Published in final edited form as:
Aging Ment Health. 2019 September ; 23(9): 1174–1179. doi:10.1080/13607863.2018.1481929.

Pain Inconsistency and Sleep in Mid to Late-Life: The Role of Depression

Scott G. Ravyts[1], **Joseph M. Dzierzewski**[1], **Stephanie C. Grah**[1], **Matthew P. Buman**[2], **Adrienne T. Aiken-Morgan**[3], **Peter R. Giacobb Jr**[4], **Beverly L. Roberts**[5], **Michael Marsiske**[6], and **Christina S. McCrae**[7]

[1]Virginia Commonwealth University, Department of Clinical Psychology, Richmond, VA

[2]Arizona State University, Exercise Science and Health Promotion, Phoenix, AZ

[3]North Carolina A&T State University, Department of Psychology, Greensboro, NC

[4]West Virginia University, College of Physical Activity and Sport Sciences, Morgantown, WV

[5]University of Florida, College of Nursing, Gainesville, FL

[6]University of Florida, Department of Clinical and Health Psychology, Gainesville, FL

[7]University of Missouri, Department of Health Psychology, Columbia, MO

Abstract

Objectives: Inconsistency in pain may lead to depression, which may then influence sleep.

Thus, the purpose of this study was to examine whether depression mediates the relationship between day-to-day inconsistency in pain and sleep in middle aged to older adults.

Methods: Baseline measures from the Active Adult Mentoring Project were used for secondary data analysis. Participants included 82 adults in mid- to late-life. Pain was assessed for seven consecutive days on an 11-point Likert-scale, with pain inconsistency defined as the seven-day individual standard deviation. A self-report daily diary was used to assess sleep efficiency (SE), total wake time (TWT), total sleep time (TST), and sleep quality (SQ), and depression was assessed using the BDI-II.

Results: Mediation analyses revealed that depression partially mediated the relationship between pain inconsistency and SE, TWT, and SQ but not TST.

Conclusions: Results indicate that depression may be an important factor through which pain inconsistency influences sleep. Although further research is warranted, these preliminary findings suggest that intervening on both pain inconsistency and depression may be one way to improve sleep in older adults.

Keywords

pain inconsistency; pain; depression; sleep

Please address all correspondence to Joseph Dzierzewski PhD, Department of Psychology, Virginia Commonwealth University, 806 West Franklin Street, Richmond VA, 23284. dzierzewski@vcu.edu.

As adults age, they face an increasing number of competing health concerns. Pain and sleep disturbance are among the most prevalent and functionally impairing health challenges found in late-life (Fagerström & Hellström, 2011; Patel, Guralnik, Dansie, & Turk, 2013). Although sleep disturbance and pain are known to frequently co-occur in older adults (Foley, Ancoli-Israel, Britz, & Walsh, 2004), the pathway between pain and sleep remains complex and not fully understood. Nevertheless, pain and sleep are known to covary and evidence suggests that pain intensity predicts sleep disturbance among older adults with both acute and chronic pain (Chen, Hayman, Shmerling, Bean, & Leveille, 2011; Dzierzewski et al., 2010; Eslami, Zimmerman, Grewal, Katz, & Lipton, 2016).

Pain, Depression, and Sleep

Beyond understanding whether sleep and pain are connected, more recent research has started to examine the mechanisms through which sleep and pain are associated. Although several models have been suggested, depression has been found to be one important mechanism underlying the connection between pain and disrupted sleep. In fact, preliminary evidence suggests that altered dopaminergic function, a neurotransmitter closely linked with depression (Dailly, Chenu, Renard, & Bourin, 2004), may be implicated in the development and interplay of pain, sleep disturbance, and depression (Finan & Smith, 2013). Moreover, preliminary studies examining the relationship between sleep, pain, and depression have shown that depression and negative affect act as significant mechanisms through which pain contributes to increased sleep disturbance (Nicassio et al., 2012; Valrie, Gil, Redding-Lallinger, & Daeschner, 2008).

Pain Inconsistency

Past research and clinical practice have traditionally focused on individuals' average or usual level of pain (Dworkin et al., 2008; Litcher-Kelly, Martino, Broderick, & Stone, 2007), however, this approach fails to capture the dynamic nature of pain (Jensen & McFarland, 1993). Pain inconsistency, defined as variability in pain from day to day, is known to be a debilitating aspect of the pain experience, particularly for individuals with chronic pain (Allen, Coffman, Golightly, Stechuchak, & Keefe, 2009; Zakoscielna & Parmelee, 2013). For example, greater pain inconsistency is associated with a number of adverse consequences including greater functional limitations, somatization, and opioid medication use (Suri, Saunders, & Von Korff, 2012). These findings suggest that pain inconsistency represents a unique aspect of the pain experience that may interfere with important areas of functioning.

