Published in final edited form as:

Pain. 2013 September ; 154(9): 1725–1731. doi:10.1016/j.pain.2013.05.020.

The Impact of Daily Arthritis Pain on Spouse Sleep

Lynn M. Martire,

Department of Human Development and Family Studies, The Pennsylvania State University

Francis J. Keefe,

Department of Psychiatry and Behavioral Sciences, Duke University

Richard Schulz,

Department of Psychiatry and University Center for Social and Urban Research, University of Pittsburgh

Mary Ann Parris Stephens, and

Department of Psychology, Kent State University

Jacqueline A. Mogle

Center for Healthy Aging, The Pennsylvania State University

Abstract

Although chronic pain has been linked to poorer psychosocial well-being in the spouse, the extent to which patient pain affects spouse sleep is unknown. The aim of the present study was to test the hypothesis that greater daily knee pain would be associated with poorer sleep for the spouse that evening. We also tested the hypothesis that this pain contagion is exacerbated in couples who have a close relationship. A total of 138 knee osteoarthritis (OA) patients and their spouse completed baseline interviews and a 22-day diary assessment. Multilevel lagged models indicated that greater knee OA pain at the end of the day was associated with spouses' poorer overall sleep quality that night and feeling less refreshed after sleep. In contrast, there was no evidence that spouse sleep was related to greater patient pain the next day. The effects of patient pain on spouse sleep were not due to disturbances in patient sleep and were also independent of spouse gender, depressive symptoms, and physical comorbidities; both partners' negative affect; and the quality of marital interactions throughout the day. As predicted, we also found that patient pain was more strongly related to less refreshing sleep for spouses who were in a close relationship. Findings illustrate that chronic pain may place the spouse's health at risk, and suggest an important target for couple-oriented interventions.

Research suggests that chronic pain negatively affects the emotional well-being and marital satisfaction of the spouse [14,15,38]. An important yet unanswered question is the degree to which patient pain also affects behavioral health outcomes such as the spouse's sleep. In the present study we used dyadic data to examine the effects of daily knee osteoarthritis (OA) pain on spouses' nightly sleep. We also examined whether the patient pain-spouse sleep association was stronger in couples with a high level of closeness.

© 2013 International Association for the Study of Pain. Published by Elsevier B.V. All rights reserved.

Corresponding author: Lynn M. Martire, Ph.D., Department of Human Development & Family Studies, 422 Biobehavioral Health Building, Penn State University, University Park, PA 16802, 814.865.7374 (p), 814.863.9423 (FAX), lmm51@psu.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

The authors have no conflicts of interest to disclose.

Sleep is a critical health behavior, and individuals whose sleep is affected by their partner's pain are at risk for physical and psychiatric problems. Self-reported sleep problems are related to increased risk for hypertension, heart disease, depression, and mortality [12,22,30,45]. Spouses whose sleep is compromised may also be less able to respond empathically to patients' symptoms and need for support.

Arthritis pain is likely to affect the sleep of the spouse for reasons related and unrelated to sharing a bed. Knee pain makes it difficult to get comfortable and to maintain sleep [17,19,47] and the resulting restlessness may disturb the bed partner. In addition, exposure to patients' physical and emotional suffering may affect mood or marital interactions in ways that make it difficult for spouses to get a good night's sleep [8,16,36,37].

Although a satisfying intimate relationship confers advantages for health [24], adults who are in a very close or interconnected relationship may be the most negatively affected by partner illness symptoms. Aron and colleagues' self-expansion model [5,7] defines closeness as including the partner in one's concept of the self. This sense of self-other overlap has been shown to lead to more empathic responding [13] and greater neurological response when a partner makes errors on cognitive tests [21]. In a related line of research, married older adults were more negatively impacted by each other's depressive mood if they were close, as indicated by both partners' report that they were a confidant to the other [44]. Taken together, these findings suggest that spouses are at greatest risk for being affected by their partner's chronic pain if they are in a relationship that partners characterize as close.

The current study tested the hypothesis that greater knee OA pain during the day would be associated with poorer sleep for the spouse that night. Two indicators of sleep were examined--overall quality of sleep, and the extent to which sleep was refreshing. We used data collected over 22 days with handheld computers to examine lagged, within-couple associations between patient pain and spouse sleep. To provide the strongest test of our hypotheses, we examined these effects independent of patient sleep and spouse gender, depressive symptoms, and physical comorbidities.

We also examined the moderating role of couple closeness in the within-couple association between pain and sleep. Closeness was measured using both partners' report of self-other overlap. Based on previous research, we predicted that patient pain would have stronger effects on spouse sleep for couples who reported high closeness than for those who reported low closeness.

