A Retrospective Cohort Analysis of the Impact of Osteoarthritis on Disability Leave, Workers’ Compensation Claims, and Healthcare Payments

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**Objectives:** Examine short-term disability (STD) and workers’ compensation (WC) associated leave and wage replacements, and overall direct healthcare payments, among employees with osteoarthritis (OA) versus other chronically painful conditions; quantifying the impact of opioid use. **Methods:** Analysis of employees with more than or equal to two STD or WC claims for OA or pre-specified chronically painful conditions (control) in the IBM MarketScan Research Databases (2014 to 2017). **Results:** The OA cohort (n = 144,355) had an estimated +1.2 STD days, +$152 STD payments, and +$1410 healthcare payments relative to the control cohort (n = 392,639; P < 0.001). WC days/payments were similar. Differences were partially driven by an association between opioid use, increased STD days/payments, and healthcare payments observed in pooled cohorts (P < 0.001). **Conclusions:** OA is associated with high STD days/payments and healthcare payments. Opioid use significantly contributes to these and this should be considered when choosing treatment.

**Keywords:** chronic pain, disability, employee, opioid, osteoarthritis, United States

**BACKGROUND**

Osteoarthritis (OA) is one of the most common musculoskeletal disorders globally and is increasing in prevalence within the United States (U.S.).1–5 OA is also an important cause of chronic pain and functional disability, characterized by varying degrees of joint pain and stiffness.1–3 Furthermore, it is a frequent cause of increased healthcare resource utilization and reductions in work productivity.5,6,8–11 The burden of OA has been consistently shown to increase with disease severity, including a strong association between severity and declining work productivity, increasing work absence, and increasing unemployment.12–15

Though their use is discouraged in treatment guidelines, opioids are one of the most common prescription medications provided to employees with OA in the U.S.5,16–20 Yet, opioids provide minimal improvements in pain and function for employees with OA and are associated with further increases in healthcare costs/utilization and lost wages.21–25

In the U.S., many employers provide short-term disability (STD) benefits for employees who are temporarily unable to work due to an illness, injury, pregnancy, or recovery from a medical procedure.26,27 Most employers are also required to provide workers’ compensation (WC) insurance that pays medical expenses and wage replacements to employees for injuries or illness that are caused by work-related activities.28 These programs are beneficial to both employers and employees, as they provide employees with a guaranteed payment to cover the financial impact of injuries or illness and fulfill employers’ obligation to compensate employees for lost time at work and healthcare costs.

Currently, little is known about the relative impact of OA on these types of disability leave in the U.S. The impact of opioid use on these outcomes is also not well characterized. Specific objectives of this retrospective, observational cohort study were to compare STD and WC leave days/payments and direct healthcare payments between employees with OA versus other chronically painful conditions in a U.S. working adult population. The effect of opioid use on these specific outcomes was also assessed.

**METHODS**

**Data Source**

This was a retrospective, non-interventional database analysis using anonymized patient-level claims data from the IBM MarketScan Research Databases (MarketScan Commercial Claims and Encounters [CCAE] and Health and Productivity Management [HPM] databases). Data are from a non-random sample of large employers’ healthcare/disability insurance claims from employees geographically dispersed throughout the U.S.

The CCAE database contains indicators for annual and monthly health benefits enrollment (including demographics, plan sponsor information, and health plan design attributes). It also includes claims for inpatient, outpatient, and prescription pharmacy treatments. Treatment claims data include information on dates of services, one or more diagnoses (International Classification of Diseases and Related Health Problems [ICD], Ninth Revision [ICD-9] or Tenth Revision [ICD-10]), therapeutic class (for pharmacy claims), and payment details.

The HPM database contains indicators of annual eligibility, and claims for STD and WC benefits. WC claims data include the primary diagnosis (ICD-9 or ICD-10) and date of injury or illness for which benefits were authorized, the number of lost workdays (if...
any), and the value of wage replacements and healthcare payments associated with the claim. STD claims data include the primary diagnosis (ICD-9 or ICD-10) and date of injury or illness for which benefits were authorized, the number of lost workdays, and the value of wage replacements.

Employee Sample
Unique individuals were identified in each database based on a common enrollee identification number. Individuals (aged 18 to 64 years) were considered for inclusion in the study based on their eligibility for benefits. They must have been the primary beneficiary (ie, the employee) and eligible for medical, pharmacy, STD, and WC benefits for all months from January 2014 through December 2017 (48 months consecutively).

Cohorts
Eligible employees were divided into two cohorts based on their treatment history for OA or other pre-specified painful conditions (ICD-9 and ICD-10 primary or secondary/additional diagnosis codes listed in Table 1). Employees were included in the OA cohort if they had two or more treatment claims with primary or supplemental diagnoses of OA. Employees were included in the other chronically painful conditions (control) cohort if they had two or more treatment claims with a diagnosis for a pre-specified painful condition at least 30 days apart.31 Employees not meeting the criteria for either cohort were excluded. For the purposes of developing statistical weights and controlling for confounding characteristics (described below), we created an indicator variable for each of the conditions included in the control cohort.