Pain Inconsistency, Depression, and Sleep

Pain inconsistency has important implications on sleep among older adults. For example, pain inconsistency has been shown to be a more reliable predictor of sleep in older adults than average pain (Ravyts et al., 2018). Depression may be one mechanism through which pain inconsistency influences sleep. Greater pain inconsistency is associated with increased depressive symptoms and decreased quality-of-life (Schneider et al., 2012; Tupper, Rosenberg, Pahwa, & Stinson, 2013), with inconsistent levels of pain predicting higher levels of emotional distress compared than consistent or predictable levels of pain (Jamison & Brown, 1991).

Objective findings associated with the consequences of pain inconsistency align with older adults' subjective experiences. For example, older adults believe that experiencing worse pain than usual will impair their sleep and increase their depressive symptoms, while experiencing less intense pain that usual is perceived to lead to decreased depressive and improved sleep (Blågestad, Pallesen, Grønli, Tang, & Nordhus, 2016). Thus, inconsistency in pain from day to day may interfere with older adults' pain expectations and negatively impact their ability to cope adaptively, leading to increased depressive symptoms and subsequently poorer sleep.

Present Study

The purpose of the present study was to extend previous research by examining the role of depression on the relationship between pain inconsistency and sleep in mid- to late-life. The potential mediating role of depression on the relationship between pain inconsistency and sleep has, to our knowledge, yet to be explored and could potentially serve to inform clinical treatments for older adults experiencing pain, as well as sleep and mood disturbance. Integrating past findings on the association between pain, depression, and sleep (Nicassio et al., 2012; Valrie et al., 2008), it was hypothesized that depression would partially mediate the relationship between pain inconsistency and sleep. Specifically, greater pain inconsistency was hypothesized to predict higher levels of depression which, in turn, would predict poorer sleep.

Methods

The current study represents a secondary analysis of baseline data from the Active Adult Mentoring Project (AAMP). The primary objective of the AAMP study was to examine the efficacy of a social-cognitive lifestyle intervention on promoting moderate intensity exercise in older adults. A description of methods pertinent to the present study are provided here, while the complete methods associated with the full AAMP study are available elsewhere (Buman et al., 2011).

Participants

Participants included 82 community-dwelling older adults recruited via local media outlets (e.g., local newspaper, university older adult participant registry). To participate in the AAMP study, potential enrollees had to be 50 years old or older and have a self-reported sedentary lifestyle [defined by the Physical Activity Guidelines Advisory Committee (2008) as less than 150 minutes per week of moderate or vigorous physical activity during the past six months]. Individuals with medical conditions that would significantly interfere with the ability to complete unsupervised exercise (e.g., major cardiovascular disease, recent cancer treatment) or with factors that would significantly interfere with study compliance or assessment (e.g., cognitive impairment, hearing or speech impairment) were excluded from participating in the study.

Procedure

Interested individuals completed a brief screening over the phone to ensure that they met eligibility criteria. Those who met the inclusion criteria came in for a baseline assessment. The baseline assessment included the measurement of pain, sleep, and depression. Participants completed both sleep and pain measures each day upon awakening for seven consecutive days.

Measures

Pain.—Participants' pain was assessed each morning upon awakening for seven consecutive days on an 11-point Likert scale ranging from 0 (no pain) to 10 (worst pain possible). The 11-point Numeric Rating scale meets criteria recommended in a pain assessment consensus statement by chronic pain researchers and is sensitive enough to detect meaningful and clinically relevant changes in pain (Dworkin et al., 2008; Ferreira-Valente, Pais-Ribeiro, & Jensen, 2011). In line with previous research, pain inconsistency was operationalized as the seven-day individual standard deviation of pain (Farrar et al., 2014). Unlike the overall range of daily pain scores, standard deviation is a more sensitive measure of pain inconsistency because it captures the average fluctuation in pain around an individual's own mean (Ravyts et al., 2018).

Sleep.—Sleep diaries completed daily upon awakening for seven consecutive days were used to assess participants' sleep. Sleep diaries provided subjective estimates of the following sleep parameters: total sleep time (TST: the total amount of time spent asleep during the night), total wake time (TWT: the total amount of time spent awake during the night, including time to initially fall asleep, time spent awake during the middle of the night, and time spent 'snoozing' in the morning), as well as sleep quality (SQ: the subjective perception of one's sleep). Finally, the sleep diaries were used to calculate participants' sleep efficiency (SE: the amount of time spent asleep divided by the total time spent in bed multiplied by 100).

