyses

The raw data were screened for accuracy, missing values, outliers, and distributional properties prior to analysis. The sample was described using descriptive statistics of demographic and baseline variables. Multivariate linear regression analyses were performed to test predictive models for the nighttime sleep complaints and daytime sleep-related consequences variables created from both the ISI and PSQI. Factors included in Model 1 were demographics (age, sex, education, marital status), medical comorbidities, and associated clinical symptoms (fatigue, depression, pain). In Model 2, significant variables from Model 1 were entered, with the addition of variables measuring sleep and pain beliefs/attitudes (DBAS, PCS). Models were run using both the full FFS and the modified FFS which removed the single sleep-related item from the scale to minimize the interaction. All analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 20 (IBM Corporation, Armonk, New York, U.S.A.). The level of statistical significance was set at $p < 0.05$.

RESULTS

A total of 367 older adults (mean age 72.9 ± 8.2 years; female 78.5%, white 90.1%) with OA and insomnia were included in the analysis. All participants had clinically significant insomnia (ISI 12.8 ± 4.8) and chronic pain (Chronic Pain Grade II 32%, III or IV 68.0%). Table 1 provides a summary of the baseline characteristic of the sample; a full description has been reported in prior publications.^{11,32,33}

Assessment for multicollinearity among predictors, especially pain severity (GCPS) and pain beliefs (PCS), were performed. The values for variance inflation factors (VIF) were non-significant (1.056–1.442). Table 2 summarizes the Model 1 regressions predicting ISI and PSQI nighttime sleep complaints and daytime sleep-related consequences including demographics, fatigue (FFS), depression (GDS), and pain severity (GCPS). Sex, education, and fatigue predicted ISI nighttime sleep complaints [$R^2 = .187$; $F = 11.458$ ($p < .001$)]; whereas fatigue was the only variable that predicted PSQI nighttime complaints [$R^2 = .106$; $F = 6.393$ ($p < .001$)]. Fatigue, depression, and pain predicted daytime sleep-related consequences for ISI [$R^2 = .418$; $F = 33.742$ ($p < .000$)]. Fatigue and depression predicted daytime sleep-related consequences for PSQI [$R^2 = .184$; $F = 11.220$ ($p < .001$)].

Table 3 summarizes the Model 2 regressions, which included the significant Model 1 predictor variables plus the additional cognitive variables measuring individual beliefs/attitudes about sleep (DBAS) and pain (PCS). When measures of sleep and pain beliefs/

attitudes were added, depression was no longer a significant predictor of ISI daytime consequences, but remained in the model for PSQI daytime complaints. In addition, sex and pain severity became nonsignificant in the model. Fatigue remained the strongest and most consistent predictor associated with both nighttime sleep complaints and daytime sleep-related consequences regardless of the scale used to measure these concepts. Comparable results were obtained whether the full FFS or the abbreviated 6-item version of the scale was used.

Education, fatigue, sleep beliefs and pain beliefs predicted ISI nighttime sleep complaints [$R^2 = .222$; $F = 21.334$ ($p < .001$)] [R^2 change .030; F change 7.023 ($p < .001$)]. Fatigue, sleep beliefs, and pain beliefs predicted PSQI nighttime sleep complaints [$R^2 = .152$; $F = 22.308$ ($p < .001$)] [R^2 change .055; F change 11.699 ($p < .001$)]. Fatigue and sleep beliefs predicted ISI daytime sleep-related consequences [$R^2 = .458$; $F = 61.113$ ($p < .001$)] [R^2 change .045; F change 15.114 ($p < .001$)]. Fatigue, depression, and pain beliefs predicted PSQI daytime sleep-related consequences [$R^2 = .199$; $F = 23.107$ ($p < .001$)] [R^2 change .018; F change 4.061 ($p < .018$)].

DISCUSSION

This study of comorbid insomnia and osteoarthritis in 367 older adults found that the demographic and clinical predictors of nighttime sleep complaints and daytime sleep-related consequences were different, and that those differences varied somewhat depending upon the self-report instrument used to measure them. The single exception was that fatigue was a consistent predictor of both nighttime sleep complaints and daytime sleep-related consequences as measured by both the ISI and the PSQI. When cognitive variables measuring individual beliefs/attitudes about sleep and pain were added to the original models, sleep and pain beliefs were stronger predictors of both nighttime sleep complaints and daytime sleep-related consequences than were clinical ratings of depression and pain. These findings have implications for better understanding the nighttime and daytime components that are integral to insomnia assessment and diagnosis in both research and clinical settings.

