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Injuries That Happen at Work Lead to More Opioid Prescriptions and Higher Opioid Costs

Abay Asfaw, PhD,
Centers for Disease Control and Prevention (CDC)–National Institute for Occupational Safety and Health (NIOSH)–Economic Research and Support Office, Washington, DC

Brian Quay, MS,
Centers for Disease Control and Prevention (CDC)–National Institute for Occupational Safety and Health (NIOSH)–Economic Research and Support Office, Cincinnati, Ohio

Tim Bushnell, PhD,
Centers for Disease Control and Prevention (CDC)–National Institute for Occupational Safety and Health (NIOSH)–Economic Research and Support Office, Cincinnati, Ohio

Regina Pana-Cryan, PhD
Centers for Disease Control and Prevention (CDC)–National Institute for Occupational Safety and Health (NIOSH)–Economic Research and Support Office, Washington, DC

Abstract

Objectives: This study aimed to compare opioid prescription incidence, supply days, and cost associated with occupational injury and other injury-caused conditions.

Methods: We used Medical Expenditure Panel Survey (MEPS) data for 2010–2019. The MEPS provides information on medical conditions and associated medical encounters, treatments, and treatment costs, as well as demographic, education, health, working status, income, and insurance coverage information. We used descriptive statistics and logistic and 2-part regressions.

Results: Controlling for covariates and compared with other injury-caused conditions, occupational injury–caused conditions resulted in 33% higher odds of opioid prescribing, 32.8 more opioid prescription supply days, and $134 higher average cost.

Conclusions: Occupational injuries were associated with higher opioid incidence and costs, and more opioid supply days. These findings point to the need to focus on making work safer and the role employers may play in supporting worker recovery from injury and opioid use disorders.

Address correspondence to: Abay Asfaw, PhD, Centers for Disease Control and Prevention (CDC)–National Institute for Occupational Safety and Health (NIOSH)–Economic Research and Support Office, 395 E Street, SW, Washington, DC 20201 (AAsfaw@cdc.gov).

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Keywords

occupational injury; opioid prescribing; prescription opioid supply days; prescription opioid costs; MEPS

The United States continues to experience an opioid misuse and overdose epidemic. Nearly half a million people died of drug overdoses that were principally associated with prescription and illicit opioids from 1999 to 2020.[1] In 2020, 68,630 deaths involved opioids, which was 8.5 times higher than the number of deaths that involved opioids in 1999.[2] Although the overall opioid prescribing rate peaked and plateaued from 2010 to 2012 and has been declining since 2012, the amount of opioids in morphine milligram equivalents (MME) prescribed per person was still roughly 3 times higher in 2015 than it was in 1999.[3] In 2016, there were 17,087 deaths associated with prescription opioids compared with 14,583 in 2010 (when opioid prescription rates peaked) and 3442 in 1999.[4,5] In 2019, more than 14,000 people died of overdoses involving prescription opioids, which was roughly 28% of all opioid overdose deaths that year.[5]

Although prescription opioids are no longer the most frequently implicated drugs in opioid deaths, they led the development of the epidemic and still contribute to the use of illicit opioids. Deaths associated with prescription opioids exceeded deaths associated with illicit opioids by a factor of more than 2 from 2003 to 2011, and still exceeded deaths associated with illicit opioids in 2013.[5,6] Furthermore, studies in Ohio, New York, Los Angeles, San Diego, and Seattle found that, in 2008 and 2009, 39% to 86% of people who used heroin reported having used prescription opioids nonmedically before beginning to use heroin.[7] Broader population studies also found that 75% to 80% of people who used heroin reported first using prescription opioids nonmedically.[8] In a study of 254 unintentional opioid-involved deaths in Utah in 2008 to 2009, 78% of decedents had taken prescription medication for pain within the last month of life, and 80% had used illicit drugs in the last 2 months.[9] A report from Rhode Island found that 24 of 69 people who died of an illicit fentanyl overdose from 2012 to early 2014 had filled an opioid prescription within 90 days of their death.[10]

Assessing opioid prescription patterns is key to understanding the opioid crisis.[11,12] Much of the research on opioid-prescribing patterns has focused on variation across demographic groups[13,14] and locations.[15,16] Particularly wide variations have been found by county, with a range from 203 MME per capita in the lowest quartile of counties to 1319 MME per capita in the highest quartile in 2015.[3] There is little research on the impact of workplace injury on the opioid crisis or comparing opioid prescription patterns across occupational and other settings. As a result, some researchers have suggested that employers are not adequately represented in efforts to reduce the opioid overdose crisis.[17] Dembe et al[18] analyzed Ohio workers' compensation data from 2008 to 2009 on Drug Enforcement Administration Schedule II opioid prescriptions, and conducted a literature review on opioid use in other workers' compensation systems and in general health care systems. Because most of the workers' compensation studies focused on low back pain patients only, they were not directly comparable to the studies based on general health insurance claims. The

review suggested that opioid use could be higher in workers' compensation systems. Two studies in Manitoba, Canada, found that workers' compensation claimants represented 2.1% of the population receiving opioid prescriptions, but 3.8% of the total opioid dosage during the 1998–2010 period, and were about 40% more likely than others to be prescribed opioids for the same musculoskeletal procedures.[19,20]

To our knowledge, no study has compared opioid prescription patterns associated with occupational injuries with other injuries using a US national, general population survey, such as the Medical Expenditure Panel Survey (MEPS). In this study, we do so using 3 metrics: opioid prescription incidence, number of days for which drugs were prescribed, and cost. We expected occupational injuries to lead to higher opioid incidence and costs than other injuries because occupational injuries are more likely to be severe and lead to poorer recovery outcomes. Injured workers might also take more opioids to return to work as soon as possible.