Depression.—Depression was measured using the Beck Depression Inventory, Second Edition (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II is a 21-item self-report instrument designed to measure characteristic attitudes and symptoms of depression during the past two weeks. The total score on the BDI-II ranges from 0 to 63, with higher scores indicating more severe depressive symptoms. The BDI-II has been validated for use among adults in mid- to late-life (Segal, Coolidge, Cahill, & O'Riley, 2008).

Statistical Analyses

To test the hypothesis that mood mediates the relationship between pain inconsistency and sleep, an asymptotic bootstrapping approach using PROCESS macro was employed (Hayes, 2013). This approach allowed for the examination of the indirect effect of pain inconsistency on sleep via depression without the requirement of a direct effect of pain inconsistency on sleep. Four different mediation models with $N = 5{,}000$ resamples were used to examine the effect of pain inconsistency on sleep via depression. Prior to being entered into the model, pain inconsistency and depression were grand-mean centered in order to reduce multicollinearity and facilitate the interpretation of the results. Pain inconsistency, operationalized as the seven-day individual standard deviation of pain, was entered as the predictor variable in all four models, and depression was entered as the mediator variable. Finally, SE, TWT, TST, and SQ each individually served as the criterion variable for the four different models, while age, gender, race, and body mass index were controlled for in each model.

Results

Participants' ages ranged from 50 to 87 with a mean of 63.37 ($SD = 8.58$). Participants were predominately female (82.9%) and White (91.4%). Mean pain inconsistency was .84 ($SD = .64$). Forty percent of the sample reported a sleep efficiency rating below 87.5%, which has been suggested as the cutoff for differentiating individuals with insomnia from healthy controls (Natale et al., 2015). Ninety percent of participants reported symptoms placing them in the minimal depression range (0–13) and 10% of the sample reported symptoms placing them in the mild depression range (14–19) according to BDI-II interpretation guidelines (Beck et al., 1996). Complete demographic information and clinical characteristics are presented in Table 1.

Pain Inconsistency, Depression, and Sleep Efficiency

While the total effect of pain inconsistency on SE (Path c, $b = -3.89$, $p = .01$) was significant, the direct effect of pain inconsistency on SE was not (Path c', $b = -2.16$, $p = .12$). However, there was a significant indirect effect of pain inconsistency on SE via depression (Path a x b, $b = -1.73$, CI: −4.90, −.36). Specifically, pain inconsistency significantly predicted depression (Path a, $b = 2.30$, $p = .01$) and depression significantly predicted SE (Path b, $b = -.75$, $p < .001$). These results indicate that the effect of pain inconsistency on SE was mediated by depression. Thus, higher pain inconsistency predicted greater depressive symptoms, which, in turn, was associated with lower SE. Calculations of effect size (*ab/c*) indicate that 44% of the variance in the relationship between pain inconsistency and SE is explained by depression.

Pain Inconsistency, Depression, and Total Wake Time

Both the total effect of pain inconsistency on TWT (Path c, $b = 25.95$, $p = .002$) and the direct effect of pain inconsistency on TWT were significant (Path c', $b = 15.80$, $p = .04$). However, this direct effect was qualified by an indirect effect of pain inconsistency on TWT via depression (Path a x b, $b = 10.15$, CI: 2.15, 29.65). Specifically, pain inconsistency predicted depression (Path a, $b = 2.30$, $p = .01$) and depression predicted TWT (Path b, $b = 4.41$, $p < .001$). Thus, higher pain inconsistency was associated with increased depressive symptoms, which, in turn, was associated with increased total wake time. Calculations of effect size (*ab/c*) indicate that 39% in the variance in the relationship between pain inconsistency and TWT is explained by depression.

Pain Inconsistency, Depression, and Total Sleep Time

In contrast to SE and TWT, there was no evidence for either a total effect of pain inconsistency (Path c, $b = 5.19$, $p = .63$) or a direct effect of pain inconsistency on TST (Path c', $b = 7.18$, $p = .53$). In addition, there was not enough evidence to suggest the presence of an indirect effect of pain inconsistency on TST via depression (Path a x b, $b = -1.99$, CI: −16.24, 5.92). Specifically, although pain inconsistency predicted depression (Path a, $b = 2.30$, $p = .01$), depression did not predict TST (Path b, $b = -.86$, $p = .58$).