Our hypothesis that predictors of nighttime sleep complaints and daytime sleep-related consequences would be different from one another was not confirmed. In Model 1 (Demographic and Clinical Factors): demographic variables (sex and education) were significant predictors for ISI nighttime sleep complaints, but not for PSQI. Fatigue was also the only predictor of nighttime sleep complaints for PSQI.

There have been numerous studies suggesting associations amongst insomnia, depression, and pain.^{34–36} In addition to some shared symptoms (sleep disturbance, irritability, change of appetite, and fatigue), a recent review article suggested a shared neurobiological substrate for these three conditions such as atrophy of the hippocampus, hypothalamic–pituitary–adrenal axis (HPA) dysregulation, and elevated levels of TNF- α and IL-1 β .³⁷ Surprisingly, comorbidity score did not emerge as a significant predictor in any of the model. This may be related to the narrow variances in the data since the sampled group had low comorbidity scores (mean 1.1, of the 0–37 possible score range).

We did not find that the ISI and PSQI had similar predictors of nighttime sleep disturbance or daytime dysfunction across scales. In Model 1, female participants reported more nighttime sleep disturbance on the ISI, although this relationship was not observed for the PSQI. Previous studies have shown that women tend to be less satisfied with their sleep than men,³⁸ perhaps due to hormonal changes in sleep architecture in older adult women.^{39–42} Higher education level was also found to be associated with less nighttime sleep complaints indexed by ISI. It has been suggested that socioeconomic variables such as education and income play an intricate role in perceived sleep quality.^{43,44}

Our findings further support the theory that sleep is a phenomenon with both physiological and psychological components. In Model 2 (Sleep Beliefs and Pain Beliefs), when the cognitive variables assessing beliefs and attitudes about sleep (DBAS) and pain (PCS) were added, pain and particularly depression became nonsignificant in most of the regressions. This failure of depression to contribute significantly across models suggests that pain and sleep cognitive/attitudinal variables are stronger predictors for sleep related complaints than mood. Notably in Model 2, the two cognitive variables (sleep beliefs and pain beliefs) along with fatigue became a strong cluster of predictors for both ISI and PSQI nighttime sleep complaints. These findings support prior research that has shown that pain coping strategies, including pain catastrophizing, are highly correlated with fatigue, physical symptoms, and psychological distress.⁴⁵ Cognitive attributions about the negative consequences of insomnia can also lead to feeling overwhelmed and helpless, which can lead to emotional distress, hyperarousal, and heightened pain perception.^{46,47} Cognitive-Behavioral Therapy targets such attributions, and has been shown to improve both pain and sleep symptoms, both independently and conjunctly, with the long-term effect up to two years.^{10,33,48}

Importantly, fatigue was the only variable that consistently predicted nighttime sleep complaints and daytime sleep-related consequences for the ISI and PSQI in both models. Studies have shown a strong link between fatigue and poor nighttime sleep among community dwelling older adults,^{8,49,50} as well as those with osteoarthritis.³⁶ There is also evidence of an association between fatigue and daytime functional impairment.^{51,52}

Regardless, the consistent appearance of fatigue as a strong predictor in all regressions in both Model 1 and Model 2 is worth noting, and suggests an important clinical consideration; namely, that evaluation of fatigue should be part of a sleep assessment, especially in the older adult population. When assessing sleep, it is important to independently evaluate complaints of fatigue versus excessive daytime sleepiness (EDS). These two terms are often used interchangeably, and broadly described by patients as “tiredness.” However, it has been suggested that fatigue is a more relevant symptom for insomnia. Fatigue has been defined as “weariness, weakness, and depleted energy,” compared to sleepiness which is “drowsiness, sleep propensity, and decreased alertness.”⁵³ Studies have shown that the level of fatigue is often unrelated to the daytime sleepiness in people with insomnia,⁵⁴ and between the two, fatigue tends to bear additional negative consequences due to associated psychological distress.⁵⁵