Method

Study Design

Data presented in this report are from an observational (i.e., non-intervention) study of couples and knee OA that combined in-person interviews conducted over an 18-month period (i.e., Time 1, Time 2 at a 6 month follow-up, and Time 3 at an 18 month follow-up) with a 22-day assessment of daily experiences immediately after the Time 1 interview. During the daily assessment protocol, patients and spouses used a handheld computer to answer questions 3 times per day (i.e., beginning-of-day, afternoon, and end-of-day). The current report utilizes data from the Time 1 and Time 2 interviews, end-of-day assessments, and beginning-of-day assessments on the following day.

Participants

To be eligible for the study, patients had to be diagnosed with knee OA by a physician, experience usual knee pain of moderate or greater intensity, be at least 50 years of age, and be married or in a long-term relationship (self-defined) in which they shared a residence

with their partner. Exclusion criteria were a comorbid diagnosis of fibromyalgia or rheumatoid arthritis, use of a wheelchair to get around, and a plan to have hip or knee surgery within the following six months. Couples were excluded from the study if the spouse had arthritis pain of moderate or greater intensity, used a wheelchair to get around, or required assistance with personal care activities. Both partners had to be cognitively functional as indicated by the accuracy of their answers to questions regarding the current date, day of the week, their age, and birth date. Both partners also had to be free of any major hearing, speech, or language problems that would interfere with the comprehension and completion of data collection conducted in English.

Primary sources of recruitment were research registries for rheumatology clinic patients and older adults interested in research; flyers distributed to University of Pittsburgh staff and faculty, and word of mouth. A total of 606 couples were screened for eligibility. Of these, 221 couples declined to participate, and the most frequent reasons were lack of interest ($N=87$) or illness in the family ($N=55$). A total of 233 couples were not eligible, and the most frequent reasons were lack of OA in the knee ($N=55$) or knee OA pain that was mild ($N=47$). The total enrolled sample comprised 152 couples (i.e., 304 individuals) which included 3 same-sex couples.

A total of 145 couples completed the diary assessment component of the study, and 138 of these couples provided sufficient data for our primary analyses (see Data Collection Procedures). Table 1 provides background information for patients and their spouses. Consistent with previous research on sleep quality in hip or knee OA patients [17], patients' average global score on the Pittsburgh Sleep Quality Index [10] was 7.1 ($SD=4.2$; range = 0 to 18) and 70% met criteria for poor sleep (i.e., global score of greater than 5).

Data Collection Procedures

Trained staff interviewed patients and spouses independently in their home. Following these interviews, couples were trained in use of the handheld computer (i.e., the Palm TX) as well as the format and content of the diary questions. The handheld computer and questionnaire were designed for easy use by older adults and people with minimal computer experience; accessible features included large font size and an oversized stylus for registering responses. Each patient and spouse was provided with a handheld computer that was clearly labeled with his or her name. Participants were trained to complete their diary assessments independently of the spouse but we did not ask whether they adhered to this request.

Our goal was to capture participants' experiences within the general time frames of morning, afternoon, and evening. Therefore, participants were instructed to answer questions: 1) within 60 minutes of rising in the morning (i.e., beginning-of-day; BOD), 2) between 2:00 and 4:00 p.m. (i.e., afternoon; AFT), and 3) upon retiring at night (i.e., end-of-day; EOD). Participants used a written log to record their daily rise time and bed time.

Completion and compliance rates were examined for the diary data. Out of a potential 6380 EOD observations ($290 \text{ individuals} \times 22 \text{ days}$), a total of 5863 were completed (92%). Compliance with the requested timing of the EOD assessment was evaluated by comparing the time of the handheld computer entries with participants' written log of daily bedtimes. EOD assessments that were completed more than 120 minutes before bedtime and BOD assessments completed more than 120 minutes after waking were excluded from analysis. Using these criteria, 5327 of the 5863 completed observations were included in analysis (i.e., 92% of the completed observations, or 83% of the total possible observations). Completion and compliance rates were virtually identical for patient and spouse.

Key Variables

Within-person and within-couple correlations between key study variables are presented in Table 2.

Patient pain—Patients provided end-of-day reports of knee pain over the past 30 minutes, using a scale from 0 to 3 (no pain to severe pain). This measure is taken from the Rapid Assessment of Disease Activity in Rheumatology [28]. The average level of pain was mild to moderate ($M = 1.46$; $SD = .67$; range = 0 – 3).

Nightly sleep—Consistent with previous daily diary research [1], nightly sleep was measured in a way that minimized participant burden. Specifically, two indicators of nightly sleep were assessed for both patients and spouses: overall quality, and refreshing sleep. First, participants were asked to rate the overall quality of their sleep during the previous night, on a scale from 0 (very good) to 3 (very bad). This question was taken from the Pittsburgh Sleep Quality Index [10] which asks about overall quality of sleep during the past month, and was re-computed so that higher scores reflect better quality sleep (0 = very bad, 1 = fairly bad, 2 = fairly good, 3 = very good). Second, participants were asked how refreshed or rested they felt after the previous night's sleep, on a scale from 0 (not at all) to 6 (extremely) with labels of slightly (2) and moderately (4). This question has been used in previous daily diary research on chronic pain [1,18].