The index date for each employee was the first claim with an eligible diagnosis code. Each employee record was divided to provide a pre-index period (January 1, 2014 to index date) and a post-index observation period (index date to December 31, 2017).

Dependent Variables
Dependent variables were the cumulative lost workdays due to STD or WC (including 0 lost days for WC claims that only incurred medical or other payments), STD payments (wage replacement), WC payments (sum of wage replacements, medical, and other payments including legal fees and vocational rehabilitation), and healthcare payments (sum of inpatient, outpatient, and prescription drug claim payments) during the observation period.

To ensure that we did not overestimate the influence of OA on STD outcomes, for example, after adjusting for the confounding influences of age and sex, we assumed no mechanism for OA to influence STD claims for conditions such as pregnancy or cancer—we only included STD claims with a diagnosis for OA, a different pre-specified painful condition, or for a condition found in the WC claims data (typically injuries and musculoskeletal conditions). This resulted in the exclusion of 64% of the STD claims that accounted for 61% of STD lost workdays and 63% of STD payments.

Prescription Medications
Employees’ prescribed use of acetaminophen, duloxetine, hyaluronic acid, tramadol, non-tramadol opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), and corticosteroids was identified by the U.S. Food and Drug Administration national drug code included with each prescription pharmacy claim. Employees with a prescription were coded as a 1 for that drug, and a 0 otherwise. For statistical weighting (described below), medications were assessed prioritized to the index period. For our final models, we included only medications prescribed for at least 3% of employees in both cohorts combined—opioids, NSAIDs, acetaminophen, and tramadol. Given our general interest in the relationship between opioid use, disability, and healthcare payments, we measured medication use at any time during the study period for use in our regression models.

Health Plan Type
We calculated an employee’s health plan type based on the number of months prior to the observation period they were enrolled in a preferred provider organization, health maintenance organization, point-of-service, or high-deductible health plan. We then converted the number of months into a proportion of the pre-observation period. While an employee could have been enrolled in more than one type of health plan, 88% were continuously enrolled in the same type of plan.

Comorbidities
We used diagnosis information (ICD-9 and ICD-10 codes) from inpatient and outpatient claims to create dichotomous variables indicating whether an employee received treatment for several comorbid conditions during the pre-observation period. These were obesity, diabetes mellitus, hypertension, hyperlipidemia, sleeping problems, anxiety, or depression (ICD codes listed in Table 1).

Demographics
Our models controlled for available employee and employer characteristics. Employer characteristics were limited to the industries of the plan sponsors included in the CCAE and HPM datasets that have both WC and STD data. Industries were durable goods manufacturing; non-durable goods manufacturing; transportation, communications and utilities; services; finance, insurance and real estate; and retail trade.

Employee demographics were sex (male or female), age, and Census region (North Central, Northeast, South, and West). Indicators for whether an employee was unionized (yes or no) and whether they were salaried or paid hourly were also given.

Statistical Method
All analyses were conducted using Stata version 14.2 (StataCorp, TX).

Statistical Weighting
One challenge when conducting analyses of observational data is that “assignment” to either a treatment or control group is non-random and may be associated with the outcome of interest.32 In this case, selection bias complicates the interpretation of effect sizes. We tried to address the risk of selection bias with inverse probability of treatment weighting (IPTW) to balance the measured characteristics across the OA and control cohorts.33

Univariate Analysis
We report the proportions of employees with a claim for WC, STD, or either type during the observation period in the supplemental material. We compared the differences across the cohorts using a test of independence from two-way contingency tables. We also report proportions for the most common diagnoses.

Regression Analyses
We conducted a series of multivariable regression models to estimate employees’ outcomes during the observation period. Each outcome was estimated using a separate model that included an indicator of the cohort, indicators of prescription medication use, non-OA pain and other comorbid conditions, health plan information, industry, and employee demographics. Additionally, each model also controlled for employees’ outcomes prior to the index period. For example, the model estimating WC lost workdays during the index period included a measure of WC lost workdays observed prior to the index period.

