Published in final edited form as:

Arthritis Care Res (Hoboken). 2019 June ; 71(6): 748–757. doi:10.1002/acr.23695.

Effects of Osteoarthritis Pain, and Concurrent Insomnia and Depression on Health Care Use in a Primary Care Population of Older Adults

Minhui Liu, PhD, RN^{1,2,3}, Susan M. McCurry, PhD^{4,5}, Basia Belza, PhD, RN, FAAN², Adrian Dobra, PhD^{2,6,7}, Diana T. Buchanan, PhD, RN², Michael V. Vitiello, PhD^{2,5}, and Michael Von Korff, ScD⁸

¹Center for Innovative Care in Aging, Johns Hopkins University School of Nursing, Baltimore, MD, USA

²Department of Biobehavioral Nursing and Health Informatics, University of Washington School of Nursing, Seattle, WA, USA

³Xiangya Nursing School, Central South University, Changsha, Hunan, China

⁴Department of Psychosocial and Community Health, University of Washington School of Nursing, Seattle, WA, USA

⁵Department of Psychiatry & Behavioral Sciences, University of Washington School of Medicine, Seattle, WA, USA

⁶Department of Statistics, University of Washington, Seattle, WA, USA

⁷Center for Statistics and the Social Sciences, University of Washington, WA, USA

⁸Kaiser Permanente Washington Health Research Institute, Seattle, WA, USA

Abstract

Objective—To examine independent and combined effects of pain with concurrent insomnia and depression symptoms on health care use (HCU) in older adults with osteoarthritis (OA).

Methods—Participants were Group Health Cooperative (GHC) patients with a primary diagnosis of OA (N = 2,976). We used survey data on pain (Graded Chronic Pain Scale), insomnia (Insomnia Severity Index), and depression (Patient Health Questionnaire-8), and HCU extracted from GHC electronic health records (office visits, length of stay [LOS], outpatient and inpatient costs, and hip/knee replacement) for three years after the survey. Negative binomial, logistic, and generalized linear models were employed to assess HCU predictors.

Results—About 34% and 29% of participants presented at least sub-clinical insomnia and at least sub-clinical depression symptoms, respectively, in addition to moderate to severe pain. Pain had the largest independent effects on increasing all types of HCU, followed by depression (moderate effects) on increased office visits, LOS, outpatient and inpatient costs, and insomnia (mild effects) on decreased LOS. No synergistic effects were found on HCU among the three

symptoms. Combined effects of pain + insomnia, and pain + depression were significant for all types of HCU and increased greatly with increasing insomnia and depression severity except for hip/knee replacement.

Conclusion—Pain is the main driver for HCU in OA. Insomnia and depression jointly increased diverse types of HCU in addition to pain and these combined effects increased greatly with increasing insomnia and depression severity. These findings indicate the important role that concurrent symptomatic conditions may play in increasing HCU.

Osteoarthritis (OA) is a debilitating disease characterized by chronic pain, joint inflammation, and stiffness, and accounts for a large percentage of physical disability with a high prevalence worldwide (1). The number of OA patients is expected to increase in the coming years in many countries, as life expectancy is also increasing and OA differentially affects older adults (2). Nevertheless, the burden of OA not only relates to its major impact on lowering quality of life but also to the heavy economic costs of the disease to individuals and health care systems (3–10). Common health care use (HCU) associated with OA includes office visits, hospitalization, outpatient and inpatient costs, and surgical procedures – joint replacements. Mean total costs were more than two times higher in patients with OA compared to those without the condition (\$12,905 vs. \$5,099) (11). OA patients incur significantly higher annual inpatient (\$6,668 vs. \$1,756) and outpatient (\$7,840 vs. \$3,675) costs compared with controls (9). In addition, patients with knee OA were found to have, on average, 6 more annual physician office visits and 3.8 more non-physician visits than OA-free controls (12). Total hip or knee replacements are costly and use rates have increased steadily over the years, which is associated with the increasing costs of a hospitalization (13, 14).