Pain Inconsistency, Depression, and Sleep Quality

As with TST, there was neither a total effect of pain inconsistency on sleep quality (Path c, $b = -.20$, $p = .07$) nor a direct effect of pain inconsistency on sleep quality (Path c', $b = -.10$, $p = .32$). Nevertheless, pain inconsistency did have an indirect effect on sleep quality via depression (Path a x b, $b = -.09$, CI: −.28, −.01). That is, pain inconsistency significantly predicted depression (Path a, $b = 2.30$, $p = .01$) and depression significantly predicted sleep quality (Path b, $b = -.04$, $p = .01$). Thus, higher pain inconsistency was associated with increased depressive symptoms, which, in turn, predicted poorer sleep quality. Figure 1 displays the results of the mediational models, for SE, TWT, TST, and SQ.

Discussion

The overall aim of the present study was to examine the role of depression on the relationship between pain inconsistency and sleep for adults in mid- to late-life. Consistent with previous literature and research, we hypothesized that depression would partially mediate the relationship between pain inconsistency and sleep, with greater pain inconsistency leading to increased depressive symptoms and subsequently poorer sleep. Results generally supported our hypothesis; depression partially mediated the relationship between pain inconsistency and SE, TWT, and SQ but not TST.

Our findings are in concordance with past literature which found that depression mediates the relationship between pain intensity and sleep (Nicassio et al., 2012; Valrie et al., 2008). However, our findings extend past research by suggesting that pain inconsistency also predicts increased depressive symptoms and sleep disturbance. Several possible factors may explain why greater pain inconsistency is positively associated with depression. One possible explanation is that pain inconsistency may promote greater illness uncertainty. The perceived unpredictability of pain, as well as a perceived lack of control over one's pain, is associated with increased depressive symptoms (Chaney et al., 1996; Reich, Johnson, Zautra, & Davis, 2006). Another possible explanation is that the inconsistent quality of pain may foster greater pain expectancy. Pain expectancy is well-known to promote avoidant coping behaviors and undermine adaptive functioning, which may increase the risk of depression (Mun et al., 2017). Finally, greater pain inconsistency may also increase pain catastrophizing, which is known to contribute to depression (Edwards et al., 2011). Taken together, the aforementioned studies suggest that pain inconsistency may contribute to depression via several potential mechanisms. Depression, in turn, is well-known to contribute to sleep disturbances among older adults, although the mechanisms through which this occurs is not fully understood (Smagula, Stone, Fabio, & Cauley, 2016).

Our findings that depression did not mediate the relationship between pain inconsistency and TST was counter to our hypothesis but may be explained by several factors. First, in contrast to SE or TWT, TST only captures times spent asleep; however, depression is known to contribute to insomnia, hypersomnia, or a combination insomnia and hypersomnia (Soehner, Kaplan, & Harvey, 2014). Thus, time spent asleep may not capture the full effect of depression on sleep as well as SE or TWT. Secondly, sleep interventions have shown that TST may be less sensitive to change than other sleep parameters (Wu, Appleman, Salazar, & Ong, 2015). The finding that there was no direct relationship between pain inconsistency and SQ or TST provides converging evidence that SE and TWT provide more comprehensive and change-sensitive measures of sleep.

The present study's findings have several clinical implications. First, the association between pain inconsistency and sleep suggests that the assessment and treatment of pain inconsistency, as well as depression, may be useful to incorporate as a part of clinical care for middle-aged and older adults with poor sleep. Secondly, our results suggest that interventions that aim to increase pain management by reducing pain inconsistency might lead to important benefits in depression and subsequently sleep disturbance. Given that both avoidance of activity and over-activity are associated with increased pain intensity and greater pain inconsistency (Andrews, Strong, & Meredith, 2012), behavioral interventions such as activity-pacing, which encourages patients to balance time spent on an activity and rest, may be beneficial. The link between pain and depression (López-López, Montorio, Izal, & Velasco, 2008), suggests that behavioral activation, which seeks to increase patients' contact with rewarding activities, may be effective in treating depression in older adults while also improving pain management (Cuijpers, van Straten, & Warmerdam, 2007; Mazzucchelli & Da Silva, 2016). Finally, introducing cognitive restructuring in order to minimize the fear avoidance that is known to contribute to pain inconsistency may be beneficial (Suri et al., 2012).