For the WC and STD lost workdays and payments models, we treated the outcomes as over-dispersed count data and used a negative binomial estimator. Healthcare payments showed a strong positive skew and initial regression models produced non-normally
| TABLE 1. Diagnosis Codes for the OA and Control Cohort Conditions and Comorbidities |
|---------------------------------|---------------------------------|---------------------------------|
| **Diagnoses** | **ICD-9 Codes** | **ICD-10 Codes** |
| **OA cohort** | | |
| OA | 715.x, 721.0x–721.4x | M13.1x, M13.8x, M15.x–M19.x, M47.0x, M47.11–M47.16, M47.21–M47.28, M47.811–M47.818, M47.891–M47.898 |
| **Pre-specified other chronically painful conditions (control) cohort** | | |
| Abdominal pain | 550.x–555.x, 789.0x, 789.6x | K40.x–K46.x, R10.x (excluding R10.83) |
| Arthropathy | 696.0, 710–719 | A18.01, A18.02, A52.16, D86.86, E08.610, E08.618, E09.610, E09.618, E10.610, E10.618, E11.610, E11.618, E13.610, E13.618, L40.5x, M00.x, M01.x, M02.x, M06.4, M07.x, M11.0x, M11.8x, M11.9, M12.5x, M12.8x, M12.9, M13.0, M14.6x, M14.8x, M15.8x, M15.9, M16.1, M16.2, M16.3, M16.4 |
| Back pain | 307.89, 724.1, 724.2, 724.5, 724.6 | M48.06, M48.07, M54, M62.830, M96.1, M99.23, M99.33, M99.43, M99.53, M99.63, M99.73 |
| Cervical radiculopathy | 722.0, 723.4, 724.4, 729.2, 732.3, 732.6 | M43.6, M53.0, M53.1, M54.00, M54.01, M54.11, M54.12, M54.13, M54.2 |
| Diabetic neuropathy | 249.x, 250.60, 357.2, 548, 648.03, 648.04 | E08.40, E08.42, E09.40, E09.42, E10.4x, E10.610, E11.4x, E11.610, E13.4x, E13.610 |
| Fibromyalgia | 729.1 | M79.7 |
| Genitourinary pain | 256, 257, 603, 604, 620.0, 625.2, 625.9, 626, 789.00 | E28.8, E29.8, N94.89, R10.2 |
| Gout | 249.0, 249.04, 249.06, 249.07, 249.08, 249.09 | M1A.0x, M1A.2x–M1A.9x, M10.0x–M10.2x |
| Headache (non-migraine) | 339, 784.0, 784.9 | G44.x, R51 |
| Joint pain (other than OA) | 714.30, 719.0, 719.4–721.9, 720, 725 | A18.01, M08.1, M25.5x, M35.3, M45.0x, M46.1x, M46.5x, M48.8x, M49.x, M79.0, M79.646 |
| Lumbar radiculopathy | 723.4, 724.4, 729.2 | G54.15, G54.16, G54.17 |
| Migraine | 346 | G35 |
| Multiple sclerosis | 340, 341, 357.0 | G71.0, G71.11, G71.13, G71.2 |
| Muscular dystrophy | 259, 333.90, 359.1, 359.2 | G50.0, M54.10, M79.2 |
| Neuralgia | 350.1, 723.3, 724.4, 729.2 | A52.15, G13.0x, G13.1x, G13.7x, G60.0, G60.1, G60.3, G60.8, G60.9, G61.1, G61.81, G61.89, G61.9, G62.x, G63, G64, G65.5x, G90.09, G99.0, M05.5x, M34.83, M54.3x, M54.4x |
| Other neuropathy | 320, 330, 337.9, 340, 355.1, 355.9, 356.4, 357.1–357.7, 359, 701.0, 710.1, 724.3 | F45.42, G89.0, G89.21, G89.29, G89.4, R52 |
| Other/chronic pain | 338.x, 780.96 | N30.1x, R35.0 |
| Painful bladder syndrome | 595, 596, 752, 752.62, 788.43, 788.99 | B02.2x |
| Post-herpetic neuropathy | 053.12, 532.0 | M05.5x, M06.6x (excluding M06.4), M08.8x, M12.0x |
| Rheumatoid arthritis | 714.x | S14.0x, S14.1x, S24.0x, S24.1x, S34.0x, S34.1x, S34.3x, G09.18, G09.22, G09.28 |
| Spinal cord injury | 952.x | G09.18, G09.22, G09.28 |
| Surgically induced pain | 338.18, 998.89 | E87.x |
| **Comorbidities of interest (both cohorts)** | | |
| Obesity | 278.0x–278.03x, 783.1, V45.86, V55.3 | E65.6x, E66.x–E67.0 |
| Diabetes mellitus | 250.x | E08.x–E13.x |
| Hypertensive disease | 401.x–405.x | I10.x–I11.x |
| Lipid metabolism disorder | 272.x | E78.x |
| Sleep-related conditions | 307.4x, 327.x, 327.0x–327.1x, 347.x, 780.5x, V69.4 | E40.x, F41.x, F44.x, F45.x |
| Anxiety | 300.0x, 300.1x, 300.2x, 300.3–300.7, 300.8x | F40.x, F41.x, F44.x, F45.x |
| Depression | 296.2x, 296.3x, 311.x | F32.x, F33.x |
| Obsessive compulsive disorder | 300.3 | F42.x, F46.1 |
| Post-traumatic stress disorder | 309.81 | F43.1x |

OA, osteoarthritis.
After IPTW, five diagnosis variables—cohorts. Before weighting, the original OA and control cohorts indicate a reasonable level of balance for a given covariate between cohorts. Maximum standardized differences of about 10% were observed. The change in the direction of the standardized difference after log transforming reflects a longer righthand skew within the OA cohort (skew = 32.6) than in the control cohort (skew = 22.6).