DATA

This analysis uses data from the MEPS, which is a complex data set comprising many files and file types. We used data for the 2010–2019 period from 4 MEPS data files.[21] All of these files are within the set of household component, full-year files. Hereinafter, we describe the MEPS, the information we used from each file, how we linked the files for each year we examined, and how we measured the variables we used.

MEPS data are collected from households and from other sources like pharmacies or health care insurers with medical records. It is designed to capture detailed data on medical conditions, treatments received, and costs of treatment to all parties, for a representative sample of the US population. Household information is gathered in a survey whose respondents are a representative sample of US households in the civilian, noninstitutionalized population drawn annually from among respondents to the National Health Interview Survey. Household questionnaires are administered to each respondent household a total of 5 times during a period of approximately 2 years. In many households, a single person provides information on all household members, but all household members are encouraged to participate. In each round of the survey, respondents are asked to describe all medical conditions that they have experienced since the previous round. These are called "current medical conditions." The MEPS defines medical conditions as "physical or mental health problems that a health care professional can identify by examining a patient."[22] For each condition identified, the respondent is asked whether that condition was due to an injury or accident. If a respondent says that a condition was caused by an injury or accident, they are then asked whether it occurred at work. Depending on the answer, the condition is classified as either an occupational injury–caused condition or another injury-caused condition. Note that formerly, respondents were asked when the reported injury occurred, but this question was dropped after 2012, and responses to this question were not used in the analysis. We used data from the MEPS medical conditions file, which contains the information on current medical conditions from the household survey.

The second MEPS file we used was the condition-event link file, which links each condition in the medical conditions file to specific medical encounter and treatment events that appear in various types of event files. Event files contain information about prescribed medicines, dental visits, other medical expenses, hospital inpatient stays, emergency department visits, outpatient visits, office-based medical provider visits, and home health. In this study, we used only the prescribed medicines event file. The prescribed medicines file—the third MEPS file we used—provided information on each "prescribed medicine purchased or otherwise obtained" by each respondent, including national drug code, medicine name, strength of medicine, quantity, number of days for which drugs were prescribed (supply days), and related cost incurred by different payers. The fourth MEPS file we used was the full-year consolidated file, which provided a wide range of demographic, socioeconomic, and health variables for each individual.

In our analysis, we considered respondents in the medical conditions file, 18 years and older, who reported a current medical condition caused by an occupational or other injury. Then, we used the MEPS condition-event link file to link each condition to prescribed medicines for these conditions in the prescribed medicines event file and created a merged file. Then, we linked individual-level information from the full-year consolidated data file to the merged file from the previous step, to append demographic, education and income, health insurance coverage, working status, health behavior, health, and geographic indicators. We considered individuals to be working if they had a job during at least one of the rounds in the survey year.

To measure our dependent variables (opioid prescription variables), we used more than 13,000 national drug codes provided by the Centers for Disease Control and Prevention[23] and Cerner Multum, Inc (Multum's April 2018 content)[24] to identify opioid prescriptions. We measured the incidence of opioid prescription as a dummy variable taking a value of 1 if the respondent was prescribed opioids, and zero otherwise. We measured the number of opioid supply days and cost as continuous variables.

Our unit of analysis was injury-caused condition-person-year. Thus, we aggregated all the information on opioid prescription incidence, supply days, and cost for each condition over 1 calendar year. If a person has more than 1 injury-caused condition in a year, they may be represented by more than 1 observation in that year. In addition, because the MEPS surveys every person over approximately 2 years, a person can also be represented by observations of the same condition in 2 different years. Note that if multiple conditions caused by injury are reported in a single year, we often do not know if these conditions were caused by one or by multiple injuries. That is why the unit of analysis was based on injury-caused conditions rather than injuries. Note also that allowing 2 observations for conditions that span 2 years effectively gives these conditions twice the weight of shorter duration conditions.