There was much day-to-day variability in both partners' daily sleep. For sleep quality, the within-person variability was 71% and 66% for patients and spouses, respectively. For refreshing sleep, the within-person variability was 55% and 54% for patients and spouses, respectively. On average, patients and spouses reported that their overall sleep quality was "fairly good" ($M = 2.05$, $SD = .41$ and $M = 2.14$, $SD = .43$, respectively) and that they felt "moderately" refreshed after sleep ($M = 3.61$, $SD = .97$ and $M = 3.68$, $SD = 1.00$, respectively).

Couple closeness—Based on previous research examining mutual reports of closeness as a moderator of emotional contagion in couples [44], a categorical, dyadic measure of closeness (high closeness, low closeness) was created. The Inclusion of Other in the Self scale (IOS) [6] was used to assess couple closeness. The IOS is a single-item, pictorial measure that is well accepted for measuring a sense of closeness or interconnectedness with another individual [2]. Participants chose the picture which best described their relationship with their spouse from a series of seven Venn-like diagrams depicting linear, progressive degrees of overlap between circles labeled "Self" and "Spouse." The scale is scored from 1 (no overlap) to 7 (almost complete overlap). This scale was administered at Time 2 (i.e., 6 months after the baseline interview).

The average closeness score was 5.2 for patients ($SD = 1.6$; range = 1 – 7) and 5.1 for spouses ($SD = 1.5$; range = 1 – 7), and the median was 5 for both partners. The within-couple correlation in closeness was moderate in size for a correlation at this level ($r = .23$; $p < .01$). Consistent with previous research, each partner's report of closeness was only moderately correlated with his or her marital satisfaction, as assessed by the Satisfaction subscale of the Dyadic Adjustment Scale [42] ($r = .63$ and $.48$ for patients and spouses, respectively). A categorical, dyadic measure of closeness (high closeness, low closeness) was created to indicate that both patient and spouse either did or did not have a score of 5 or higher on this measure (i.e., the median for both partners). Approximately half (43%) of the couples were classified as having high closeness.

Covariates

As described in the Data Analysis section, our multilevel models controlled for spouse gender, depressive symptoms, and physical comorbidities, as well as beginning-of-day reports of spouse negative affect, patient pain, and patient sleep. Data on spouse gender, depressive symptoms in the past week, and physical comorbidities were collected during the baseline interview. Depressive symptoms were assessed with a 10-item version of the Centers for Epidemiologic Studies—Depression scale (CES-D) [4,32]. The average score was 6.6 ($SD = 4.8$, range = 0–26) and Cronbach's alpha was .74. The Physical Comorbidity Index consists of 24 questions assessing current problems of different physiological systems, including those that are likely to affect sleep (e.g., cardiovascular or cerebrovascular, musculoskeletal, respiratory, digestive, endocrine), and yields a count of 0 to 24 [27]. The average number of comorbidities was 3.1 ($SD = 1.8$; range = 0–9).

Spouses' negative affect was assessed at the beginning of day. This measure is the average of 4 items representing feelings over the past 30 minutes (i.e., depressed or blue, frustrated, angry or hostile, and worried or anxious) [39] which are rated from 0 to 6 ($M = .48$; $SD = .68$; range = 0–4.3). Other covariates from the diary data that were collected at the beginning of day are described above (i.e., patient knee pain and sleep quality). Patients' average level of knee pain at the beginning of day was 1.31 ($SD = .62$; range = 0–3).

Data Analysis

Multilevel modeling [33] was used to examine lagged associations between patient end-of-day knee pain and spouse nightly sleep, and analyses were conducted using SAS PROC MIXED. The dependent variables were modeled separately in these two-level models (i.e., observations nested within individuals). In these analyses we modeled within-couple variability in associations between patient pain and spouse sleep. In tests of the first hypothesis, each spouse sleep outcome was modeled as a simultaneous function of patient knee pain (within-person centered) and Level 1 or 2 covariates likely to be associated with spouse sleep or patient pain. Level 1 covariates included patient sleep quality (or refreshing sleep) and beginning-of-day reports of spouse negative affect and patient pain because of their potential overlap with spouses' reports of their own sleep. These daily variables were within-person centered. Level 2 covariates were spouse gender, depressive symptoms, and physical comorbidities, all of which were grand-mean centered.

The second hypothesis was tested by adding a main effect for couple closeness, and an interaction between patient pain and couple closeness, to these models. This allowed us to determine whether within-couple associations between patient pain and spouse sleep were moderated by between-couple differences in couple closeness. The ESTIMATE command from SAS PROC MIXED was used to generate slope estimates and standard errors for low versus high closeness couples.