The weighted mean index date across both cohorts occurred on March 29, 2015, suggesting an average observation period of about 33 months and a pre-index period of about 16 months. Of particular interest for the current study, after weighting, around one in five employees across both cohorts had at least one pre-index opioid (21%) or NSAID prescription (18%). The most common painful conditions for inclusion in the control group were non-OA joint pain, limb pain, and back pain. Taken together, 86% of the control cohort had at least one of these conditions, compared with 72% of the OA cohort. During the pre-index period, the weighted OA cohort had lower mean WC and STD days and WC and STD payments than the control cohort (Table 2). Healthcare payments for the OA cohort were skewed rightward, resulting in marginally higher mean payments.

Univariate Analyses
Supplemental Table 1, http://links.lww.com/JOM/A996, shows the proportions of employees with any WC or STD claim during the observation period and with the most common diagnoses associated with each type of claim.

Regression Analyses
In the IPTW-weighted multiple regression models (Table 3), we were principally interested in coefficients for the OA cohort, use of opioids, and the interaction between these covariates.

Given the OA cohort × opioids interaction included in the models, Table 4 reports the overall OA cohort and opioids coefficients and the linear combinations of the main and interaction action effects for the four sample populations represented by the interaction.

Cohort Comparison
On average, employees in the OA cohort were estimated to have 12% fewer WC days and 16% lower WC payments than employees in the control cohort over the observation period (Table 4; payments were P < 0.05). Employees in both cohorts were estimated to have about 0.6 WC days and $184 to $219 in WC payments, with an overall average of $199 (±$25; Fig. 2A and B).

Estimated incidence rates for STD days over the observation period were 90% higher in the OA cohort (Table 4; P < 0.001), while STD payments were about twice as high (Table 4; P < 0.001). The models estimated about 1.4 STD days and $160 STD payments for the control cohort over observation, and 1.2 additional STD days and $152 in additional STD payments for the OA cohort (Fig. 2C and D).

Healthcare payments were estimated to be about 9% higher among the OA cohort (Table 4; P < 0.001); estimated at $17,027 (±$198) for the OA cohort and $15,617 (±$116) for the control cohort (Fig. 2E).

Impact of Opioids
Opioid use was a significant predictor for all outcomes. Employees prescribed opioids had significantly higher estimated lost workdays and payments (Table 4). For lost workdays, the overall estimated IRR for opioids was about 2.4 for WC and 5.5 for STD. IRR values for payments were 2.2 for WC and 7.2 for STD. Estimated healthcare payments were twice as high for employees prescribed opioids than payments for employees without opioid indicators for abdominal pain, genitourinary pain, non-OA joint pain, back pain, and limb pain—had an absolute standardized difference of at least 10%. The log of pre-index medical treatment payments had a standardized difference of ~20.7%, whereas the standardized difference of the untransformed variable was 0.9%.

The change in the direction of the standardized difference after log transforming reflects a longer righthand skew within the OA cohort (skew = 32.6) than in the control cohort (skew = 22.6).
### TABLE 2. Summary of the Original and IPTW Cohorts

| Prescribed medications, % | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|---------------------------|-----------|----------------|--------------------------------------|--------------|
| Opioids                   | 42        | 17             | 55.4                                 | 20           |
| NSAIDs                    | 41        | 12             | 70.1                                 | 17           |
| Acetaminophen             | 5         | 2              | 18.6                                 | 2            |
| Tramadol                  | 12        | 2              | 39.0                                 | 4            |

| Comorbidities of interest, % | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|------------------------------|-----------|----------------|--------------------------------------|--------------|
| Obesity                      | 28        | 20             | 18.3                                 | 20           |
| Diabetes                     | 18        | 14             | 12.8                                 | 14           |
| Hypertensive disease         | 51        | 38             | 26.2                                 | 39           |
| Lipoid disorder              | 54        | 44             | 20.0                                 | 45           |
| Sleeping problems            | 27        | 19             | 20.0                                 | 19           |
| Anxiety                      | 19        | 17             | 5.8                                  | 15           |
| Depression                   | 14        | 11             | 9.9                                  | 10           |