Chronic pain is the main complaint of OA patients and the primary reason to seek help from health care providers (15). Besides pain, OA patients are susceptible to other concurrent symptoms that are prevalent and may induce or exacerbate OA pain, such as insomnia and depression (16). Previous studies showed that patients with knee OA report problems with initiating sleep (31%), difficulty maintaining sleep at night (81%), and general sleep problems (77%) (17, 18). Data from the Osteoarthritis Initiative showed that patients with multi-site OA were associated with higher odds (1.43 to 1.72) of developing depression compared to those without OA (19). In addition to high prevalence, increasing evidence suggests a complicated relationship among the three symptoms. Parmelee and colleagues found that sleep disturbance was independently associated with pain and depression. The sleep-pain relationship was mediated by depression; sleep disturbance interacted with pain to exacerbate depression among individuals with high pain levels (20). Clinical trials also showed reciprocal relationships between pain and sleep that changes in pain at baseline longitudinally predicted changes sleep complaints or improved sleep significantly reduced OA pain (21, 22). In other words, insomnia and depression may increase the risk for the onset and/or exacerbation of OA pain.

Given the complex interactions and mutual exacerbations among pain, insomnia, and depression, it is possible that co-occurrence results in cost increases that are greater than simply the sum of the costs of these separate conditions. It is important to understand how

pain, insomnia and depression independently contribute to HCU in older adults with OA and whether there are synergistic effects that jointly drive the increased HCU. In our current study, we aim to 1) investigate the effects of pain, insomnia, and depression on HCU and whether there is synergy among these symptoms on HCU; and 2) examine how pain, insomnia, and depression jointly contribute to HCU in older adults with OA.

PARTICIPANTS AND METHODS

Participants

The dataset used in this study was from part of a National Institutes on Aging (NIA)-funded clinical trial (ClinicalTrials.gov Identifier: NCT01142349) that compared the efficacy of three behavioral group interventions for older adults with concurrent OA and insomnia to help them manage their pain and insomnia symptoms (23). The study was carried out collaboratively between the University of Washington (UW) and Group Health Cooperative (GHC) (acquired by Kaiser Permanente in 2017), a Seattle-area integrated health care plan with over 600,000 enrollees. Prior to the clinical trial, from 2008 to 2010, a screening survey questionnaire was mailed to 8,057 GHC members age 60+ who had an electronic medical record (EMR) OA diagnosis associated with a health care visit in the prior three years. The questionnaire asked respondents about the frequency and interference level of their OA pain over the previous three months, and the frequency and nature of their sleep problems. A total of 3,041 participants completed the screening questionnaire and gave permission to access their EMRs. This study used data from the screening survey and participants' GHC EMRs. The clinical trial was approved by the UW Human Subjects Division and the GHC Institutional Review Board. This secondary data analysis was reviewed by the UW Human Subjects Division and qualified for an exemption.

Inclusion criteria for receiving the screening survey were: age 60+, continuously enrolled in GHC one year prior to screening, receiving primary care services at one of six regional participating clinics, not in the "No Contact for Research File," and at least one visit noted in the EMR for OA by any diagnosing providers (e.g., physician, nurse practitioner, etc.) in the prior three years. The parents study excluded participants if their EMR indicated a diagnosis of: (a) rheumatoid arthritis, (b) obstructive sleep apnea, (c) periodic leg movement disorder, (d) restless leg syndrome, (e) sleep-wake cycle disturbance, (f) rapid eye movement (REM) behavior disorder, (g) dementia or receiving cholinesterase inhibitors, (h) Parkinson's disease or another neurodegenerative disease known to directly impact sleep, (i) cancer in the past year and receiving chemotherapy or radiation therapy in the past year, and/or (j) inpatient treatment for congestive heart failure within the previous six months.

Dataset Elements

Symptom measures

Pain.: The Graded Chronic Pain Scale (GCPS) assesses two dimensions of overall chronic pain severity: pain intensity and pain-related disability (24). Subscale scores for pain intensity and disability are combined to calculate a chronic pain grade with five hierarchical categories, with grade 0 meaning no pain and grade IV meaning high disability-severely limiting pain (25). Internal consistency of 0.74 (Cronbach's alpha) has been reported for

patients with chronic back pain (24). The GCPS also has a high test-retest reliability and construct validity (26, 27). Participants were asked to specifically report only arthritis pain on the GCPS, and to exclude other sources of pain. Pain was coded as a binary variable: mild pain (GCPS = 1) and moderate to severe pain (2 to 4); no participant scored zero pain.