Results

As shown in Table 2, the two indicators of sleep were moderately correlated for both partners ($r = .54$ for spouses and $r = .64$ for patients). Patients' reports of sleep quality and refreshing sleep were not significantly correlated with their pain on the previous day ($r = .01$ and $.02$, respectively) but were concurrently related to beginning-of-day reports of pain ($r = -.11$ and $-.11$, $p < .001$, not shown).

Does Patient Pain Impact Spouse Sleep?

Table 3 presents the fixed effects for each of the predictors and covariates in the lagged multilevel models. Spouse depressive symptoms and current (i.e., beginning of day) reports

of negative affect were related to poorer sleep quality and less refreshing sleep. In addition, patient sleep quality (or refreshing sleep) was positively associated with the respective spouse sleep outcomes.

The left half of Table 3 presents the multilevel results for spouse sleep quality. As predicted, the effect of patient pain was negative and significant (estimate = $-.06$, $p = .05$), indicating that when the patient reported greater knee pain at the end of the day, the spouse had poorer sleep quality that night. The right half of the table presents the results for spouse refreshing sleep. The effect of patient pain also was significant for this outcome (estimate = $-.16$, $p < .01$), indicating that the spouse felt less rested or refreshed from sleep after a day in which the patient had greater knee pain.

We conducted supplementary analyses using multilevel, ordinal logistic regression. These analyses treat each sleep outcome as a set of ordered categories and show how a unit increase in patient pain is related to decrements in spouse sleep. The odds of the spouse having poorer quality sleep or less refreshing sleep increased by 22% and 31%, respectively, with every unit increase in patient pain.

Does Spouse Sleep Impact Patient Pain?

We tested the reverse temporal order by examining the effects of spouse sleep on patient end-of-day pain on the next day. We included the same set of covariates that were in the original analyses. Findings from these lagged models indicated that spouse sleep quality was not associated with greater or lesser patient knee pain the following day (estimate = $-.03$; $SE = .02$; $p = .22$) and spouse refreshing sleep also was not associated with greater or lesser patient knee pain the following day (estimate = $-.00$; $SE = .01$; $p = .90$).

Does Closeness Exacerbate the Negative Effects of Patient Pain on Spouse Sleep?

Tests of our second hypothesis revealed a significant interaction between patient pain and couple closeness for the outcome of refreshing sleep (estimate = $.23$; $SE = .11$; $p < .05$)¹. Compared to couples who were not very close, and as predicted, greater patient pain was associated with less refreshing sleep for spouses in a very close relationship. Figure 1 depicts this interaction, showing a reduction in refreshing sleep at higher levels of patient pain (estimate = $-.27$; $SE = .08$; $p < .01$). In contrast, there was no statistically significant association between patient pain and spouse refreshing sleep in couples with low closeness (estimate = $-.04$; $SE = .07$; $p = .60$). The interaction between patient pain and couple closeness was not significant in the model predicting spouse sleep quality (estimate = $-.03$; $SE = .06$; $p = .66$)².

What are the Likely Mechanisms of the Patient Pain-Spouse Sleep Association?

As noted earlier, arthritis pain is likely to affect the sleep of the spouse for reasons related and unrelated to sharing a bed. Perhaps the most obvious explanation is that patients' pain disturbs their own sleep, which in turn detracts from spouses' sleep. However, controlling for patient sleep quality (or refreshing sleep) in our models did not change the observed effects of patient pain on spouse sleep (Table 3).

¹We also tested our hypotheses controlling for spouses' sleep on the previous night. Our findings were unchanged regarding the association between patient daily pain and spouse sleep that night. However, the addition of this covariate to our moderation models reduced the statistical significance of the interaction between patient pain and couple closeness for spouse refreshing sleep (estimate = $.12$; $p = .11$), possibly due to reduced power in this model.

²An alternative test of this hypothesis would utilize the partner's report of relationship closeness rather than the dyadic measure of interest in this study. Partner's perception of closeness did not moderate the patient pain-spouse sleep associations.

Previous research suggests that chronic pain takes a toll on the couple's relationship [23,43], and that the quality of marital interactions affects sleep efficiency that night [16]. In addition, there is evidence that pain may exert its effects on spouse mood through its adverse effects on patients' daily mood [8]. Therefore, we conducted a series of ancillary analyses to determine if controlling for these factors would alter the association between patient pain on spouse sleep and possibly explain this association. Specifically, we re-ran our analyses controlling for end-of-day reports of patients' or spouses' negative affect, and spouses' reports of how tense and how enjoyable their interactions with the patient were throughout the day. There were no significant changes in the effects of patient pain on spouse sleep from those observed in our original models.