| Pre-specified chronically painful conditions in the control cohort, % | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|---------------------------------------------------------------------|-----------|----------------|--------------------------------------|--------------|
| Abdominal pain                                                      | 30        | 31             | –3.4                                 | 23           |
| Arthropathy                                                         | 7         | 2              | 23.5                                 | 3            |
| Cervical radiculopathy                                             | 31        | 18             | 31.3                                 | 19           |
| Fibromyalgia                                                       | 8         | 5              | 14.4                                 | 4            |
| Genitourinary pain                                                 | 20        | 22             | –4.6                                 | 14           |
| Headache (non-migraine)                                            | 15        | 14             | 2.8                                  | 11           |
| Lumbar radiculopathy                                               | 23        | 9              | 38.6                                 | 11           |
| Migraine                                                           | 7         | 7              | 2.5                                  | 5            |
| Neuropathy                                                         | 13        | 5              | 26.3                                 | 6            |
| Neonopathy                                                         | 16        | 9              | 22.5                                 | 9            |
| Chronic pain, other                                                | 18        | 7              | 34.0                                 | 9            |
| Joint pain (other than OA)                                         | 70        | 41             | 61.3                                 | 43           |
| Back pain                                                           | 55        | 41             | 28.8                                 | 38           |
| Limb pain                                                          | 72        | 57             | 31.6                                 | 51           |
| Bladder pain                                                       | 7         | 6              | 2.5                                  | 5            |

| Demographics | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|--------------|-----------|----------------|--------------------------------------|--------------|
| Age, yrs     | 51        | 45             | 66.1                                 | 47           |
| Female, %    | 40        | 39             | 2.0                                  | 35           |

| Industry of employment, % | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|--------------------------|-----------|----------------|--------------------------------------|--------------|
| Manufacturing, durable goods | 43        | 40             | 5.6                                  | 41           |
| Transportation, communications, utilities | 22        | 22             | 0.3                                  | 22           |
| Services                | 15        | 15             | –0.3                                 | 14           |
| Manufacturing, nondurable goods | 7         | 9              | –8.1                                 | 8            |
| Finance, insurance, real estate | 8         | 9              | –1.2                                 | 8            |
| Retail trade            | 4         | 5              | –0.9                                 | 4            |

| Health plan type, based on % months enrolled | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|-----------------------------------------------|-----------|----------------|--------------------------------------|--------------|
| PPO                                           | 52        | 51             | 3.0                                  | 51           |
| High-deductible                                | 31        | 34             | –6.5                                 | 34           |
| POS                                           | 5         | 5              | 2.6                                  | 5            |
| HMO                                           | 8         | 7              | 2.8                                  | 8            |

| Employee characteristics, % | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|-----------------------------|-----------|----------------|--------------------------------------|--------------|
| Unionized                   | 29        | 24             | 10.5                                 | 25           |
| Hourly                      | 53        | 48             | 10.7                                 | 49           |

| Employee region, % | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|--------------------|-----------|----------------|--------------------------------------|--------------|
| North Central      | 30        | 27             | 6.3                                  | 27           |
| Northeast          | 12        | 14             | –4.3                                 | 13           |
| South              | 45        | 44             | 2.3                                  | 44           |
| West               | 13        | 16             | –7.1                                 | 15           |

| Pre-index outcomes, mean | OA Cohort | Control Cohort | Standardized Difference Before IPTW | IPTW Cohorts |
|-------------------------|-----------|----------------|--------------------------------------|--------------|
| WC days                 | 2.3       | 0.9            | 6.2                                  | 1.3          |
| WC payments             | $627      | $252           | 6.9                                  | $325         |
| STD days                | 4.5       | 0.5            | 20.6                                 | 1.5          |
| STD payments            | $473      | $36            | 16.3                                 | $151         |
| Healthcare payments     | $13,222   | $3965          | 34.4                                 | $5719        |
| Healthcare payments (log) | 8.0    | 5.8            | 76.5                                 | 5.7          |

Lower absolute standardized differences in means indicate a greater balance among cohorts for a specific covariate. Standardized differences no greater than 10% to 25% have been proposed as indicating acceptable balance. Control cohort comprises employees with a broad range of other (non-OA) chronically painful conditions.

HMO, health maintenance organization; IPTW, inverse probability treatment weighting; NSAIDs, nonsteroidal anti-inflammatory drugs; OA, osteoarthritis; POS, point-of-service; PPO, preferred provider organization; STD, short-term disability; WC, workers' compensation.