This study has some limitations. The assessment of sleep was based on self-reported measures. Nighttime sleep complaints and daytime sleep related consequences were indexed

using ISI and PSQI subscales, which in the case of the ISI have only been validated in non-English populations. The PSQI nighttime sleep complaints subscale was based on a single question/item, and the daytime dysfunction subscale is only two items. However, these PSQI subscales are widely used and validated.⁵⁶ In addition, this is a descriptive study that does not allow us to make the causal attributions. It is likely that many of the relationships between the variables we examined are bidirectional, and future studies are needed to explore possible causal directionalities. Finally, the study also has several strengths, including; a relatively large sample size, a well characterized primary care population, and a study sample that was comparable to the larger nonparticipating GHC population of older adults with OA and insomnia symptoms.¹¹

In summary, this study found both similarities and differences in factors predicting nighttime sleep complaints and daytime sleep-related consequences. Fatigue, sleep beliefs/attitudes and pain beliefs/attitudes consistently predicted nighttime sleep complaints and to a somewhat lesser degree daytime sleep-related consequences using the two most widely cited measures of sleep and insomnia. Individual beliefs about sleep and pain were stronger predictors of sleep difficulties than was depression or other medical morbidities. This is one of the few studies with a large older adult sample that demonstrated such a consistent relationship between fatigue, pain beliefs, and sleep. Future studies examining sleep phenomena should consider using validated scales to evaluate individual beliefs about sleep and pain, and to independently assess fatigue and the related concept of excessive daytime sleepiness.

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References

1. Sarzi-Puttini P, Cimmino MA, Scarpa R, et al. Osteoarthritis: an overview of the disease and its treatment strategies. *Seminars in arthritis and rheumatism*. 2005; 35(1 Suppl 1):1–10.
2. Foley D, Ancoli-Israel S, Britz P, Walsh J. Sleep disturbances and chronic disease in older adults: results of the 2003 National Sleep Foundation Sleep in America Survey. *Journal of psychosomatic research*. 2004; 56(5):497–502. [PubMed: 15172205]
3. APA. *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*. 5. Washington DC: American Psychiatric Publishing; 2013.
4. American Academy of Sleep Medicine. *International Classification of Sleep Disorders*. 3. Darlen, IL: American Academy of Sleep Medicine; 2014.
5. Parish JM. Sleep-related problems in common medical conditions. *Chest*. 2009; 135(2):563–572. [PubMed: 19201722]
6. Baglioni C, Battagliese G, Feige B, et al. Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. *Journal of affective disorders*. 2011; 135(1–3): 10–19. [PubMed: 21300408]
7. Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: a meta-analysis of prospective cohort studies. *BMC psychiatry*. 2016; 16(1):375. [PubMed: 27816065]
8. Goldman SE, Ancoli-Israel S, Boudreau R, et al. Sleep problems and associated daytime fatigue in community-dwelling older individuals. *The journals of gerontology. Series A, Biological sciences and medical sciences*. 2008; 63(10):1069–1075.