Discussion

Our findings extend a literature that has largely focused on the effects of chronic illness on spouses' emotional well-being, by showing that chronic pain jeopardizes a behavior that is critical for spouses' physical health. In this study we were also able to show that patient pain affected spouse sleep that evening, but spouse sleep did not affect patient pain on the following day. Although the effects of patient pain on spouse sleep were small in magnitude, such daily changes likely accumulate over time to harm spouse health. Finally, we found that the negative impact of patient pain on spouse sleep was especially strong for couples who reported a high level of closeness, suggesting an interesting focus for future research.

Our daily diary included two questions about the previous night's sleep—the quality, and the extent to which the individual felt refreshed. Previous research has shown that the extent to which sleep is refreshing is not highly related to other sleep indicators such as insomnia [31]. Consistent with that study, we found that refreshing sleep and overall quality of sleep were not highly overlapping. Why might this be the case? Judgments of sleep quality may be more closely tied to hours of sleep than are reports of feeling rested or refreshed. That is, people may report that they do not feel refreshed or rested despite sleeping for an adequate number of hours, or may get few hours of sleep but feel rested. We found that feeling refreshed by sleep was the outcome most affected by patient pain for spouses in a close relationship.

Our findings raise the question of how knee pain affects spouses' sleep. One likely pathway is through the negative impact on patients' sleep. However, patients' knee pain during the day was not significantly related to their sleep that night (Table 2), and controlling for patient sleep did not affect the association between patient pain and spouse sleep. Previous research has reported that arthritis patients' sleep is impaired by pain [3,17,47]. However, with the exception of a recent longitudinal study showing within-patient associations in weekly pain and sleep interference [19], most studies have focused on cross-sectional, between-patient associations (i.e., showing that patients who have more pain also have poorer sleep). Our ancillary analyses also showed that patient pain and sleep were related concurrently. Thus, our nonsignificant, lagged association between patient pain and sleep suggests that patients' day-to-day sleep quality is driven by factors other than pain, or that the effects of pain may need to accumulate over multiple days in order to impact sleep.

In an effort to identify other potential mechanisms linking patient pain and spouse sleep we examined this association independent of patients' and spouses' negative affect and the quality of their daily marital interactions. In these analyses there was essentially no change in the effect of patient pain on spouse sleep, suggesting that these were not mechanisms in our sample.

Spouses may be affected by patient pain in ways that were not assessed in the current study. One line of research shows that when an individual observes a social partner in pain there is activation in many of the same brain areas activated by pain itself [20,34,40]. Our recent work demonstrates that spouses experience changes in heart rate and blood pressure in response to arthritis patients' suffering [29]. Thus, an important goal for future research is to explore how daily chronic pain affects family members' sleep through short-term changes in parameters of physiological function. In addition, factors such as patient emotional disclosure [11] and spouses' empathic reactions or distress specific to patient pain may explain how spouses' sleep is affected, and are important to explore in future research.

In this study we tested and found support for the hypothesis that patient pain would have stronger effects on spouse sleep for couples who reported high closeness, using a common measure of relationship closeness (i.e., the Inclusion of Other in the Self Scale; IOS). The IOS measures a general aspect of closeness or interconnectedness that is thought to tap aspects of both subjective feelings and objective interaction. Our finding that spouse sleep was most negatively impacted in couples who were close is consistent with previous research on older couples [44] and highlights the possibility that different facets of marital functioning may have differential moderating effects. It has been shown that having a satisfying relationship can buffer individuals from their partner's daily stressors and negative mood [35,41]. In contrast, a close relationship in which two partners are highly involved in each other's daily experiences may have negative consequences for couples living with chronic illness. Supporting this point, one recent study found that the contagion of negative affect between men with prostate cancer and their wives was exacerbated in couples who collaborated or worked together as a team to manage the illness [9]. In addition, the neuroimaging research described above indicates that individuals with greater empathy exhibit the highest levels of brain activation when viewing another person in pain [34]. Our finding raises the question of whether there is a trade-off for couples, in that individuals in a close relationship may benefit in some ways (e.g., greater emotional intimacy) but also be at greater risk when the partner's health is poor.

It is important to acknowledge limitations of this research and important next steps for future research. First, our assessment of nightly sleep did not include more specific information regarding problems such as delayed sleep onset and inability to maintain sleep, or objective measures of sleep. The self-reported sleep indicators that we measured each day have been linked with important health outcomes [12,22,30,45], and our findings add to this literature by demonstrating the implications of chronic arthritis pain for partners' sleep. In future research it would be valuable to examine these research questions using objective measures of sleep (e.g., actigraphy, polysomnography). Second, we did not collect information from partners about whether or not they shared a bed each night based on the assumption that spouse sleep is affected by patient pain in part due to reasons unrelated to sharing a bed. Future research that measures this variable will need to define what proportion of each night would meet criteria for shared (i.e., percentage of hours), and which partner's report is most important. Third, although our single-item measures

Another limitation of our study is the assessment of dyadic closeness approximately 5 months after the diary assessment of patient pain and spouse sleep. We believe that our sample of couples who have been together for 34 years on average, as well as our use of a dyadic score for closeness, may lessen concern that there was a significant change in closeness over this 5-month period. In addition, our study focused on partners who reported a high level of closeness on average, and thus our findings may not generalize to couples who are not close. In fact, couples who agree to participate in dyadic research may have higher levels of closeness and overall relationship satisfaction than those who do not.