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### TABLE 3. Regression Coefficients and Standard Errors for Weighted Regression Models

| Condition                              | WC Days | WC Payments | STD Days | STD Payments | Healthcare Payments (Log) |
|----------------------------------------|---------|-------------|----------|--------------|---------------------------|
| Osteoarthritis                         | -0.143  | -0.164      | 0.359    | 0.295        | -0.045                    |
| Opioids                                | 0.864   | 0.814       | 1.410    | 1.57         | 0.595                     |
| Osteoarthritis × opioids                | 0.032   | -0.025      | 0.558    | 0.745        | 0.260                     |
| NSAIDs                                 | 0.321   | 0.276       | 0.142    | 0.130        | 0.046                     |
| Acetaminophen                          | 0.333   | 0.066       | 0.438    | 0.550        | 0.209                     |
| Tramadol                               | 0.396   | 0.449       | 0.660    | 0.707        | 0.265                     |
| Index date                              | -0.001  | 0.000       | 0.000    | 0.000        | -0.001                    |
| Obesity                                | -0.236  | 0.053       | 0.098    | 0.078        | 0.129                     |
| Diabetes mellitus                      | 0.070   | 0.071       | 0.139    | 0.110        | 0.296                     |
| Hypertensive disease                   | 0.197   | 0.064       | 0.103    | 0.121        | 0.169                     |
| Lipid metabolism disorder             | 0.024   | -0.085      | -0.193   | -0.258       | 0.071                     |
| Sleep problems                         | 0.097   | 0.070       | 0.003    | 0.003        | 0.225                     |
| Anxiety                                | 0.060   | -0.022      | 0.228    | 0.244        | 0.107                     |
| Depression                             | 0.121   | 0.084       | 0.197    | 0.231        | 0.146                     |
| Abdominal pain                         | 0.088   | 0.003       | 0.211    | 0.326        | 0.208                     |
| Arthropathy                            | 0.228   | 0.189       | 0.206    | 0.215        | 0.445                     |
| Cervical radiculopathy                 | 0.199   | 0.034       | 0.122    | 0.104        | 0.123                     |
| Fibromyalgia                           | -0.165  | -0.247      | -0.273   | -0.423       | -0.067                    |
| Gastroesophageal pain                  | 0.003   | 0.089       | -0.077   | -0.029       | 0.132                     |
| Headache (non-migraine)                | 0.221   | 0.141       | 0.129    | 0.136        | 0.150                     |
| Lumbar radiculopathy                   | 0.096   | 0.155       | 0.410    | 0.448        | 0.095                     |
| Migraine                               | -0.240  | -0.207      | 0.180    | 0.107        | 0.096                     |
| Neuropathy                             | -0.222  | -0.166      | -0.088   | -0.082       | -0.053                    |
| Neuropathy                             | 0.070   | 0.055       | 0.436    | 0.478        | 0.208                     |
| Chronic pain, other                    | -0.067  | 0.080       | 0.437    | 0.504        | 0.198                     |
| Joint pain                             | 0.152   | 0.185       | 0.481    | 0.532        | 0.187                     |
| Back pain                              | 0.088   | 0.064       | -0.022   | -0.028       | 0.020                     |
| Limb pain                              | 0.205   | 0.105       | 0.419    | 0.570        | 0.183                     |
| Bladder pain                           | 0.344   | 0.371       | 0.006    | -0.105       | 0.148                     |
| Age                                    | 0.025   | 0.022       | 0.018    | 0.033        | 0.012                     |
| Female                                 | 0.198   | -0.032      | -0.026   | 0.009        | 0.121                     |
| Manufacturing, durable goods           | 0.910   | 0.558       | 0.706    | 0.443        | 0.007                     |
| Transportation, communications, utilities | 1.998  | 0.713       | 0.420    | -0.036       | -0.034                    |
| Services                               | 2.644   | 0.474       | -0.317   | -0.358       | 0.107                     |
| Finance, insurance, real estate        | 0.462   | -0.552      | 0.588    | -0.004       | 0.102                     |
| PPO (enrolled months)                  | 1.143   | 0.942       | -0.009   | 0.387        | 0.052                     |
| High-deductible                        | 1.993   | 0.609       | -0.166   | 0.009        | -0.078                    |
| POS                                    | -0.080  | -0.371      | -0.187   | 1.319        | 0.168                     |
| HMO                                    | 0.372   | 0.610       | -0.004   | 0.017        | -0.081                    |
| Unionized                              | 1.090   | 0.625       | 0.338    | 0.222        | -0.026                    |
| Hourly                                 | 2.125   | 0.206       | 1.483    | 0.980        | -0.065                    |
| North Central region                   | -0.443  | -0.049      | 0.034    | 0.235        | 0.050                     |
| Northeast region                       | 0.511   | 0.251       | 0.287    | 0.436        | 0.125                     |
| West region                            | 0.214   | 0.721       | 0.015    | -0.129       | 0.051                     |
| WC days: pre-index                     | 0.008   | 0.002       | 0.000    | 0.000        | 0.000                     |
| WC payments: pre-index                 | 0.000   | 0.000       | 0.000    | 0.000        | 0.000                     |
| STD days: pre-index                    | 0.002   | 0.001       | 0.000    | 0.000        | 0.000                     |
| Healthcare payments: pre-index (log)   | 0.087   | 0.002       | 0.000    | 0.000        | 0.000                     |
| Constant                               | 14.840  | 20.568      | 6.665    | 8.747        | 36.415                    |
| Inflation                              | 5.228   | 5.264       | 3.613    | 4.634        | 23.233                    |
| Pseudo R-squared                       | 0.023   | 0.007       | 0.029    | 0.009        | 0.000                     |
| R-squared                              | 0.495   |             |          |              |                           |
| N                                     | 536,994 | 536,994     | 536,994  | 536,994      | 536,994                   |