Insomnia. The Insomnia Severity Index (ISI) was designed to assess the nature, severity, and impact of insomnia and monitor treatment response in adults (28). The ISI is a seven-item measure with scores ranging from 0 to 28, with a higher score indicating more severe insomnia. Internal consistency is excellent for both community and clinical samples (Cronbach's alpha of 0.90 and 0.91, respectively) (29). The insomnia variable was coded according to validated cut-points for this scale which were: no insomnia (< 7), sub-threshold insomnia (8 to 14) and clinical insomnia (15 to 28) (30). For purposes of terminological consistency with the depression instrument used, the term of sub-clinical insomnia was used throughout the paper to replace sub-threshold insomnia.

Depression. The eight-item Patient Health Questionnaire depression scale (PHQ-8) has been shown to be a valid diagnostic and severity measure for depressive disorders in large clinical trials (31, 32) and is a reliable measure for depression in population-based studies (33). Total scores range from 0 to 24, with higher scores representing more severe depression. The depression variable was coded according to validated cut-points for this scale as follows: no depression (< 4), sub-clinical depression (5 to 9), and current depression (10 to 24) (34).

Health care use—A programmer at GHC used Current Procedural Terminology (CPT®) codes to identify relevant HCU variables from participants' EMRs. An index date was defined as the date when the screening questionnaire was mailed to the participant. Medical records of one year before (Year 1) and three years after (Year 2 – 4) were used. HCU variables include: 1) Health care visits: total numbers of office visits overall; 2) Total length of stay (LOS) (days); 3) Surgical procedures: a) knee replacement (CPT codes: 27445–27447; ICD-9 procedure codes 2010: 81.54 – 81.56) and b) hip replacement (CPT codes: 27125, 27130, 27132; ICD-9 procedure codes 2010: 81.51 – 81.53); and 4) Health care costs: overall costs in US dollars for outpatient and inpatient use, separately.

Participant characteristics—Demographics were collected from the screening survey, including age, sex, race, marital status, employment status, and educational levels. Age and sex were verified from the EMRs and replaced if participants did not report their age or sex. Months of enrollment in GHC for each of the four years and Charlson Comorbidity Index (CCI) scores (representing overall burden of multi-comorbidity) were calculated from participants' EMRs by the GHC programmer (35).

Data Analysis

Participants with no enrollment in GHC after the index date were excluded (N = 6) which left a sample of 3,035. Participants with missing data on more than two of the following variables, 17.6% of the screened sample, were excluded: pain, insomnia, depression, education, marital status, race and employment (0.7 – 4.0% were missing any one of these

variables). Final sample size was 2,976 participants. Multiple imputation technique was used with five imputations to accommodate the remaining missing information for variables mentioned above in the statistical analyses (36). Demographics, symptoms of pain, insomnia, and depression, months of enrollment, CCI, and corresponding HCU variables were used in the imputation models.

Two different analytic approaches were used to examine the data. The first, symptom approach, was to examine the independent effects of each symptom on HCU and identify whether there was presence of synergy among the symptoms, controlling for demographics and CCI. In this approach, symptoms as continuous variables were included in regression models and interaction terms (pain*insomnia, pain*depression, insomnia*depression, and pain*insomnia*depression) were introduced one at a time. The second, group approach, was to further investigate independent and combined effects of three symptoms on HCU using clinically meaningful participant groups that were formed by the combination of three symptoms severities. Given the high correlation between insomnia and depression, data analyses could not be completed due to small numbers of participants in certain categories, such as the category “mild pain & clinical insomnia & no depression” (n = 6). Therefore, two categorical participant variables were created based on the combination of symptom severities, with one variable representing the severity of pain and insomnia, and the other representing the severity of pain and depression. With this group approach, we could investigate independent effects of pain, insomnia and depression, and combined effects of pain and insomnia, and pain and depression. This allowed us to examine how the severity of insomnia and depression contribute to HCU in addition to different pain levels.