Our main explanatory variable was a dummy variable indicating causation by an injury at work rather than by other types of injuries. Covariates included the following: sex, age category (18–29, 30–44, 45–64, and 65+ years), race and ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic other), marital status (never married, married, widowed, divorced, separated), education (less than high school diploma, high school

diploma, some college, bachelor's or higher), health insurance coverage (private, public, no health insurance), working status (worked during the survey year), current smoking status (yes), physical activity (moderate or vigorous physical activity 3 times per week), comorbidities (none, 1 or more), geographic region (Northeast, Midwest, South, West), year of the survey (2010–2019), and poverty status (poor, near poor, low income, middle income, high income). The poverty status variable is computed by the Agency for Healthcare Research and Quality that sponsors the MEPS, using family composition (size, sex and age), family income, and living standards in different states and cities.[25]

METHODS

We used descriptive and multivariable analyses to examine the association of occupational injury–caused conditions with opioid prescriptions. The descriptive analysis simply compared occupational injury–caused conditions with other injury-caused conditions in terms of opioid prescription incidence, supply days, and opioid prescription cost between 2010 and 2019. These 2 groups of conditions were also compared in terms of all the person characteristics captured by the covariate variables listed previously. We used *t* tests to determine the statistical significance of differences in opioid prescription incidence, the mean number of opioid supply days, and the mean cost of prescribed opioids. Changes in these measures between 2010–2014 and 2015–2019 were also compared.

To assess the association of occupational injury–caused conditions with opioid prescription outcomes, we also used a logistic regression model that controlled for the same set of person characteristics, some of which are likely to be strongly associated with type of work injury and resulting conditions. Note that Kim[26] used a similar set of covariates when he used the MEPS to examine depression after occupational injury. At the time of our analysis, there was an overall declining trend in the use of prescription opioids.[27] To control for this and unmeasured trends that would affect opioid use, we also included year-fixed effects.

To assess the association of occupational injury–cased conditions with number of opioid supply days and cost, we used a 2-part regression model, because injury-caused conditions that did not result in opioid prescriptions had zero supply days and cost. In the first part of the model, we estimated the probability of an injury-caused condition to result in a nonzero number of opioid supply days or nonzero opioid cost using the whole sample and a logistic regression model. In the second part of the model that included the subsample with positive outcomes only, we estimated the number of opioid supply days or cost using a generalized linear model (GLM) with a log link. Finally, we multiplied the results from the first and the second parts to obtain the overall association of occupational injury–caused conditions with opioid prescription outcomes. We used a logarithmic transformation of the dependent variables to address skewness.

The following equation describes our 2-part model:

$$E(Y/X) = \underbrace{\Pr(Y > 0)}_{\text{PART1}} \times \underbrace{E(Y/Y > 0, X)}_{\text{PART2}} \times D$$

Y was the number of opioid supply days or cost of opioids per injury-caused condition-person-year, X was the vector of explanatory variables, and D was Duan's smearing estimator[28] that we used to transform the unconditional logarithmic estimates to their original values.

As noted previously, in the MEPS, respondents can report more than 1 medical condition due to injury within a year and may also report conditions in 2 separate years. In our sample, 56% of respondents reported 1, 26% reported 2, 8% reported 3, and the rest reported 4 or more medical conditions. This might violate the assumption of independence of observations because the incidence of opioid prescription for a respondent's second medical condition may depend on the incidence of opioid prescription for this respondent's first medical condition. To address this issue, we relaxed the assumption of independence of observations and assumed instead independence among observation "clusters," that is, respondents. In other words, standard errors of observations could be correlated within but not between respondents. We used the Huber-White sandwich estimator[29] to estimate the model under the relaxed assumption.

There were 66,914 injury-caused conditions-person-year-reported in MEPS during the period 2010–2019. We excluded observations reported by respondents younger than 18 years (10,430) or serving in the military (183), as well as observations with any missing data for the covariates we used (6051). We used STATA's survey data analysis programs (StataCorp, College Station, TX). We converted the cost of opioids to 2020 dollars using the medical care consumer price index.[30]

RESULTS

Descriptive Statistics

Our sample for the period 2010–2019 included 26,743 injured respondents 18 years and older. We examined 50,250 (weighted 56.8 million) injury-caused condition-person-years, of which 22.1% were due to occupational injuries. Table 1 presents descriptive statistics. All differences in measures of opioid prescriptions between occupational and nonoccupational injury–caused conditions were significant at the 1% level.

The incidence of opioid prescription was 18.9% for occupational injury–caused conditions compared with 14.0% for other injury-caused conditions. The unconditional average number of opioid supply days (average number of supply days for all injury-caused conditions) was 12 days for occupational injury–caused conditions compared with 6 days for other injury-caused conditions. The conditional average number of opioid supply days (average number of supply days for injury-caused conditions with nonzero supply days) was 90 days for occupational injury–caused conditions compared with 57 days for other injury-caused conditions. The unconditional average opioid cost (average opioid costs for all injury-caused conditions) was $78 for occupational and $34 for other injury-caused conditions. The conditional average opioid cost (average opioid costs for injury-caused conditions with nonzero costs) was $412 for occupational injury–caused conditions and $242 for other injury-caused conditions.

Changes in opioid use for the 2 groups of injury-caused conditions are shown in Figures 1–3, comparing 2010–2014 and 2015–2019. Incidence of prescriptions declined a little more than 20% for both occupational injury– and other injury-caused conditions. Supply days per injury-caused condition, however, declined just slightly for both groups of conditions, implying an increase in supply days per prescription. Average opioid cost for occupational injury–caused conditions declined just 2.5%, whereas cost declined 40.5% for other injury-caused conditions. More detailed figures and tables with annual data are shown in Appendix 1, http://links.lww.com/JOM/B205.