Control cohort comprises employees with a broad range of other (non-OA) chronically painful conditions.
HMO, health maintenance organization; nbreg, negative binomial regression; NSAIDs, nonsteroidal anti-inflammatory drugs; OA, osteoarthritis; POS, point-of-service; PPO, preferred provider organization; STD, short-term disability; WC, workers’ compensation.

*P < 0.05

**P < 0.01

***P < 0.001

Prescriptions. On average, employees not prescribed opioids had about 0.4 WC days and about 0.8 STD days. Employees prescribed opioids had an additional 0.5 WC days and an additional 3.8 STD days (Fig. 2A and C). Employees prescribed opioids also had an additional $163 in WC payments, $520 in additional STD payments, and $12,239 in additional healthcare payments (Fig. 2B, D, and E).

Since NSAIDs, acetaminophen, and tramadol were included as controls in the models, the strict opioid comparison was to
employees not prescribed any of the most common pain management drugs. Wald chi-squared tests conducted after each model indicated that the coefficient for opioids was significantly higher (P < 0.05 in each case) than the coefficients for the other drugs.

**Cohort and Opioids Interactions**

Opioid use was a particularly strong predictor of higher STD days/payments and healthcare payments in the OA cohort (Table 4). Among employees not prescribed opioids, estimated incidence rates for STD days were about 43% higher in the OA cohort (P < 0.001). By comparison, the IRR is 150% higher among employees prescribed opioids. Comparable results for STD payments were of similar magnitudes.

Among employees not prescribed opioids, estimated healthcare payments were about 4% lower for the OA cohort than for the control cohort. By comparison, among employees prescribed opioids, estimated healthcare payments were 24% higher in the OA cohort. This suggests that the positive and significant overall association between the OA cohort and healthcare payments is driven by employees prescribed opioids.

**DISCUSSION**

Findings from this retrospective, non-interventional database analysis demonstrate that U.S. employees with OA had an estimated 90% higher incidence of STD days, 96% higher STD payments, and 9% higher healthcare payments than control cohort employees with other chronically painful conditions. While WC lost workdays were generally uncommon, they were 12% fewer and associated with 16% lower WC payments among employees with OA. These data demonstrate the particular importance of OA as a cause of disability lost workdays, associated wage replacements, and healthcare payments in the context of other chronically painful conditions. A combined cohort analysis additionally showed all outcomes to be higher among employees who took opioids versus those who did not. The effect of opioid use was found to be a major driver of increased disability days and payments in employees with OA.

The negative association between OA, work productivity, and overall economic burden has been demonstrated in a number of studies, but usually in comparison with the general population of employees. 

The absolute number of additional disability days and payments incurred by employees with OA varies considerably with methodology (region, population, data source, joints affected by OA, modeling, etc) and is not easily compared between studies. Using data from the 2009 U.S. National Health and Wellness Survey, DiBonaventura et al showed rate ratios for absenteeism and presenteeism in employees with OA to range from 1.04 to 1.86 relative to those without OA, depending on disease severity. These findings are similar to our findings of around twice the risk of STD days and STD payments compared with employees with other chronically painful conditions.

Our study showed a lower risk of WC days and payments (~0.8 times risk) among employees with OA versus other chronically painful conditions. However, we also found almost no WC claims for OA in either cohort. Employees with chronic pain might be less likely to claim WC than employees in the general population due to the “healthy worker effect” — where “unhealthy” employees (those with physical limitations) are less likely to take physically demanding jobs, thus are less likely to incur work-related injuries and also find it easier to stay at work after an injury (eg, on light duties) because of the nature of their job and workplace. This effect might be occurring more commonly in our cohort with other chronically painful conditions (mainly non-OA joint pain, back pain, or limb pain). It has been suggested that factors other than comorbidities, such as age, can have a considerable role to play in the costs associated with work-related injuries; however, age was controlled for in our models.