All data analyses were performed using Stata version 14.0 (37). Due to the skewed distribution of the outcome variables, analyses using negative binomial models were conducted to examine the independent and combined effects of pain, insomnia, and depression on office visits and hospital LOS after the index date. The negative binomial model was appropriate because the count data was over-dispersed with the conditional variance exceeding the condition mean. Logistic regression was conducted to investigate the independent and combined effects of the three symptoms on whether participants had a hip/knee replacement or not. Generalized linear models with a gamma family and log-link function were used to assess the independent and combined effects of the three symptoms on outpatient and inpatient costs. Months of enrollment in GHC were included as an exposure variable because the length of enrollment was different in participants. All models were adjusted for demographics and CCI.

Two models were examined for each HCU category (a pain/insomnia model and a pain/depression model) in the group approach. In the pain/insomnia models, the mild pain/no insomnia category was treated as reference. Independent effects of pain were determined by comparing the category with pain but not insomnia symptoms (moderate to severe pain & no insomnia) to the reference category, and independent effects of insomnia were determined by comparing the categories with insomnia but mild pain (mild pain & sub-clinical to clinical insomnia) to the reference category. In the pain/depression models, the mild pain/no depression category was treated as reference. Independent effects of pain were determined by comparing the category with pain but no depression (moderate to severe pain & no

depression) to the reference category, and independent effects of depression were determined by comparing the categories with depression but mild pain (mild pain & sub-clinical to current depression) to the reference category. Incidence rate ratio (IRR) which means a ratio of two rates of events per unit time, coefficient, and odds ratio (OR) plus 95% confidence interval (CI) are reported; a p value less than .05 was considered statistically significant.

RESULTS

Table 1 and Table 2 present participant demographic characteristics and symptom severity, respectively. Participants were, on average, 72 years old (range 60 – 90, SD = 8.81), largely Caucasian (90.86%), female (66.23%), married (60.67%) and highly educated (57.39% community college or higher). All participants experienced at least mild pain.

Approximately 47% of them reported moderate to severe pain, 55% at least sub-clinical insomnia, and 45% sub-clinical to current depression. About 34% of participants had concurrent moderate to severe pain and at least sub-clinical insomnia, and 29% of participants presented concurrent moderate to severe pain and at least sub-clinical depression.

Table 3 describes the pattern of HCU for participants. It shows that the percentage of participants with no office visits, and with more than 24 visits, per year steadily increased over the 4 years. Similar to office visits, the percentage of participants with no outpatient costs or costs between \$20,000 and \$30,000 per year went up steadily after the index date. Almost 90% of participants had no hospitalizations, but this percentage decreased over the years and was paralleled by decreasing inpatient costs over the same time period. About 4% of the participants had a hip or knee replacement; this percentage decreased after the index date.

Table 4 shows the results from the analyses in the first analytic approach using continuous symptom variables. Two-way and three-way interaction terms were first screened, but either they were statistically insignificant or the statistically significant coefficients were less than one suggesting the absence of synergy. Table 4 presents the independent effects of each symptom on HCU without interaction terms and adjusting the other two symptoms. Among the three symptoms, pain had the largest positive effects on all types of HCU, after controlling for insomnia and depression. Depression had a modest positive effect on office visits, LOS, outpatient costs and inpatient costs, controlling for pain and insomnia. However, insomnia had mild negative effects on only LOS after adjusting pain and depression.

Figure 1 and Figure 2 show the results from the analyses in the second analytic approach using clinically meaningful participant groups, which are the independent effects of pain, insomnia and depression, and combined effects of pain + insomnia, and pain + depression severity on office visits, LOS, outpatient and inpatient costs, and hip/knee replacement after adjusting for demographics, CCI, and months of enrollment in GHC (specific numbers are available in the Supplementary Table 1). The analyses of the pain/insomnia models are reported first, followed by the results of the pain/depression models.

Office visits.