Multivariable Analyses

Incidence of Opioid Prescription—Table 2 presents results from the model that included covariates. After controlling for covariates, the odds of opioid prescription were 33% (95% confidence interval [CI], 21%–46%) higher for occupational injury than other injury-caused conditions ($P < 0.01$). Several covariates were statistically significant. Respondents aged 30 to 64 years were more likely to be prescribed opioids than younger and older respondents. Hispanic and never married respondents were less likely to be prescribed opioids than non-Hispanic White and married respondents. Compared with respondents with a bachelor's degree or higher, respondents with less than a high school diploma, high school diploma, and some college were more likely to be prescribed opioids. Working respondents were less likely to be prescribed opioids compared with nonworking respondents. Smoking and having comorbidities increased and physical activity decreased the likelihood of opioid prescription after injury. Injured respondents in poor and near-poor households were more likely to be prescribed opioids than respondents from high-income households. Respondents in the South and Midwest were more likely to be prescribed opioids than respondents in the Northeast, the reference category. As expected, there was an overall decline in the incidence of opioid prescription over time.

Opioid Supply Days—The results of the first and second parts of the 2-part model are presented in Appendices 2 and 3, http://links.lww.com/JOM/B205, respectively. In both parts, the estimated coefficients for occupational injury–caused conditions were positive and statistically significant at the 1% level. Table 3 presents the marginal (or incremental) effects for the combined logistic regression and GLM parts of the 2-part model. Occupational injury–caused conditions resulted in 6 (95% CI, 4.4–7.6 days) more opioid supply days than other injury-caused conditions, matching our descriptive results. Covariates with statistically significant relationships to supply days included age (most supply days for the 45- to 64-year age group), race and ethnicity (least supply days for Hispanics), education (more days for high school diploma and some college), working (fewer supply days), smoking and having comorbidities (more supply days), physical activity (less supply days), having public insurance (most supply days), and living in the South (most supply days).

Cost of Opioids—The first and second parts of the 2-part model for opioid costs are presented in Appendices 4 and 5, http://links.lww.com/JOM/B205, respectively. As in the case of opioid supply days, occupational injury–caused conditions were positively and significantly related to the probability of spending and the amount of spending conditional on positive spending. The combined logistic regression and GLM parts of the 2-part model

are presented in Table 4. Occupational injury–caused conditions resulted in $29 more opioid cost per year (95% CI, $16–$43) than other injury-caused conditions (compared with $44 more in our descriptive results). Covariates with statistically significant relationships to opioid prescription cost included sex (higher cost for male individuals), age (higher cost for the 45- to 64-year-old age groups), race and ethnicity (lowest cost for Hispanics), being widowed and separated (lower cost), some college (highest cost), working (lower cost), smoking (higher cost), being physically active (lower cost), and having public insurance (higher cost).

DISCUSSION

Our results highlight the significant role of occupational injuries in generating opioid prescriptions for US adults. The results presented in Table 1 indicate that 22.1% ([12,541,344/56,842,461] × 100) of injury-caused health conditions reported by adults in a given year during the period 2010–2019 stem from occupational injuries. However, because opioids are prescribed more often for occupational injury–caused conditions than other injury-caused conditions, occupational injuries accounted for 27.7% ([2,374,213/8,585,396] × 100) of all opioid prescriptions for injury-caused conditions. In addition, because opioids were prescribed for more days per prescription for occupational injury–caused conditions, occupational injuries accounted for 37.1% ([155 million/413 million] × 100) of total supply days and 39.5% ([$978 million/$2480 million] × 100) of total cost for adults receiving opioid prescriptions for injury-caused conditions. See Table 1 for the details. Our multivariable analyses also showed that occupational injury–caused conditions increased the odds of opioid prescriptions by 33%, the number of opioid supply days per injury-caused condition by 6 days, and the cost of opioid prescriptions by $29 per year, controlling for covariates. No set of covariates is complete, but the covariates included several key demographic, socioeconomic, and health behavior variables, so that the differences in opioid prescriptions we found are likely to be due in large part to the nature of work injuries and the care provided under workers' compensation rather than the personal characteristics of those who were injured. All these results were statistically significant at the 1% level in their respective models.

Although we are not aware of many other studies that have compared occupational to other injuries, our results are in agreement with other studies that find evidence of higher levels of opioid prescriptions for occupational injuries, including Dembe et al[18] and Kraut et al[19,20] cited in the Introduction section. We found evidence of longer treatment (number of days), as did Kim[26] and Lilley et al.[31] We also found differences by demographic groups, as did Frenk et al.[13] and Paulozzi et al.[14] There are several reasons why occupational injuries might lead to greater frequency and supply days of opioid prescriptions. First, occupational injuries are often more severe and are associated with longer treatment and recovery time than other injuries,[26,31] leading to more pain and pain of longer duration. Severity and longer treatment times may be partially due to occupational injuries having a different mix of causes than other injuries. According to an analysis of MEPS data, occupational injuries were more likely to be caused by falls, much less often associated with sports, and less likely to be caused by motor vehicle accidents.[26] In an analysis of National Health Interview Survey data, higher proportions of occupational injuries were caused by overexertion, cutting or

piercing, and machinery, but smaller proportions were related to falls and motor vehicles.[32] A study using a Canadian population survey showed that occupational injuries were more likely to involve accidental contact with sharp objects, being struck by an object, accidental contact with a hot object, and overexertion, but less likely to involve a fall or a motor vehicle.[33] In addition, some occupational injuries, especially musculoskeletal disorders, are caused by regular work tasks that may be difficult to avoid during the recovery period, possibly leading to more pain. More opioid use could be one way of coping with pain to stay at work or to quickly return to work.