The present study has several limitations. First, poor sleep, pain, and depression are three frequently co-occurring and mutually interacting disorders; thus, alternative explanations regarding the associations between pain inconsistency, sleep, and depression are possible. For example, disrupted sleep might be a precursor of increased pain inconsistency or depression. Additionally, depression may influence, as well as be influenced by pain inconsistency. A second limitation is that the study did not assess information about participants' general health status, nor did it include information about factors that may have contributed to pain inconsistency such as the use of pain medication. Finally, the physical activity demands of the parent study may have limited the participation of individuals with chronic pain, thereby potentially preventing the generalization of the current findings to individuals with chronic pain. However, the presence of an indirect effect in our current sample with limited variability in pain, depressive symptoms and sleep may also be more pronounced in population-based samples with a greater a range of pain, mood disturbance, and sleep.

Several future directions are suggested by the current findings. First, given the cross-sectional nature of the present study, future research would benefit from longitudinally examining the relationship between pain inconsistency, depression, and sleep. In addition, expanding research on the relationship between pain inconsistency, depression, and sleep among middle aged and older adults with diagnosed chronic pain, insomnia, or depression would allow for the results to be translated to clinical samples. Finally, future research might also benefit from exploring whether intervening on pain inconsistency through the introduction of adaptive pain coping skills might lead to improvements in depression and sleep.

In summary, the present study extends past research on pain and sleep by highlighting the significant role of depression on the relationship between pain inconsistency and sleep in mid- to late-life. Although further research is warranted, our findings suggest that intervening on either pain inconsistency or depression may be have important implications for sleep in older adults.

Acknowledgements

This work was supported by the National Institute on Aging (1R36AG029664–01, PI: Aiken-Morgan; T32AG020499, PI: Dzierzewski; F31AG032802, PI: Dzierzewski; 1K23AG049955, PI: Dzierzewski) and University of Florida (Age Network research award, PI: McCrae).

References

Allen KD, Coffman CJ, Golightly YM, Stechuchak KM, & Keefe FJ (2009). Daily pain variations among patients with hand, hip, and knee osteoarthritis. Osteoarthritis and Cartilage, 17(10), 1275–1282. 10.1016/j.joca.2009.03.021 [PubMed: 19410670]

Andrews NE, Strong J, & Meredith PJ (2012). Activity pacing, avoidance, endurance, and associations with patient functioning in chronic pain: A systematic review and meta-analysis. Archives of Physical Medicine and Rehabilitation, 93(11), 2109–2121. 10.1016/j.apmr.2012.05.029 [PubMed: 22728699]

Beck AT, Steer RA, & Brown GK (1996). Manual for the Beck Depression Inventory-II. San Antonio, TX: Psychological Corporation.

Blågestad T, Pallesen S, Grønli J, Tang NKY, & Nordhus IH (2016). How perceived pain influence sleep and mood more than the Reverse: A novel, exploratory study with patients awaiting total hip arthroplasty. Frontiers in Psychology, 7(1), 1–11 10.3389/fpsyg.2016.01689 [PubMed: 26858668]

Buman MP, Giacobbi PR Jr, Dzierzewski JM, Morgan AA, McCrae CS, Roberts BL, & Marsiske M (2011). Peer volunteers improve long-term maintenance of physical activity with older adults: a randomized controlled trial. Journal of Physical Activity and Health, 8(s2), S257–S266.

Chaney JM, Mullins LL, Uretsky DL, Doppler MJ, Palmer WR, Wees SJ, … Reiss MJ (1996). Attributional style and depression in rheumatoid arthritis: The moderating role of perceived illness control. Rehabilitation Psychology, 41(3), 205.

Chen Q, Hayman LL, Shmerling RH, Bean JF, & Leveille SG (2011). Characteristics of chronic pain associated with sleep difficulty in older adults: the Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly (MOBILIZE) Boston study. Journal of the American Geriatrics Society, 59(8), 1385–1392. [PubMed: 21806564]

Cuijpers P, van Straten A, & Warmerdam L (2007). Behavioral activation treatments of depression: A meta-analysis. Clinical Psychology Review, 27(3), 318–326. 10.1016/j.cpr.2006.11.001 [PubMed: 17184887]

Dailly E, Chenu F, Renard CE, & Bourin M (2004). Dopamine, depression and antidepressants. Fundamental & Clinical Pharmacology, 18(6), 601–607. 10.1111/j.1472-8206.2004.00287.x [PubMed: 15548230]

Dworkin RH, Turk DC, Wyrwich KW, Beaton D, Cleeland CS, Farrar JT, … others. (2008). Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. The Journal of Pain, 9(2), 105–121. [PubMed: 18055266]

Dzierzewski JM, Williams JM, Roditi D, Marsiske M, McCoy K, McNamara J, … McCrae CS (2010). Daily variations in objective nighttime sleep and subjective morning pain in older adults with insomnia: Evidence of covariation over time. Journal of the American Geriatrics Society, 58(5), 925–930. [PubMed: 20406316]