In the pain/insomnia models, independent effects of pain (IRR: 1.25, 95% CI: 1.13 – 1.37) and insomnia (IRR: 1.15, 95% CI: 1.06 – 1.24) were significant. Combined effects of pain and insomnia were significant and slightly higher than the independent effects but combined effects did not increase with insomnia severity. In the pain/depression models, independent effects of pain (IRR: 1.23, 95% CI: 1.13 – 1.33) and depression (IRR: 1.14, 95% CI: 1.05 – 1.23) were significant. Combined effects of pain and depression were significant and slightly higher than the independent effects, and combined effects were similar between different depression severities.

LOS.

Neither independent effects of insomnia nor depression were significant on LOS. Independent effects of pain were significant and similar in either the pain/insomnia (IRR: 1.91, 95% CI: 1.39 – 2.61) or the pain/depression models (IRR: 1.77, 95% CI: 1.32 – 2.37). Combined effects of pain and insomnia were significant and effects increased slightly with insomnia severity. Combined effects of pain and depression were significant and LOS was two times longer in participants with current depression (IRR: 2.62, 95% CI: 1.92 – 3.58) compared to those with no depression (IRR: 1.77, 95% CI: 1.32 – 2.37) when moderate to severe pain was present.

Outpatient costs.

Independent effects of insomnia (coefficient: 1.12, 95% CI: 1.01 – 1.23) and depression (coefficient: 1.19, 95% CI: 1.07 – 1.32) were significant. Independent effects of pain were significant in both the pain/insomnia and pain/depression models. Combined effects of pain and insomnia, and combined effects of pain and depression were significant and effects increased with insomnia or depression severity.

Inpatient costs.

Neither insomnia nor depression independently increased inpatient costs. Independent effects of pain almost doubled inpatient costs in the pain/insomnia (coefficient: 2.06, 95% CI: 1.51 – 2.82) and the pain/depression models (coefficient: 1.74, 95% CI: 1.32 – 2.30) compared to reference groups. Combined effects of pain and insomnia, and combined effects of pain and depression were significant but did not change much with insomnia or depression severity.

Hip/knee replacement.

Insomnia and depression did not independently predict hip or knee replacement. Compared to reference groups, participants with pain symptom only were about two times more likely to receive a hip or knee replacement in either the pain/insomnia models (OR: 2.31, 95% CI: 1.59 – 3.35) and the pain/depression models (OR: 2.04, 95% CI: 1.46 – 2.85) compared to reference groups. Combined effects of pain and insomnia and combined effects of pain and depression did not change with insomnia or depression severity.

DISCUSSION

Our study used data from surveys and EMRs to examine how pain, insomnia, and depression independently and jointly influence HCU, specifically, total office visits, LOS, health care costs, and hip/knee replacement. About half the participants presented with at least one of the three symptoms (pain, insomnia, depression), and around 34% and 29% suffered from insomnia or depression, respectively, in addition to moderate to severe pain. To our knowledge, this study is the first attempt to evaluate the effects of pain considering concurrent conditions including insomnia and depression on HCU in older adults with OA.

We examined the independent effects of pain, insomnia and depression on HCU using two different analytic approaches with the first using continuous symptom variables (symptom analyses) and the second using clinically meaningful participant groups (group analyses). As might be expected, in both analytic approaches we found pain severity was the strongest independent predictor of all types of HCU in older adults with OA. Participants with pain only were about two times more likely to have inpatient-related HCU, including hospital LOS, inpatient costs, and hip/knee replacement compared to those without the symptoms. Total knee/hip replacement is widely used to relieve OA pain, which also explains the likelihood of having longer LOS and higher inpatient costs (38). However, independent effects of pain were smaller on outpatient-related HCU (office visits and outpatient costs). For example, participants with pain symptoms only had 1.23 to 1.25 times more office visits compared to those without any of the three symptoms.