9. Schrimpf M, Liegl G, Boeckle M, Leitner A, Geisler P, Pieh C. The effect of sleep deprivation on pain perception in healthy subjects: a meta-analysis. *Sleep medicine*. 2015; 16(11):1313–1320. [PubMed: 26498229]
10. Vitiello MV, McCurry SM, Shortreed SM, et al. Cognitive-behavioral treatment for comorbid insomnia and osteoarthritis pain in primary care: the lifestyles randomized controlled trial. *Journal of the American Geriatrics Society*. 2013; 61(6):947–956. [PubMed: 23711168]
11. McCurry SM, Von Korff M, Vitiello MV, et al. Frequency of comorbid insomnia, pain, and depression in older adults with osteoarthritis: predictors of enrollment in a randomized treatment trial. *Journal of psychosomatic research*. 2011; 71(5):296–299. [PubMed: 21999972]
12. Von Korff M, Vitiello MV, McCurry SM, et al. Group interventions for co-morbid insomnia and osteoarthritis pain in primary care: the lifestyles cluster randomized trial design. *Contemp Clinical Trials*. 2012; 33(4):759–768.
13. Edinger JD, Bonnet MH, Bootzin RR, et al. Derivation of research diagnostic criteria for insomnia: report of an American Academy of Sleep Medicine Work Group. *Sleep*. 2004; 27(8):1567–1596. [PubMed: 15683149]
14. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain*. 1992; 50(2):133–149. [PubMed: 1408309]
15. Charlson ME, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. *Journal of clinical Epidemiology*. 1994; 47:1245–1251.
16. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of chronic diseases*. 1987; 40:373–383.
17. Bastien CH, Vallieres A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep medicine*. 2001; 2(4):297–307. [PubMed: 11438246]
18. Morin CM, Belleville G, Belanger L, Ivers H. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep*. 2011; 34(5):601–608. [PubMed: 21532953]
19. Chen PY, Yang CM, Morin CM. Validating the cross-cultural factor structure and invariance property of the Insomnia Severity Index: evidence based on ordinal EFA and CFA. *Sleep medicine*. 2015; 16(5):598–603. [PubMed: 25863811]
20. Fernandez-Mendoza J, Rodriguez-Munoz A, Vela-Bueno A, et al. The Spanish version of the Insomnia Severity Index: a confirmatory factor analysis. *Sleep medicine*. 2012; 13(2):207–210. [PubMed: 22172961]
21. Sadeghniai-Haghighi K, Montazeri A, Khajeh-Mehrzi A, Nedjat S, Aminian O. The Insomnia Severity Index: cross-cultural adaptation and psychometric evaluation of a Persian version. *Qual Life Res*. 2014; 23(2):533–537. [PubMed: 23912857]
22. Yu DS. Insomnia Severity Index: psychometric properties with Chinese community-dwelling older people. *Journal of Advanced Nursing*. 2010; 66(10):2350–2359. [PubMed: 20722803]
23. Buysse DJ, Hall ML, Strollo PJ, et al. Relationships between the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and clinical/polysomnographic measures in a community sample. *Journal of Clinical Sleep Medicine*. 2008; 4(6):563–571. [PubMed: 19110886]
24. Carpenter JS, Andrykowski MA. Psychometric evaluation of the Pittsburgh Sleep Quality Index. *Journal of psychosomatic research*. 1998; 45(1):5–13. [PubMed: 9720850]
25. Mollaveva T, Thuraiajah P, Burton K, Mollaveva S, Shapiro CM, Colantonio A. The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep medicine reviews*. 2016; 25:52–73. [PubMed: 26163057]
26. Yesavage JA, Brink TL, Rose TL, et al. Development and validation of a geriatric depression screening scale: a preliminary report. *Journal of Psychiatric Research*. 1982; 17(1):37–49.
27. Gradisar M, Lack L, Richards H, et al. The Flinders Fatigue Scale: preliminary psychometric properties and clinical sensitivity of a new scale for measuring daytime fatigue associated with insomnia. *Journal of Clinical Sleep Medicine*. 2007; 3(7):722–728. [PubMed: 18198807]
28. Lovato N, Lack L, Wright H, Kennaway DJ. Evaluation of a brief treatment program of cognitive behavior therapy for insomnia in older adults. *Sleep*. 2014; 37(1):117–126. [PubMed: 24470701]