Edwards RR, Cahalan C, Calahan C, Mensing G, Smith M, & Haythornthwaite JA (2011). Pain, catastrophizing, and depression in the rheumatic diseases. Nature Reviews. Rheumatology, 7(4), 216–224. 10.1038/nrrheum.2011.2 [PubMed: 21283147]

Eslami V, Zimmerman ME, Grewal T, Katz M, & Lipton RB (2016). Pain grade and sleep disturbance in older adults: evaluation the role of pain, and stress for depressed and non-depressed individuals. International Journal of Geriatric Psychiatry, 31(5), 450–457. 10.1002/gps.4349 [PubMed: 26422058]

Fagerström C, & Hellström A (2011). Sleep complaints and their association with comorbidity and health-related quality of life in an older population in Sweden. Aging & Mental Health, 15(2), 204–213. 10.1080/13607863.2010.513039 [PubMed: 21140301]

Farrar JT, Troxel AB, Haynes K, Gilron I, Kerns RD, Katz NP, … Dworkin RH (2014). Effect of variability in the 7-day baseline pain diary on the assay sensitivity of neuropathic pain randomized clinical trials: an ACTTION study. Pain, 155(8), 1622–1631. 10.1016/j.pain.2014.05.009 [PubMed: 24831421]

Ferreira-Valente MA, Pais-Ribeiro JL, & Jensen MP (2011). Validity of four pain intensity rating scales. Pain, 152(10), 2399–2404. 10.1016/j.pain.2011.07.005 [PubMed: 21856077]

Finan PH, & Smith MT (2013). The comorbidity of insomnia, chronic pain, and depression: Dopamine as a putative mechanism. Sleep Medicine Reviews, 17(3), 173–183. 10.1016/j.smrv.2012.03.003 [PubMed: 22748562]

Foley D, Ancoli-Israel S, Britz P, & Walsh J (2004). Sleep disturbances and chronic disease in older adults. Journal of Psychosomatic Research, 56(5), 497–502. 10.1016/j.jpsychores.2004.02.010 [PubMed: 15172205]

Hayes A (2013). Introduction to mediation, moderation, and conditional process analysis. NewYork, NY: Guilford Press http://doi.org/978-1-60918-230-4

Jamison RN, & Brown GK (1991). Validation of hourly pain intensity profiles with chronic pain patients. Pain, 45(2), 123–128. 10.1016/0304-3959(91)90176-X [PubMed: 1876417]

Jensen MP, & McFarland CA (1993). Increasing the reliability and validity of pain intensity measurement in chronic pain patients. Pain, 55(2), 195–203. 10.1016/0304-3959(93)90148-I [PubMed: 8309709]

Zakoscielna Karolina M., & Parmelee Patricia A.. (2013). Pain variability and its predictors in older adults: Depression, cognition, functional status, health, and pain. Journal of Aging and Health, 25(8), 1329–1339. 10.1177/0898264313504457 [PubMed: 24122353]

Litcher-Kelly L, Martino SA, Broderick JE, & Stone AA (2007). A systematic review of measures used to assess chronic musculoskeletal pain in clinical and randomized controlled clinical trials. The Journal of Pain, 8(12), 906–913. 10.1016/j.jpain.2007.06.009 [PubMed: 17690014]

López-López A, Montorio I, Izal M, & Velasco L (2008). The role of psychological variables in explaining depression in older people with chronic pain. Aging & Mental Health, 12(6), 735–745. 10.1080/13607860802154408 [PubMed: 19023725]

Mazzucchelli TG, & Da Silva M (2016). The potential of behavioural activation for the treatment of chronic pain: An exploratory review. Clinical Psychologist, 20(1), 5–16. 10.1111/cp.12088

Mun CJ, Thummala K, Davis MC, Karoly P, Tennen H, & Zautra AJ (2017). Predictors and social consequences of daily pain expectancy among adults with chronic pain. Pain, 158(7), 1224–1233. 10.1097/j.pain.0000000000000903 [PubMed: 28328575]

Natale V, Léger D, Bayon V, Erbacci A, Tonetti L, Fabbri M, & Martoni M (2015). The consensus sleep diary: quantitative criteria for primary insomnia diagnosis. Psychosomatic Medicine, 77(4), 413–418. 10.1097/PSY.0000000000000177 [PubMed: 25905662]