Independent effects of insomnia and depression were inconsistent between the two analytic approaches; continuous symptoms versus participant groups. Insomnia was independently predictive of LOS in symptom analyses, but it predicted office visits and outpatient costs in group analyses. Depression independently predicted all HCU except for hip/knee replacement symptom analyses but it was independently predictive of only office visits and outpatient costs. This difference could be explained by that pain and depression positively contributed to HCU, however, insomnia negatively influenced HCU. Additionally, in the group analyses we examined the independent effects through clinically meaningful participant groups (e.g., moderate to severe pain & no insomnia) and when examining the effects of one symptom, we could not completely tease out the effects of the other two.

In symptom analyses, we found that insomnia independently predicted fewer LOS after adjusting pain and depression. It was not supported by previous studies that patients with insomnia were more likely to have hospitalizations (39, 40). However, these studies on HCU related to insomnia did not particularly focus on older adults with OA, and they did not control for other medical conditions, or they adjusted disease conditions including OA for data analyses instead of pain symptoms as we did here. This inconsistency suggests that further research studies are needed to look into how insomnia impacts decreasing LOS particularly in older adults with OA. In group analyses, insomnia and depression as concurrent symptoms independently contributed to total office visits and outpatient costs but not inpatient-related health care services. The finding is consistent with previous studies showing that insomnia and depression contribute to increased health care consultations and related costs (41, 42).

Our study also examined whether there was presence of synergy among pain, insomnia and depression and further investigated combined effects of pain + insomnia, and pain + depression, which has been rarely reported previously, relative to OA. The absence of synergy in symptom analyses suggested that the combined effects were additive, a finding confirmed by the group analyses. In group analyses, we found that combined effects were equivalent to the addition of independent effects, where independent effects of pain + insomnia and pain + depression were already significant in HCU (e.g., office visits and outpatient costs). Despite the absence of synergistic effects, the combined effects of pain + insomnia, and pain + depression were significant for all types of HCU and increased greatly with insomnia and depression severity for certain HCU types. For example, participants with current depression were more likely to have longer LOS (IRR: 2.62, 95% CI: 1.92 – 3.58) compared to those who had moderate to severe pain and sub-clinical depression (IRR: 2.11, 95% CI: 1.61 – 2.78), and those who had moderate to severe pain only (IRR: 1.77, 95% CI: 1.32 – 2.37). This association can be partially supported by previous studies that have shown that psychological factors like depression prolonged LOS in conditions like heart failure (43, 44). The association also suggests the severity of insomnia and depression in contributing to HCU in addition to pain.

However, it should be noted that combined effects of pain + insomnia, and pain + depression on hip or knee replacement decreased with insomnia or depression severity when pain symptoms were present. Multiple studies have revealed high prevalence of preoperative depression and postoperative sleep disturbance in patients undergoing total hip or knee replacement, and effects of preoperative depression in predicting poor health outcomes after the surgery. However, these studies do not contribute to our understanding of how the symptoms jointly influence the likelihood of receiving total hip or knee replacement (45–47). Since we examined only a 3-year period after the index date, it is possible that depression or insomnia may postpone the surgical procedure; therefore, further studies are needed to understand the reasons behind this trend.

The study has several limitations. First, this research was conducted in a single health plan in Washington State, and in a region in which highly educated persons are overrepresented relative to the general U.S. population (16), so results may not generalize to other care settings or patient populations. Second, the parent study included only older adults with OA and insomnia and may not generalize to middle aged adults with OA. Third, this study did not include information about specific painful OA sites or non-OA pain, so the effects of widespread pain or joint-specific pain on HCU remain unknown. However, these limitations enhance the relevance of the results to arthritis-related pain intensity and pain-related disability. Finally, insomnia, depression, and pain were measured at a single point in time, but these may have changed over the follow-up period. Analyses assessing HCU in relation to current symptom levels may yield different results than reported here.