Second, there is evidence that occupational injuries are more likely to be associated with poor recovery outcomes than other injuries.[31,34,35] Lilley et al.[31] showed that, 12 months after injury, workers with occupational injuries had poorer outcomes, including higher risk of absence and lower overall functional capacity. Studies have consistently found worse surgery outcomes for workers' compensation patients than for others.[36,37] Third, job insecurity might also force workers to return to work before they are fully recovered leading to more opioid use.[17] Job strain (high job demand and low job control) is also a major risk factor for a less successful return of injured workers to work,[38] which could be associated with depression, and thus more opioid use. Fourth, there is evidence that occupational injuries are more likely to be associated with postinjury depression.[17,26,31,39,40] Depression and pain have been recognized as having a strong bidirectional relationship, and depressed patients, although only slightly more likely to receive opioid therapy for their pain initially, are twice as likely to transition to long-term use of opioids.[41] Finally, health care for occupational injuries is often provided under guidelines established by workers' compensation systems, which are governed by different rules and types of insurance policies than those used in general health care systems. Thus, access to care and the providers used differ, and there are generally no out-of-pocket payments with workers' compensation insurance in contrast to general medical insurance.

Increased awareness of the risks of opioid use, new Centers for Disease Control and Prevention opioid prescription and chronic pain guidelines,[42] and state-level policies focused on the reduction of inappropriate opioid prescribing seem to have resulted in a decrease in opioid prescriptions in recent years.[12,43–46] Our results also show a decrease in opioid prescriptions: more than a 20% decrease in the share of injury-causing conditions associated with an opioid prescription, although less than a 5% decrease in average supply days per injury-caused condition. Because of differing study time periods, scope of conditions included, and opioid metrics, these results can only roughly be compared with previously published information on overall trends in opioid prescriptions for the general population and in workers' compensation systems. After peaking in 2010, the amount of opioids dispensed by pharmacies in the United States declined 18% from 782 MME per capita in 2010 to 640 MME per capita in 2015, although this was still more than 3 times higher than in 1999.[43] This overall figure reflected a 13.1% decline in the rate of prescriptions, a 16.9% decline in average MME per prescription, but a 33% increase in average supply days per prescription over this period. Our finding of 20% fewer prescriptions but less than 5% fewer supply days also implies an increase in supply days per prescription. Using another metric based on data on filled prescriptions at retail pharmacies from 2008 to 2018, the percentage of adults who filled an opioid prescription declined 31%, from 27.8% to 19.2%.[47] The

steepest decline during this period was between 2015 and 2018 when the percentage of men filling opioid prescriptions declined from 22% to 16% and the percentage of women filling opioid prescriptions declined from 28% to 22%.

Among workers' compensation claims, a large decline in workers' compensation opioid prescriptions has previously been observed. The percent of workers' compensation claims with prescriptions that included at least one prescription for opioids declined from 55% in 2012[48] to 34% in 2020,[49] based on data from 40 states. Another study from the Workers' Compensation Research Institute[48] focused more specifically on claims with prescriptions among nonsurgical claims with more than 7 days away from work, finding declines in the percentage of these claims with opioid prescriptions. Among 27 states, the median decline was 13 percentage points between 2012/2013 and 2016/2017 (equivalent to a 19% decline in incidence). During the same period and within this same set of claims, this study also found large declines in the average MME per claim with an opioid prescription, with a median decline of 36% among the 27 states. In the present study, we also found a substantial decline in the incidence of opioid prescriptions. However, we saw little change in days supply and opioid cost per injury-caused condition. This suggests that the amount of opioids prescribed may have declined much less than prescription incidence, and much less than was found in the Workers Compensation Research Institute study. However, we could not directly measure the amount of opioids prescribed in MME units in this study, and time period and types of claims examined differed from the Workers Compensation Research Institute study. The disparity that we saw between the large decline in opioid cost for other injury-caused conditions and the small decline in opioid cost for occupational injury–caused conditions suggests the need for further examination of trends in amount of opioids prescribed for work.