Nicassio PM, Ormseth SR, Kay M, Custodio M, Irwin MR, Olmstead R, & Weisman MH (2012). The contribution of pain and depression to self-reported sleep disturbance in patients with rheumatoid arthritis: Pain, 153(1), 107–112. 10.1016/j.pain.2011.09.024 [PubMed: 22051047]

Patel KV, Guralnik JM, Dansie EJ, & Turk DC (2013). Prevalence and impact of pain among older adults in the United States: findings from the 2011 National Health and Aging Trends Study. Pain, 154(12), 2649–2657. 10.1016/j.pain.2013.07.029. [PubMed: 24287107]

Ravyts SG, Dzierzewski JM, Grah SC, Buman MP, Aiken-Morgan AT, Giacobb PR Jr, ... & McCrae CS (2018). Sleep and Pain in Mid-to Late-Life: An Exploration of Day-to-Day Pain Inconsistency. Clinical gerontologist, 41(2), 123–129. 10.1080/07317115.2017.1345818 [PubMed: 28742446]

Reich JW, Johnson LM, Zautra AJ, & Davis MC (2006). Uncertainty of illness relationships with mental health and coping processes in fibromyalgia patients. Journal of Behavioral Medicine, 29(4), 307–316. 10.1007/s10865-006-9054-7 [PubMed: 16680530]

Schneider S, Junghaenel DU, Keefe FJ, Schwartz JE, Stone AA, & Broderick JE (2012). Individual differences in the day-to-day variability of pain, fatigue, and well-being in patients with rheumatic disease: associations with psychological variables. Pain, 153(4), 813–822. 10.1016/j.pain. 2012.01.001 [PubMed: 22349917]

Segal DL, Coolidge FL, Cahill BS, & O'Riley AA (2008). Psychometric properties of the Beck Depression Inventory II (BDI-II) among community-dwelling older adults. Behavior Modification, 32(1), 3–20. 10.1177/0145445507303833 [PubMed: 18096969]

Smagula SF, Stone KL, Fabio A, & Cauley JA (2016). Risk factors for sleep disturbances in older adults: Evidence from prospective studies. Sleep Medicine Reviews, 25(Supplement C), 21–30. 10.1016/j.smrv.2015.01.003 [PubMed: 26140867]

Soehner AM, Kaplan KA, & Harvey AG (2014). Prevalence and clinical correlates of co-occurring insomnia and hypersomnia symptoms in depression. Journal of Affective Disorders, 167, 93–97. 10.1016/j.jad.2014.05.060 [PubMed: 24953480]

Suri P, Saunders KW, & Von Korff M (2012). Prevalence and Characteristics of Flare-ups of Chronic Non-specific Back Pain in Primary Care: A Telephone Survey. The Clinical Journal of Pain, 28(7), 573–580. 10.1097/AJP.0b013e31823ae173 [PubMed: 22699128]

Tupper SM, Rosenberg AM, Pahwa P, & Stinson JN (2013). Pain intensity variability and its relationship with quality of life in youths with juvenile idiopathic arthritis. Arthritis Care & Research, 65(4), 563–570. 10.1002/acr.21850 [PubMed: 22972759]

Valrie CR, Gil KM, Redding-Lallinger R, & Daeschner C (2008). Daily mood as a mediator or moderator of the pain-sleep relationship in children with sickle cell disease. Journal of Pediatric Psychology, 33(3), 317–322. 10.1093/jpepsy/jsm058 [PubMed: 17690117]

Wu JQ, Appleman ER, Salazar RD, & Ong JC (2015). Cognitive behavioral therapy for insomnia comorbid with psychiatric and medical conditions: a meta-analysis. JAMA Internal Medicine, 175(9), 1461–1472. 10.1001/jamainternmed.2015.3006 [PubMed: 26147487]