29. Edinger JD, Wohlgemuth WK. Psychometric comparisons of the standard and abbreviated DBAS-10 versions of the dysfunctional beliefs and attitudes about sleep questionnaire. *Sleep medicine*. 2001; 2(6):493–500. [PubMed: 14592264]
30. Espie CA, Inglis SJ, Harvey L, Tessler S. Insomniacs' attributions. psychometric properties of the Dysfunctional Beliefs and Attitudes about Sleep Scale and the Sleep Disturbance Questionnaire. *Journal of psychosomatic research*. 2000; 48(2):141–148. [PubMed: 10719130]
31. Sullivan MJ, Bishop S, Pivik J. The Pain Catastrophizing Scale: Development and Validation. *Psychological Assessment*. 1995; 7:524–532.
32. McCurry SM, Shortreed SM, Von Korff M, et al. Who benefits from CBT for insomnia in primary care? Important patient selection and trial design lessons from longitudinal results of the Lifestyles trial. *Sleep*. 2014; 37(2):299–308. [PubMed: 24497658]
33. Vitiello MV, McCurry SM, Shortreed SM, et al. Short-term improvement in insomnia symptoms predicts long-term improvements in sleep, pain, and fatigue in older adults with comorbid osteoarthritis and insomnia. *Pain*. 2014; 155(8):1547–1554. [PubMed: 24793909]
34. Chiu YH, Silman AJ, Macfarlane GJ, et al. Poor sleep and depression are independently associated with a reduced pain threshold. Results of a population based study. *Pain*. 2005; 115(3):316–321. [PubMed: 15911158]
35. Roberts MB, Drummond PD. Sleep Problems are Associated with Chronic Pain Over and Above Mutual Associations with Depression and Catastrophizing. *The Clinical journal of pain*. 2015
36. Hawker GA, French MR, Waugh EJ, Gignac MA, Cheung C, Murray BJ. The multidimensionality of sleep quality and its relationship to fatigue in older adults with painful osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society*. 2010; 18(11):1365–1371.
37. Boakye PA, Olechowski C, Rashedi S, et al. A Critical Review of Neurobiological Factors Involved in the Interactions Between Chronic Pain, Depression, and Sleep Disruption. *The Clinical journal of pain*. 2016; 32(4):327–336. [PubMed: 26035521]
38. van den Berg JF, Miedema HM, Tulen JH, Hofman A, Neven AK, Tiemeier H. Sex differences in subjective and actigraphic sleep measures: a population-based study of elderly persons. *Sleep*. 2009; 32(10):1367–1375. [PubMed: 19848365]
39. Campbell SS, Gillin JC, Kripke DF, Erikson P, Clopton P. Gender differences in the circadian temperature rhythms of healthy elderly subjects: relationships to sleep quality. *Sleep*. 1989; 12(6):529–536. [PubMed: 2595176]
40. Duffy JF, Cain SW, Chang AM, et al. Sex difference in the near-24-hour intrinsic period of the human circadian timing system. *Proceedings of the National Academy of Sciences, U.S.A.* 2011; 108(Suppl 3):15602–15608.
41. Moe KE, Prinz PN, Vitiello MV, Marks AL, Larsen LH. Healthy elderly women and men have different entrained circadian temperature rhythms. *Journal of the American Geriatrics Society*. 1991; 39(4):383–387. [PubMed: 2010588]
42. Murphy PJ, Campbell SS. Sex hormones, sleep, and core body temperature in older postmenopausal women. *Sleep*. 2007; 30(12):1788–1794. [PubMed: 18246988]
43. Stamatakis KA, Kaplan GA, Roberts RE. Short sleep duration across income, education, and race/ethnic groups: population prevalence and growing disparities during 34 years of follow-up. *Annals Epidemiology*. 2007; 17(12):948–955.
44. Grandner MA, Williams NJ, Knutson KL, Roberts D, Jean-Louis G. Sleep disparity, race/ethnicity, and socioeconomic position. *Sleep medicine*. 2016; 18:7–18. [PubMed: 26431755]
45. Somers TJ, Kurakula PC, Criscione-Schreiber L, Keefe FJ, Clowse ME. Self-efficacy and pain catastrophizing in systemic lupus erythematosus: relationship to pain, stiffness, fatigue, and psychological distress. *Arthritis care & research*. 2012; 64(9):1334–1340. [PubMed: 22505314]
46. Morin CM, Benca RM. Insomnia nature, diagnosis, and treatment. *Handbook of clinical neurology*. 2011; 99:723–746. [PubMed: 21056225]
47. Vowles KE, McCracken LM, Eccleston C. Processes of change in treatment for chronic pain: the contributions of pain, acceptance, and catastrophizing. *European journal of pain*. 2007; 11(7):779–787. [PubMed: 17303452]