Our results also showed that publicly insured respondents, relative to privately insured, were more likely to receive an opioid prescription, had more days supplied, and had higher total cost of prescriptions. Using the National Ambulatory Medical Care Survey for 1992 to 2001, Olsen et al[50] showed that the odds of patients with Medicare and Medicaid receiving an opioid in a primary care physician's visit were 2 times higher than in patients with private insurance. Educational attainment helps explains variation in the likelihood of receiving opioid prescription in our models, with the likelihood of receiving opioids decreasing as the level of education increases. Similar results were found in other analyses.[51,52] This could be partly because education is a proxy for type of occupation (ie, blue collar vs white collar) and blue-collar workers are more likely to have a work injury that requires medical attention.[53,54]

Our results also showed that the incidence of opioid prescription was higher for respondents from the South and Midwest than respondents from the Northeast region. Similar results were reported by Webster et al[16] and Paulozzi et al.[15] Smoking increased the likelihood of opioid prescription associated with injury, days opioids were supplied, and opioid costs. Our results showed that the odds of current smokers receiving an opioid prescription related to injury-caused conditions were 38% higher than nonsmokers. Using the Danish health survey of 2005, Ekholm et al[55] showed a strong association between smoking, chronic pain, and opioid prescription. Similar results were reported by other researchers.[56–58] This study

also found a strong negative association between physical activity and incidence of opioid prescription, days opioids were supplied, and opioid costs. Respondents who engaged in moderate or vigorous physical activity 3 times per week had 13% lower odds of receiving an opioid prescription, had 2.3 less opioid days, and had $13 less opioid costs related to injury-caused conditions. This could be due to 2 reasons. First, because of lack of information, we did not include obesity as one of the control variables. Obesity is associated with severe injuries and complications.[59,60] Physical inactivity is also strongly associated with obesity. Second, physically active people are more likely to be healthy and quickly recover from injuries.[61,62]

This study is subject to some limitations. First, some relevant covariates were omitted. Obesity may be among the most important of these because it might be highly correlated with severity of injury, recovery from injury, and overall health status, and consequently opioid use. It is not clear, however, whether it is associated with relative tendency to experience injuries at work versus other settings. The MEPS stopped collecting body mass index for adult respondents as of 2017. However, the physical activity variable might have captured some of the effects of obesity. Second, our analysis could not take account of the time at which the injury occurred. As of 2013, MEPS no longer asked respondents when the injury causing their condition occurred. Thus, the injury—occupational or otherwise—could have occurred any time before the time of the survey, either within or before the survey year. To fully understand the differences between the impact of occupational and other injury-caused conditions on opioid use, it would be ideal to have information on duration of conditions and treatment after injury. Clearly, longer duration of conditions could be one factor behind more opioid prescriptions for occupational injury–caused conditions. Third, although injury-caused condition-person-years were the unit of analysis that best fit the constraints of the MEPS data, there is a possibility that comparison of occupational and other injury-caused conditions could have been biased if occupational and other injuries give rise to conditions of different duration. Because conditions were measured in units of 1 calendar year, many conditions resulting from an injury spanned 2 or more years, giving rise to 2 or more observations. However, when this happened, opioid prescriptions for the condition were split between years, reducing the average opioid prescriptions per injury-caused condition-year. The algebraic result was that longer duration of conditions after injury was associated with less than proportionally higher duration per injury-caused condition-year and thus less than proportionally higher number of opioid supply days and cost of opioid prescriptions (assuming opioid prescriptions are proportional to condition duration). Because our results indicated higher frequency, supply days, and cost of opioid prescriptions for occupational injury conditions, we might suspect that occupational injuries are more severe and thus of longer duration. If so, the difference between opioid prescriptions for occupational and other injury-caused conditions might be underestimated.

CONCLUSIONS

We found that occupational injury–caused conditions accounted for a large percentage of opioids prescribed for injury and had 33% higher odds of an opioid prescription than other injury-caused conditions. Although occupational injury–caused conditions were more

likely to lead to an opioid prescription, the higher level of opioid use with which they were associated was likely due more to a greater intensity of opioid prescriptions for those conditions, represented by a greater number of supply days and higher opioid costs per prescription. Because we controlled for several key demographic, socioeconomic, and health behavior characteristics, the higher rate, duration, and cost of opioid prescriptions are likely to be due largely to a combination of greater severity of occupational injuries and differences in care received in workers' compensation systems. Proceeding further to understand how occupational injury–caused conditions affect prescription opioid use could create avenues and opportunities to intervene by providing insight into the use and effectiveness of opioids versus alternative approaches to pain management. A related extension of this work would be an examination of the differences in opioid prescriptions by type of occupational injury.

The ultimate concern about opioid prescriptions is that they can sometimes lead to misuse, use disorder, and death. The contribution of prescription opioids to these outcomes may be changing as the opioid overdose crisis in the United States continues to evolve. Overall, opioid prescription rates have decreased over the last decade, but opioid overdose continues to grow. Rates of drug overdose deaths involving natural and semisynthetic opioids, and methadone—all of which generally represent prescription opioids—decreased between 2018 and 2019, whereas the rate of overdose deaths involving synthetic opioids other than methadone—which generally represent illicit opioids—continued to increase.[63] However, the role of prescription opioids is still likely to be important. Examining how different types of injuries lead to opioid use and misuse, and risk for opioid use disorder using longitudinal data and quasi-experimental methods would provide insight into causal connections and more specific points for intervention.