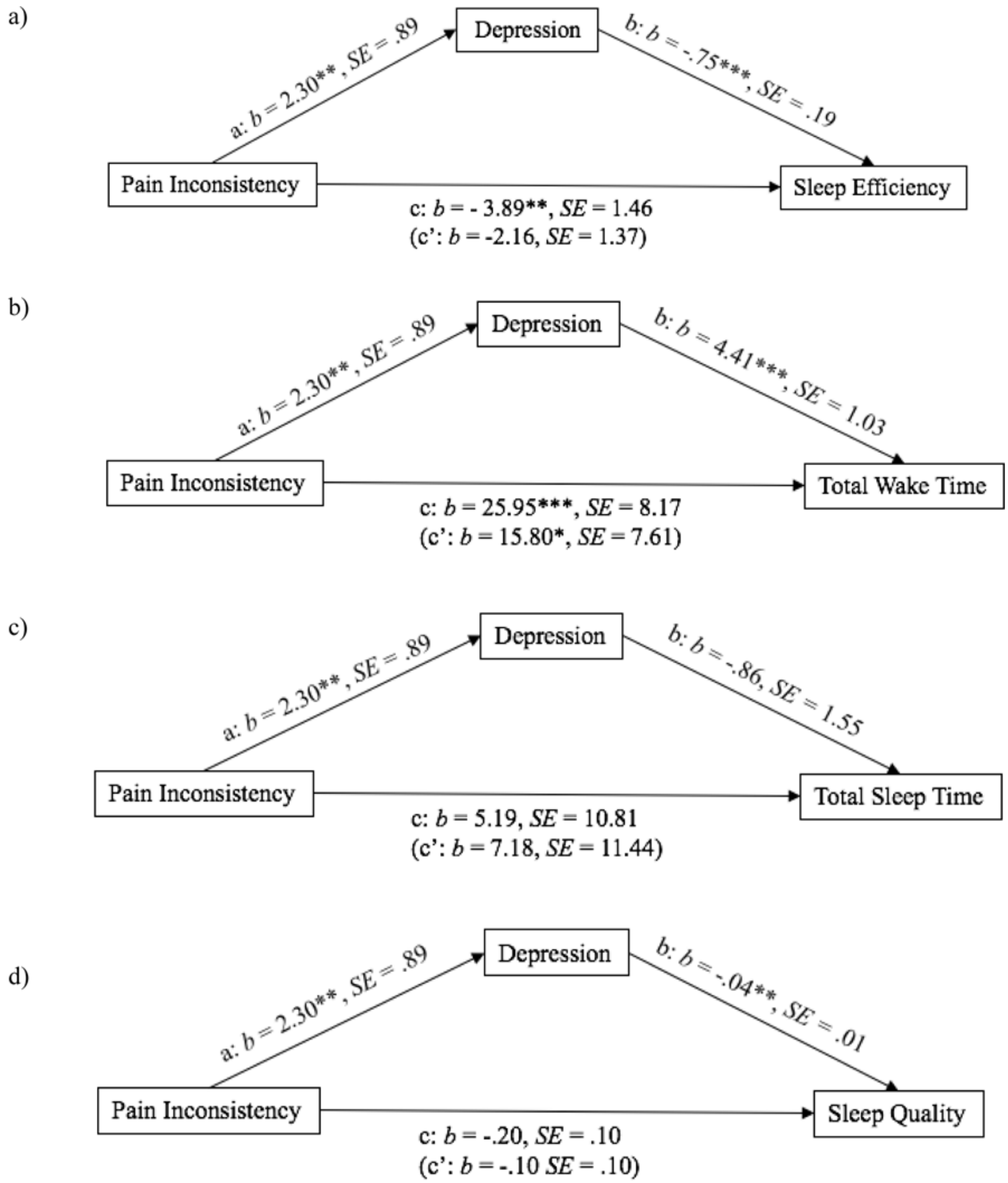

Figure 1.

Mediation models for the relationship between pain inconsistency and sleep via depression. *Note.* Standardized regression coefficients for the relationship between pain inconsistency and a) sleep efficiency, b) total wake time, c) total sleep time, and d) sleep quality as partially mediated by depression. The standardized regression coefficient between pain inconsistency and sleep parameter, when controlling for depression, is in parentheses. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$.

Table 1

Participant Descriptive Statistics (N=82)

Variable	Mean (Std. Deviation)
Participant Demographics	
Age[a]	63.37 (8.58)
Education[a]	16.15 (2.23)
Gender (Number of Males)	14
Race/Ethnicity (Number of Racial/Ethnic Minorities)	7
Body Mass Index	27.54 (6.08)
BDI-II[b]	6.07 (4.72)
Sleep Characteristics	
Sleep Efficiency[c]	87.44 (8.21)
Total Wake Time[d]	64.01 (47.84)
Total Sleep Time[d]	429.32 (56.02)
Sleep Quality[e]	3.57 (1.00)
Pain Characteristics	
Average Pain Rating[f]	1.55 (1.50)
Pain Inconsistency[g]	.84 (.64)

Notes:

[a] units of measurement in years

[b] BDI-II measured on a scale from 0 to 63

[c] sleep efficiency measured as a percentage

[d] sleep variables measured in minutes

[e] sleep quality measured on a scale from 1 to 5

[f] pain rated on a scale from 0 to 10

[g] measured as the within-person standard deviation of pain