To conclude, compromised sleep caused by exposure to a loved one's suffering may be one pathway to spousal caregivers' increased risk for health problems including cardiovascular disease [25,46]. In developing behavioral couple-oriented interventions for arthritis, it is important to identify the types of couples in which the spouse is most affected by patient suffering [26]. Our findings suggest that assessing the extent to which partners are closely involved in each other's lives would help to identify spouses who are especially at risk for being affected by patient symptoms and in need of strategies for maintaining their own health and well-being.

Acknowledgments

This research was supported in part by a grant from the National Institutes of Health (R01 AG026010).

References

1. Affleck G, Urrows S, Tennen H, Higgins P, Abeles M. Sequential daily relations of sleep, pain intensity, and attention to pain among women with fibromyalgia. *Pain*. 1996; 68:363–368. [PubMed: 9121825]
2. Agnew, CR.; Loving, TJ.; Le, B.; Goodfriend, W. Thinking close: measuring relational closeness as perceived self-other inclusion. In: Mashek, DJ.; Aron, A., editors. *Handbook of closeness and intimacy*. Mahwah, NJ: Lawrence Erlbaum Associates Inc.; 2004. p. 103-115.
3. Allen KD, Renner JB, Devellis B, Helmick CG, Jordan JM. Osteoarthritis and sleep: The Johnston County osteoarthritis project. *J Rheumatol*. 2008; 35:1102–1107. [PubMed: 18484690]
4. Andresen E, Malmgren J, Carter W, Patrick D. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies, Depression scale). *American Journal of Preventive Medicine*. 1994; 10:77–84. [PubMed: 8037935]
5. Aron, A.; Aron, EN. *Love and the expansion of self: Understanding attraction and satisfaction*. New York, NY, US: Hemisphere Publishing Corp/Harper & Row Publishers; 1986.
6. Aron A, Aron EN, Smollan D. Inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology*. 1992; 63:596–612.
7. Aron A, Aron EN, Tudor M, Nelson G. Close relationships as including other in the self. *Journal of Personality and Social Psychology*. 1991; 60:241–253.
8. Badr H, Laurenceau J-P, Scharf L, Basen-Engquist K, Turk D. The daily impact of pain from metastatic breast cancer on spousal relationships: A dyadic electronic diary study. *PAIN*. 2010; 151:644–654. [PubMed: 20833474]
9. Berg CA, Wiebe DJ, Butner J. Affect covariation in marital couples dealing with stressors surrounding prostate cancer. *Gerontology*. 2011; 57:167–172. [PubMed: 20616529]
10. Buysse DJ, Reynolds CF III, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*. 1989; 28:193–213. [PubMed: 2748771]
11. Cano A, Leong LEM, Williams AM, May DKK, Lutz JR. Correlates and Consequences of the Disclosure of Pain-Related Distress to One's Spouse. *Pain*. 2012; 153:2441–2447. [PubMed: 23059054]
12. Chien K-L, Chen P-C, Hsu H-C, Su T-C, Sung F-C, Chen M-F, Lee Y-T. Habitual sleep duration and insomnia and the risk of cardiovascular events and all-cause death: Report from a community-based cohort. *Sleep*. 2010; 33:177–184. [PubMed: 20175401]
13. Cialdini RB, Brown SL, Lewis BP, Luce C, Neuberg SL. Reinterpreting the empathy–altruism relationship: When one into one equals oneness. *Journal of Personality and Social Psychology*. 1997; 73:481–494. [PubMed: 9294898]
14. Flor H, Turk DC, Scholz OB. Impact of chronic pain on the spouse: Marital, emotional and physical consequences. *Journal of Psychosomatic Research*. 1987; 31:63–71. [PubMed: 3820147]
15. Geisser ME, Cano A, Leonard MT. Factors associated with marital satisfaction and mood among spouses of persons with chronic back pain. *Journal of Pain*. 2005; 6:518–525. [PubMed: 16084466]