In conclusion, our study, which reveals the pattern of HCU and a high prevalence of concurrent insomnia and depression in addition to OA pain, has important implications. This is the first study to examine the independent effects of pain, insomnia and depression, to investigate potential presence of synergy, and to report combined effects of pain with concurrent insomnia and depression on HCU in older adults with OA. The study underscores

the substantial independent impact of pain on HCU in OA and suggests an absence of synergy among pain, insomnia, and depression. The combined effects of pain + insomnia, and pain + depression were additive and increased diverse types of HCU and these effects increased greatly with increasing insomnia and depression severity after controlling for pain. This indicates the important role that concurrent symptomatic conditions may play in increasing use of health care services.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENTS

This project was supported by PHS grant R01 AG031126 (MVV, SMM, and MVK), a de Tornyay Healthy Aging Doctoral Scholarship, Hester McLaws Nursing Scholarship and the China Scholarship Council (CSC) Fellowship. The authors wish to thank Katie Saunders for extracting data from the electronic medical records and Ruth Etzioni, PhD for earlier reviews of the data analyses.

Funding sources:

This publication was supported by PHS grant R01 AG031126 (MVV, SMM, and MVK), de Tornyay Healthy Aging Doctoral Scholarship, Hester McLaws Nursing Scholarship, and the China Scholarship Council (CSC) Fellowship.

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SIGNIFICANCE AND INNOVATIONS

1. To our knowledge, this is the first study to examine the independent effects of pain, insomnia and depression, to investigate the potential presence of synergistic effects, and to report combined effects of pain with concurrent insomnia and depression on health care use in older adults with OA.
2. The study findings 1) reveal the high prevalence of OA pain, concurrent insomnia, and depression; 2) underscore the substantial independent impact of pain on health care use in OA; and 3) suggest an absence of synergy among pain, insomnia, and depression.
3. The combined effects of pain + insomnia, and pain + depression were additive and increased diverse types of health care use, and these effects increased greatly with increasing insomnia and depression severity after controlling for pain. This indicates the important role that concurrent symptomatic conditions may play in increasing use of health care services.

Figure 1.

Independent and combined effects of pain + insomnia and pain + depression on office visits, length of stay and hip/knee replacement *

*Adjusted for demographics, Charlson Comorbidity Index, and months of enrollment in Group Health Cooperative.

Figure 2.
Independent and combined effects of pain + insomnia and pain + depression on outpatient and inpatient costs *

*Adjusted for demographics, Charlson Comorbidity Index, and months of enrollment in Group Health Cooperative.

Table 1.

Participant demographics

Variables	N	Mean	SD
Age	2,976	72.16	8.81
Months of enrollment			
Y1	2,976	12	0.08
Y2 – Y4	2,976	34.45	5.66
	N	Number	Percentage
Gender	2,976		
Female		1,971	66.23%
Male		1,005	33.77%
Education	2,971		
Lower than college		1,266	42.61%
College		721	24.27%
Graduate or professional		984	33.12%
Marital status	2,965		
Married/living as married		1,799	60.67%
Single/never married		120	4.05%
Separated/divorced		477	16.09%
Widowed		569	19.19%
Employment	2,911		
Employed		678	23.29%
Unemployed		436	14.98%
Retired		1,797	61.73%
Race	2,922		
White		2,655	90.86%
Asian		119	4.07%
African American		97	3.32%
Others		51	1.75%
Charlson Comorbidity Index	2,976		
= 0		1,917	64.42%
1		1,059	35.58%
Months of enrollment			
Y1	2,976	12	0.08
Y2 – Y4	2,976	34.45	5.66

Notes: SD = Standard deviation; Y = year

Table 2.

Distribution of symptom and participant categories

Symptom/patient categories	N	Number	Percentage
Pain	2,940		
Mild pain		1,556	52.93%
Moderate to severe pain		1,384	47.07%
Insomnia	2,959		
No insomnia		1,333	45.05%
Sub-clinical insomnia		1,119	37.82%
Clinical insomnia		507	17.13%
Depression	2,927		
No depression		1,603	54.77%
Sub-clinical depression		711	24.29%
Current depression		613	20.94%
Pain & Insomnia	2,923		
Mild pain & no insomnia		931	31.85%
Mild pain & sub-clinical insomnia		509	17.41%
Mild pain & clinical insomnia		109	3.73%
Moderate to severe pain & no insomnia		383	13.10%
Moderate to severe pain & sub-clinical insomnia		598	20.46%
Moderate to severe pain & clinical insomnia		393	13.45%
Pain & Depression	2,891		
Mild pain & no depression		1,055	36.49%
Mild pain & sub-clinical depression		368	12.73%
Mild pain & current depression		110	3.80%
Moderate to severe pain & no depression		526	18.19%
Moderate to severe pain & sub-clinical depression		442	15.29%
Moderate to severe pain & current depression		390	13.49%

Table 3.