These findings point to the need to focus on ways to reduce the relatively greater use of opioids to treat pain associated with injuries that occur at work. The most fundamental approach is simply doing more to prevent work injuries and sources of pain, including workers who have already been injured. Beyond that, there is a need to continue the development and promotion of alternative methods of pain management that are less likely to lead to misuse and overdose. There are also additional work-specific steps that can help and need more study. For example, there is a need to examine the extent to which access to paid sick leave could decrease the need for prescription opioids as a form of pain management. More broadly, the National Institute for Occupational Safety and Health has initiated a program to study and promote the development of workplace-supported recovery approaches. These approaches also include increasing employee awareness of opioid use disorders; reducing stigma; providing access to medication-assisted treatment and counseling for substance use disorders, as well as peer support and coaching; and providing second-chance employment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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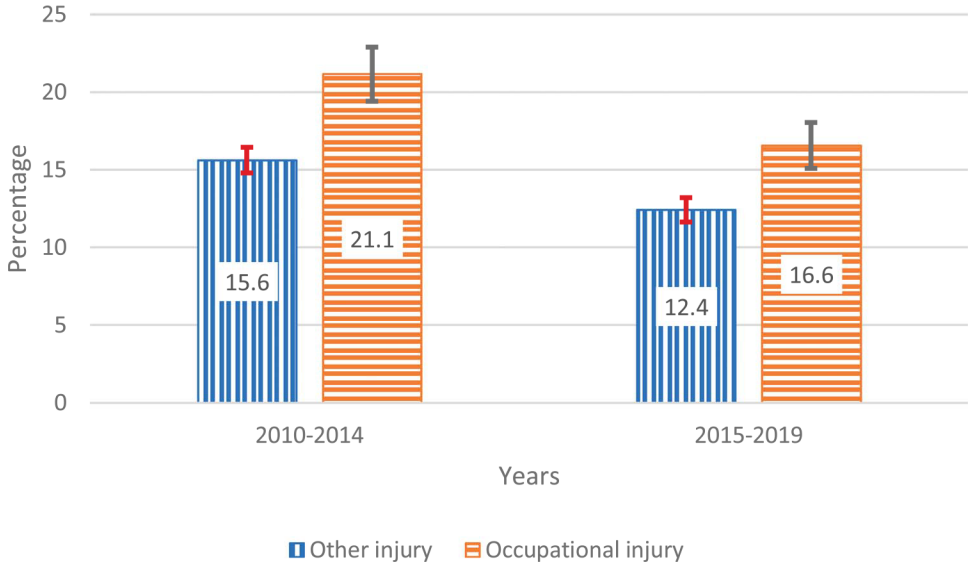

FIGURE 1.
Incidence of opioid prescription (2010–2014 vs 2015–2019) by reported type of injury.

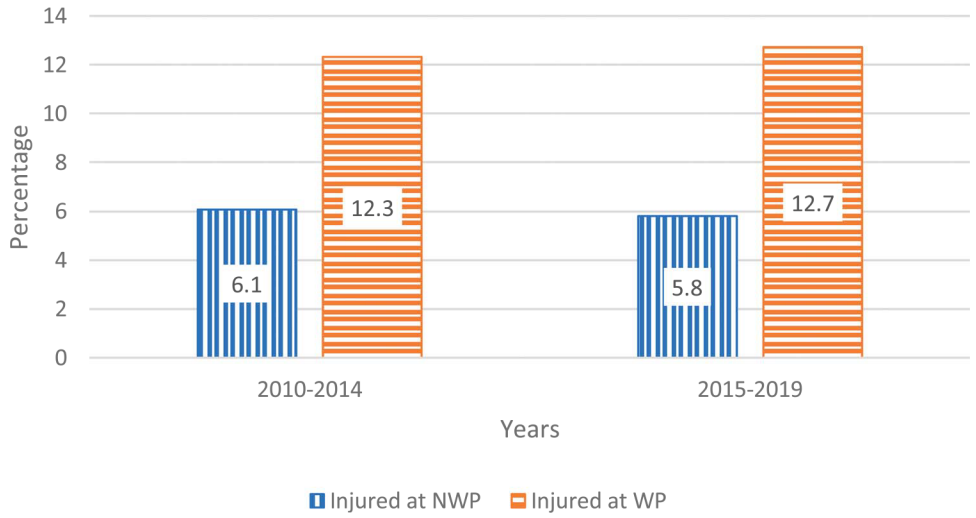

FIGURE 2.
Opioid supply days (2010–2014 vs 2015–2019) by reported type of injury.