16. Hasler BP, Troxel WM. Couples' nighttime sleep efficiency and concordance: Evidence for bidirectional associations with daytime relationship functioning. *Psychosomatic Medicine*. 2010; 72:794–801. [PubMed: 20668283]
17. Hawker GA, French MR, Waugh EJ, Gignac MAM, Cheung C, Murray BJ. The multidimensionality of sleep quality and its relationship to fatigue in older adults with painful osteoarthritis. *Osteoarthritis and Cartilage*. 2010; 18:1365–1371. [PubMed: 20708004]
18. Haythornthwaite JA, Hegel MT, Kerns RD. Development of a sleep diary for chronic pain patients. *Journal of Pain and Symptom Management*. 1991; 6:65–72. [PubMed: 2007794]
19. Hutchings A, Calloway M, Choy E, Hooper M, Hunter DJ, Jordan JM, Zhang Y, Baser O, Long S, Palmer L. The Longitudinal Examination of Arthritis Pain (LEAP) study: Relationships between weekly fluctuations in patient-rated joint pain and other health outcomes. *J Rheumatol*. 2007; 34:2291–2300. [PubMed: 17937461]
20. Jackson PL, Brunet E, Meltzoff AN, Decety J. Empathy examined through the neural mechanisms involved in imagining how I feel versus how you feel pain. *Neuropsychologia*. 2006; 44:752–761.
21. Kang SK, Hirsh JB, Chasteen AL. Your mistakes are mine: Self-other overlap predicts neural response to observed errors. *Journal of Experimental Social Psychology*. 2010; 46:229–232.
22. Kawakami N, Takatsuka N, Shimizu H. Sleep Disturbance and Onset of Type 2 Diabetes. *Dia Care*. 2004; 27:282–283.
23. Keefe F, Lipkus I, Lefebvre J, Hurwitz H, Clipp E, Smith J, Porter L. The social context of gastrointestinal cancer pain: A preliminary study examining the relation of patient pain catastrophizing to patient perceptions of social support and caregiver stress and negative responses. *Pain*. 2003; 103:151–156. [PubMed: 12749969]
24. Kiecolt-Glaser J, Newton T. Marriage and health: His and hers. *Psychological Bulletin*. 2001; 127:472–503. [PubMed: 11439708]
25. Lee S, Colditz GA, Berkman LF, Kawachi I. Caregiving and risk of coronary heart disease in US women: A prospective study. *American Journal of Preventive Medicine*. 2003; 24:113–119. [PubMed: 12568816]
26. Martire L, Schulz R, Helgeson V, Small B, Saghaei E. Review and meta-analysis of couple-oriented interventions for chronic illness. *Annals of Behavioral Medicine*. 2010; 40:325–342. [PubMed: 20697859]
27. Martire LM, Scheier MF. Physical comorbidity index. 2000
28. Mason JH, Anderson J, Meenan R, Haralson K, Lewis-Stevens D, Kaine J. The rapid assessment of disease activity in rheumatology (RADAR) questionnaire: Validity and sensitivity to change of a patient self-report measure of joint count and clinical status. *Arthritis & Rheumatism*. 1992; 35:156–162. [PubMed: 1734905]
29. Monin J, Schulz R, Martire L, Jennings JR, Lingler JH, Greenberg M. Spouses' cardiovascular reactivity to their partners' suffering. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2010; 65B:195–201.
30. Perlis ML, Giles DE, Buysse DJ, Tu X, Kupfer DJ. Self-reported sleep disturbance as a prodromal symptom in recurrent depression. *Journal of Affective Disorders*. 1997; 42:209–212. [PubMed: 9105962]
31. Power JD, Perruccio AV, Badley EM. Pain as a mediator of sleep problems in arthritis and other chronic conditions. *Arthritis Care & Research*. 2005; 53:911–919. [PubMed: 16342098]
32. Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*. 1977; 1:385–401.
33. Raudenbush, SW.; Bryk, AS. Hierarchical linear models: Applications and data analysis methods. Thousand Oaks, CA: Sage Publications; 2002.
34. Saarela MV, Hlushchuk Y, Williams AC, de C, Schürmann M, Kalso E, Hari R. The compassionate brain: Humans detect intensity of pain from another's face. *Cereb. Cortex*. 2007; 17:230–237. [PubMed: 16495434]
35. Saxbe D, Repetti RL. For better or worse? coregulation of couples' cortisol levels and mood states. *Journal of Personality and Social Psychology*. 2010; 98:92–103. [PubMed: 20053034]