Descriptive analysis for total office visits, length of stay, total outpatient and inpatient costs, and hip/knee replacement

Health care use	Year 1 (n/%)	Year 2 (n/%)	Year 3 (n/%)	Year4 (n/%)
Total office visits				
0	55 (1.85%)	86 (2.89%)	165 (5.54%)	236 (7.93%)
1 – 6	1,162 (39.05%)	1,091 (36.66%)	1,109 (37.26%)	1,070 (35.95%)
6 – 12	904 (30.38%)	921 (30.95%)	775 (26.04%)	787 (26.4%)
12 – 24	668 (22.45%)	653 (21.94%)	691 (23.22%)	635 (21.34%)
> 24	187 (6.28%)	225 (7.56%)	236 (7.93%)	248 (8.33%)
Length of stay (days)				
0	2,665 (89.55%)	2,618 (87.97%)	2,580 (86.69%)	2,567 (86.26%)
1 – 3	221 (7.43%)	126 (4.23%)	256 (8.6%)	236 (7.93%)
> 3	90 (3.02%)	232 (7.80%)	140 (4.70%)	173 (5.81%)
Total outpatient costs				
0	4 (0.13%)	13 (0.44%)	85 (2.86%)	160 (5.38%)
0 – \$10,000	2,379 (79.94%)	2,250 (75.60%)	2,076 (69.76%)	1,982 (66.60%)
\$10,000 – \$20,000	391 (13.14%)	456 (15.32%)	494 (16.60%)	494 (16.60%)
\$20,000 – \$30,000	127 (4.27%)	138 (4.64%)	167 (5.61%)	175 (5.88%)
> \$30,000	75 (2.52%)	119 (4.00%)	154 (5.17%)	165 (5.54%)
Total inpatient costs				
0	2,661 (89.42%)	2,615 (87.87%)	2,580 (86.69%)	2,566 (86.22%)
0 – \$5,000	61 (2.05%)	73 (2.45%)	60 (2.02%)	60 (2.02%)
\$5000 – \$10,000	79 (2.65%)	58 (1.95%)	98 (3.29%)	88 (2.96%)
\$10,000 – \$15,000	86 (2.89%)	95 (3.19%)	79 (2.65%)	82 (2.76%)
> \$15,000	89 (2.99%)	135 (4.54%)	159 (5.34%)	180 (6.05%)
Hip/knee replacement	109 (3.66%)	130 (4.37%)	120 (4.03%)	113 (3.80%)

Table 4.

Independent effects of pain, insomnia and depression on office visits, length of stay, outpatient and inpatient costs, and hip/knee replacement

Symptoms	Office visits IRR (95% CI)	Length of stay IRR (95% CI)	Outpatient costs Coefficient (95% CI)	Inpatient costs Coefficient (95% CI)	Hip/knee replacement OR (95% CI)
Pain	1.05 (1.02 – 1.09)	1.38 (1.26 – 1.52)	1.12 (1.08 – 1.16)	1.32 (1.22 – 1.45)	1.32 (1.18 – 1.48)
Insomnia	1.01 (1.00 – 1.01)	0.97 (0.95 – 0.99)	1.00 (0.99 – 1.01)	0.98 (0.96 – 1.00)	1.00 (0.97 – 1.03)
Depression	1.01 (1.00 – 1.02)	1.04 (1.01 – 1.07)	1.02 (1.01 – 1.03)	1.03 (1.00 – 1.05)	1.00 (0.96 – 1.03)

IRR: incidence rate ratio; OR: odds ratio; CI: confidence interval.

Incidence rate ratios, odds ratios and confidence intervals that are significant are in bold.

Models adjusted for demographics, Charlson Comorbidity Index, and months of enrollment in Group Health Cooperative.