While the estimated mean annual number of disability days associated with OA may not be as high as other chronic conditions, such as spinal injury or limb loss, the high prevalence of OA means that these lost days can have a large cumulative impact on employers. We found that employees with OA incurred an extra $1410 (9%) in estimated healthcare payments (inpatient, outpatient, and prescription drug claims) compared with employees with other chronically painful conditions over a mean observation period of 33 months. This is in the context of the known high costs of treating chronic pain conditions, indicating that OA is associated with a particularly notable economic burden. While the impact of OA versus the general employee population has been demonstrated, the relative impact versus other chronically painful conditions has not been well studied.

Prior to our study, we are only aware of Jetha et al who identified arthritis to be associated with the longest duration of disability (STD and long-term disability claims combined) when compared with seven other chronic conditions (diabetes, hypertension, coronary artery disease, depression, low back pain, chronic pulmonary disease, or cancer) in a large sample from a U.S. private insurance claims database. Opioids continue to be prescribed to patients with OA despite the number of annual prescriptions declining in the U.S. as a result of efforts to address the opioid epidemic. Treatment guidelines generally recommend against the use of opioids in patients with OA due to limited evidence of a positive impact on pain or function; however, treatment options are limited. 

A major finding from our study was that, across cohorts, opioid use was associated with significantly higher number of estimated disability days and payments of all types. The magnitude of the differences exceeded those between cohorts (2.4- and 2.2-times higher WC days and
payments; 5.5- and 7.2-times higher STD days and payments; 2.1-times healthcare payments). Analysis of the interaction between opioids and the OA cohort showed that, in our data, opioid use was a major driver of the additional STD days, STD payments, and healthcare payments observed in employees with OA versus employees with other chronically painful conditions. Further study evaluating the impact of opioids in more detail is warranted, that is, by medication, number of prescriptions, or morphine milligram equivalents. Previous literature has demonstrated links between opioid use, decreased work productivity, and higher costs when used to treat chronic noncancer pain, such as low back pain.47,48 Our study is one of few to focus specifically on people with OA. Zhao et al21 previously studied U.S. Medical Expenditure Panel Survey data from U.S. adults with OA and found opioid use to have a strong association with direct and indirect costs, more so than the level of pain interference with activities. Wei et al24 studied U.S. claims data and electronic health records and found opioid use in patients with OA to be independently associated with higher healthcare resource use and costs. Similarly, an observational longitudinal assessment of patients with OA and chronic pain in Spain found meaningful increases in resource use and costs after starting opioids, despite modest reductions in pain.23 The reasons that opioids are associated

FIGURE 2. Estimated outcomes by cohort and opioid use. Control cohort comprises employees with a broad range of other (non-OA) chronically painful conditions. Shows mean ± 95% confidence interval from a multivariate regression model. Indicates opioids prescribed during the study period. OA, osteoarthritis; STD, short-term disability; WC, workers’ compensation.
with negative outcomes in people with chronic pain (including pain due to OA) are likely multifactorial. Opioids have been shown to provide no additional benefit in pain-related function over non-opioid medications for people with back pain and OA and are associated with more adverse effects. The known adverse effect profile and risk of addiction associated with opioids likely contributes to the negative work productivity outcomes observed in our analysis.

Notable strengths of our study include the large sample size and the long length of follow-up (mean observation of ~33 months), which exceeds most similar studies. The breadth of data captured is also a major strength. We believe that our comparison strategy (OA vs other chronically painful conditions) is unique, allowing the dissection of the impact of OA on work productivity to be carved out in comparison to a large group of chronically painful conditions.

Our study approach also has several limitations. Firstly, IBM MarketScan data are derived from a non-random sample of large employers’ healthcare and disability insurance benefits and are not generalizable to the population of U.S. employees working for small or mid-sized employers. Secondly, our cohort does not include those with more severe and limiting chronic pain. We required continuous employment and benefit enrollment from 2014 to 2017, so those who subsequently left employment (and lost their insurance coverage) due to chronic pain are not included in our analysis. Thirdly, because data are based on treatment-seeking/benefit claiming behavior, they may not be comprehensive with regards to health conditions that did not trigger treatment or a claim. We do not have records of reportable on-the-job injuries that did not result in claims for medical treatment or wage replacement. This may have resulted in an undercount of less serious or “near-miss” incidents where OA or opioids were contributing factors. Fourthly, supplemental sources of health condition data such as self-reported health risk assessments, values obtained by lab tests, details of disease severity or duration, or data about patient characteristics, such as socioeconomic status (eg, household income), race/ethnicity, and granular geographic location (eg, zip code or census block) are not available but may have associations with our outcomes. This could contribute to omitted variable bias. Additionally, WC and STD claims do not capture the full burden of illness, and lost workdays as a result of absenteeism (and lost their insurance coverage) due to chronic pain are not included in our analysis. Finally, but important limitation is related to the designation of other chronic conditions which exceeds most similar studies. The breadth of data captured is unique, allowing the dissection of the impact of OA on work productivity to be carved out in comparison to a large group of chronically painful conditions.

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