36. Schulz R, Beach SR, Hebert RS, Martire LM, Monin JK, Tompkins CA, Albert SM. Spousal suffering and partners depression and cardiovascular disease: The cardiovascular health study. *American Journal of Geriatric Psychiatry*. 2009; 17:246–254. [PubMed: 19454851]
37. Schulz R, Hebert RS, Dew MA, Brown SL, Scheier M, Beach S, Czaja S, Martire L, Coon D, Langa K, Gitlin L, Stevens A, Nichols L. Patient suffering and caregiver compassion: New opportunities for research, practice, and policy. *The Gerontologist*. 2007; 47:4–13. [PubMed: 17327535]
38. Schwartz L, Slater MA. The impact of chronic pain on the spouse: clinical and research implications. *Holistic Nurse Practitioner*. 1991; 6:9–16.
39. Scollon CN, Diener E, Oishi S, Biswas-Diener R. An experience sampling and cross-cultural investigation of the relation between pleasant and unpleasant affect. *Cognition & Emotion*. 2005; 19:27–52.
40. Singer T, Seymour B, O'Doherty J, Kaube H, Dolan RJ, Frith CD. Empathy for pain involves the affective but not sensory components of pain. *Science (Washington)*. 2004; 303:1157–1162. [PubMed: 14976305]
41. Slatcher R, Robles T, Repetti R, Fellows M. Momentary work worries, marital disclosure, and salivary cortisol among parents of young children. *Psychosomatic Medicine*. 2010; 72:887–896. [PubMed: 20841560]
42. Spanier G. Measuring dyadic adjustment: New scales for assessing the quality of marriage and similar dyads. *Journal of Marriage and the Family*. 1976; 38:15–28.
43. Stephens MAP, Martire L, Cremeans-Smith J, Druley J, Wojno W. Older women with osteoarthritis and their caregiving husbands: Effects of pain and pain expression on husband's well-being and support. *Rehabilitation Psychology*. 2006; 51:3–12.
44. Tower RB, Kasl SV. Depressive symptoms across older spouses: Longitudinal influences. *Psychology and Aging*. 1996; 11:683–697. [PubMed: 9000299]
45. Troxel WM, Buysse DJ, Matthews KA, Kip KE, Strollo PJ, Hall M, Drumheller O, Reis SE. Sleep symptoms predict the development of the metabolic syndrome. *Sleep: Journal of Sleep and Sleep Disorders Research*. 2010; 33:1633–1640.
46. Vitaliano PP, Zhang J, Scanlan JM. Is caregiving hazardous to one's physical health? a meta-analysis. *Psychological Bulletin*. 2003; 129:946–972. [PubMed: 14599289]
47. Wilcox S, Brenes GA, Levine D, Sevcik MA, Shumaker SA, Craven T. Factors related to sleep disturbance in older adults experiencing knee pain or knee pain with radiographic evidence of knee osteoarthritis. *Journal of the American Geriatrics Society*. 2000; 48:1241–1251. [PubMed: 11037011]

Figure 1.

The moderating effect of couple closeness for spouse refreshing sleep. Estimated values are presented for the within-couple association between patient knee pain and spouse sleep for couples with high or low closeness, at three levels of patient pain on the previous day (i.e., a patient's average and one point above/below their average).

Table 1

Demographic Characteristics of Patients and Spouses (N = 138)

Variable	Patients	Spouses
	M (SD) or %	M (SD) or %
Age	65.4 (9.5)	65.2 (11.4)
Gender = male	42%	59%
Years of education	16.1 (2.0)	15.9 (2.0)
Race = Caucasian	88%	87%
Employed	43%	46%
Years married/in relationship	34.3 (16.5)	
Household income	\$40,000–59,000	
Duration of knee OA (years)	12.3 (10.9)	

Table 2

Within-Person Correlations Between Key Variables

Patient	Spouse Sleep Quality	Spouse Refreshing Sleep	Patient Sleep Quality	Patient Knee Pain
Refreshing Sleep Previous Day				
Spouse Refreshing Sleep	.54***			
Patient Sleep Quality	.08***	.07***		
Patient Refreshing Sleep	.06**	.08***	.64***	
Patient Knee Pain Previous Day	-.04*	-.02	-.01	-.02
Couple Closeness	-.02	.01	.01*	-.03

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

Table 3

Multilevel Lagged Models Predicting Spouse Nightly Sleep from Patient Daily Knee Pain

Fixed Effects	Spouse Sleep Quality ^a		Spouse Refreshing Sleep ^a	
	estimate	(SE)	estimate	(SE)
Intercept	2.23	0.13 ***	3.80	0.29 ***
Covariates				
Spouse gender	-0.04	0.07	-0.07	0.16
Spouse depressive symptoms	-0.03	0.01 ***	-0.09	0.02 ***
Spouse physical comorbidities	-0.01	0.02	-0.02	0.05
Spouse current negative affect ^a	-0.05	0.01 ***	-0.09	0.02 ***
Patient current knee pain ^a	0.03	0.03	0.03	0.06
Patient sleep quality/refreshing sleep ^a	0.05	0.02 *	0.08	0.02 **
Patient knee pain previous day	-0.06	0.03 *	-0.16	0.05 **

Note. *N*couples = 138, *N*observations = 1740. Gender: 1 = male, 2 = female

^a Assessed at the beginning of day

* *p* .05.

** *p* .01.

*** *p* .001.