48. Cherkin DC, Anderson ML, Sherman KJ, et al. Two-Year Follow-up of a Randomized Clinical Trial of Mindfulness-Based Stress Reduction vs Cognitive Behavioral Therapy or Usual Care for Chronic Low Back Pain. *Jama*. 2017; 317(6):642–644. [PubMed: 28196244]
49. Hardy SE, Studenski SA. Fatigue and function over 3 years among older adults. *The journals of gerontology. Series A, Biological sciences and medical sciences*. 2008; 63(12):1389–1392.
50. Endeshaw YW. Do sleep complaints predict persistent fatigue in older adults? *Journal of the American Geriatrics Society*. 2015; 63(4):716–721. [PubMed: 25851828]
51. Vestergaard S, Nayfield SG, Patel KV, et al. Fatigue in a representative population of older persons and its association with functional impairment, functional limitation, and disability. *The journals of gerontology. Series A, Biological sciences and medical sciences*. 2009; 64(1):76–82.
52. Lin F, Chen DG, Vance DE, Ball KK, Mapstone M. Longitudinal relationships between subjective fatigue, cognitive function, and everyday functioning in old age. *International Psychogeriatrics*. 2013; 25(2):275–285. [PubMed: 23083533]
53. Pigeon WR, Sateia MJ, Ferguson RJ. Distinguishing between excessive daytime sleepiness and fatigue: toward improved detection and treatment. *Journal of psychosomatic research*. 2003; 54(1):61–69. [PubMed: 12505556]
54. Lichstein KL, Means MK, Noe SL, Aguillard RN. Fatigue and sleep disorders. *Behaviour research and therapy*. 1997; 35(8):733–740. [PubMed: 9256516]
55. Hossain JL, Ahmad P, Reinish LW, Kayumov L, Hossain NK, Shapiro CM. Subjective fatigue and subjective sleepiness: two independent consequences of sleep disorders? *Journal of sleep research*. 2005; 14(3):245–253. [PubMed: 16120099]
56. Buysse DJ, Reynolds CF 3rd, Monk TH, Hoch CC, Yeager AL, Kupfer DJ. Quantification of subjective sleep quality in healthy elderly men and women using the Pittsburgh Sleep Quality Index (PSQI). *Sleep*. 1991; 14(4):331–338. [PubMed: 1947597]

Highlight

- Fatigue, sleep beliefs and pain beliefs consistently predicted nighttime sleep complaints.
- Individual beliefs about sleep and pain were strong predictors of sleep difficulties.
- Fatigue was the strongest predictor associated with day and night sleep complaints.

Table 1

Demographic characteristics of the participants (n = 367)

<i>Demographics</i>	
Mean Age (SD)	72.9 (8.2) years
Sex (female)	78.5%
Education	
12 years	12.5%
Some college	34.1%
College graduate	53.5%
Employment	
Retired	78.5%
Full-time work	8.0%
Part-time work	9.1%
Other	4.4%
Racial status	
White	90.1%
Nonwhite	9.9%
Marital status	
Married/living as married	53.7%
Never married	5.0%
Separated or divorced	19.4%
Widowed	21.9%
Charlson Comorbidity Index (CCI)(0–37), mean (SD)	1.1 (1.9)
<i>Sleep related comorbid conditions</i>	
Insomnia Severity Index (ISI)(0–28), mean (SD)	12.8 (4.8)
ISI score ≥ 15	36.5%
ISI items 1–4 (nighttime sleep complaint) (score range 0–16)	7.6 (3.1)
ISI items 5–7 (daytime sleep related function) (score range 0–12)	3.9 (2.4)
Pittsburgh Sleep Quality Index (PSQI) (0–21), mean (SD)	9.4 (3.6)
PSQI item 6 (nighttime sleep complaint) (score range 0–3)	1.4 (0.7)
PSQI items 8 & 9 (daytime sleep related function) (score range 0–3)	1.1 (0.6)
Flinders Fatigue Scale (FFS)(0–31), mean (SD)	11.3 (6.2)
Geriatric Depression Scale (GDS)(0–30), mean (SD)	6.7 (5.1)
Dysfunctional Beliefs and Attitudes About Sleep scale (DBAS)(0–100), mean (SD)	48.6 (16.6)
Pain Catastrophizing Scale (PCS)(0–52), mean (SD)	10.9 (9.3)

Graded Chronic Pain Scale (GCPS)(0–10), mean (SD)	4.3 (1.5)
Grade II	32.1%
Grade III or IV	68%

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Table 2

Model 1 - Predicting nighttime sleep complaint and daytime sleep related consequences with demographic and clinical measures (mean scores)

	Nighttime Sleep Complaints			Daytime Sleep-Related Consequences		
	Standardized β	Unstandardized b (SE)	p	Standardized β	Unstandardized b (SE)	p
ISI	Age	-.016	.757	Age	-.044	.606
	Sex	.117	.018	Sex	.039	.580
	Education	-.156	.002	Education	-.048	.224
	Marital	.001	.987	Marital	-.083	.125
	Comorbidity	.044	.372	Comorbidity	.024	.690
	Fatigue	.357	<.001	Fatigue	.537	<.001
	Depression	.099	.063	Depression	.113	.003
	Pain	-.011	.838	Pain	.063	.038
Total $R^2 = .187$; $F = 11.458$ ($p < .001$)			Total $R^2 = .418$; $F = 33.742$ ($p < .001$)			
PSQI	Standardized β	Unstandardized b (SE)	p	Standardized β	Unstandardized b (SE)	p
	Age	-.070	.194	Age	-.073	.153
	Sex	-.010	.841	Sex	-.015	.755
	Education	-.045	.402	Education	.031	.543
	Marital	-.032	.533	Marital	.027	.589
	Comorbidity	.042	.411	Comorbidity	-.035	.475
	Fatigue	.227	<.001	Fatigue	.296	<.001
	Depression	.102	.068	Depression	.168	.002
	Pain	.106	.056	Pain	.098	.064
Total $R^2 = .106$; $F = 6.393$ ($p < .001$)			Total $R^2 = .184$; $F = 11.220$ ($p < .001$)			

All variables entered in each model are reported. Variables that were not significant are shaded.

Insomnia Severity Index (ISI)

Pittsburgh Sleep Quality Index (PSQI)

Fatigue: Flinders Fatigue Scale – revised, excluding the sleep item (FFS)

Pain: Graded Chronic Pain Scale (GCPS)

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Depression: Geriatric Depression Scale (GDS)
Sleep belief: Dysfunctional Beliefs About Sleep (DBAS)
Pain belief: Pain Catastrophizing (PCS)

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Model 2 - Predicting nighttime sleep complaint and daytime sleep related consequences with demographic, clinical measures and attitudes/beliefs about sleep and pain

Table 3

	Nighttime Sleep Complaints			Daytime Sleep-Related Consequences		
	Standardized β	Unstandardized b (SE)	p	Standardized β	Unstandardized b (SE)	p
ISI	Sex	.083	.628 (.354)	.077		
	Education	-.159	-.274 (.081)	.001	Fatigue	.223 (.020)
	Fatigue	.315	.179 (.029)	<.001	Depression	.026 (.022)
	Sleep beliefs	.130	.025 (.009)	.010	Pain	.102(.070)
	Pain beliefs	.135	.045 (.017)	.009	Sleep beliefs	.030 (.006)
Total R ² = .222; F = 21.334 (p = < .001)					Pain beliefs	.023 (.012)
					Total R ² = .458; F = 61.113 (p = < .001)	
PSQI		Standardized β	Unstandardized b (SE)	p	Standardized β	Unstandardized b (SE)
	Fatigue	.220	.029 (.007)	<.001	Fatigue	.032 (.006)
	Sleep beliefs	.187	.008 (.002)	<.001	Depression	.016 (.007)
	Pain beliefs	.133	.010 (.004)	.013	Sleep beliefs	.003 (.002)
Total R ² = .152; F = 22.308 (p = < .001)					Pain beliefs	.007 (.003)
					Total R ² = .199; F = 23.107 (p = < .001)	

All variables entered in each model are reported. Variables that were not significant are shaded.

Insomnia Severity Index (ISI)

Pittsburgh Sleep Quality Index (PSQI)

Fatigue: Flinders Fatigue Scale – revised, excluding the sleep item (FES)

Pain: Graded Chronic Pain Scale (GCPS)

Depression: Geriatric Depression Scale (GDS)

Sleep belief: Dysfunctional Beliefs About Sleep (DBAS)

Pain belief: Pain Catastrophizing (PCS)