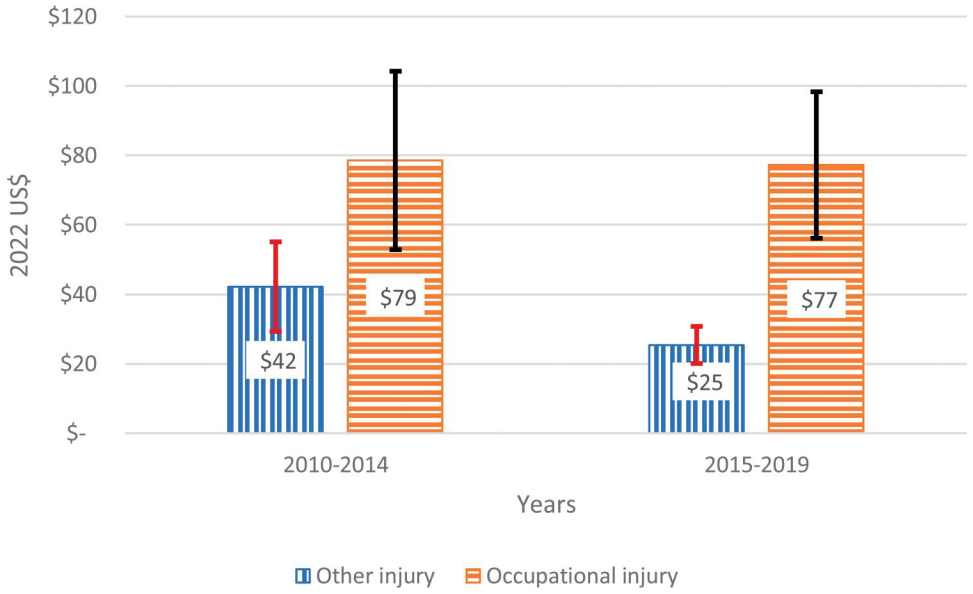

FIGURE 3.
Opioid cost (2010–2014 vs 2015–2019) by reported type of injury (2022 US$).

TABLE 1.

Descriptive Statistics by Reported Type of Injury

Variable	Total	Occupational Injury	Other Injury	*t* Test* (*P* Value)
Number of injured respondents	26,743	5,868	20,875	
Number of injury-caused conditions (observations)	50,250	11,755	38,495	
Weighted number of injury-caused conditions	56,842,461	12,541,344	44,301,117	
Weighted number of injury-caused conditions with opioid prescription	8,585,397	2,374,213	6,211,183	
Percent of injury-caused conditions with opioid prescription	15.1	18.9	14.0	0.001
Weighted number of injury-caused conditions with positive opioid supply days	6,229,576	1,720,793	4,508,783	
Total injury-caused opioid supply days (million)	413	155	258	
Unconditional mean number of days opioids were prescribed	7	12	6	0.001
Conditional mean number of days opioids were prescribed	66	90	57	0.001
Total injury-caused opioid cost, 2020 US$ (million	2,478	978	1,500	
Unconditional mean cost of prescribed opioids, 2020 US$	44	78	34	0.001
Conditional mean cost of prescribed opioids, 2020 US$	289	412	242	0.001
Sex (1 = male), %	48.9	62.4	45.1	0.001
Age category (column sum), %				
18–29	16.3	14.5	16.8	
30–44	22.6	26.4	21.6	
45–64	39.3	49.3	36.5	
65+	21.8	9.8	25.1	
Race and ethnicity (column sum), %				
Hispanic	10.2	14.2	9.1	
Non-Hispanic White (reference category)	73.4	67.4	75.1	
Non-Hispanic Black	9.8	11.3	9.4	
Non-Hispanic other	6.5	7.1	6.4	
Marital status, %				
Married (reference category)	46.5	49.7	45.9	
Widowed	7.8	3.3	9.1	
Divorced	17.1	17.1	16.4	
Separated	2.6	2.5	2.4	

Variable	Total	Occupational Injury	Other Injury	*t* Test* (*P* Value)
Never married	25.8	25.8	26.3	
Education (column sum), %				
Less than high school diploma	12.4	12.6	12.3	
High school diploma	27.4	33.9	25.6	
Some college	30.8	33.0	30.2	
Bachelor's degree or higher (reference category)	29.4	20.5	31.9	
Working during the survey year, %†	61.9	75.4	58.1	
Current smoker, %	34.0	39.0	32.6	
One or more comorbidities, %	85.7	83.4	86.3	
Physical activity, %‡	49.7	50.7	49.3	
Health insurance (column sum), (%)				
Private	66.5	67.8	66.1	
Public	25.5	19.9	27.2	
Uninsured	8.0	12.3	6.8	
Family poverty status (column sum), *%*				
Poor	14.2	12.5	15.16	
Near poor	4.6	5.0	4.5	
Low income	13.9	15.6	13.4	
Middle income	27.9	32.4	26.6	
High income (reference category)	39.4	34.5	40.9	
Region (column sum), %				
Northeast (reference category)	16.6	17.1	16.5	
Midwest	24.7	23.9	24.9	
South	33.0	32.5	33.2	
West	25.7	26.6	25.4	

*We used *t* test to compare the mean number of days opioids were prescribed and the mean cost of opioids between occupational and other-injury-caused conditions.

†Some working respondents reported other injuries.

‡We measured physical activity by the percentage of adults who reported that they spent half an hour or more in moderate or vigorous physical activity at least 3 times a week.

TABLE 2.

Incidence of Opioid Prescription: Logistic Regression With Covariates

Variable	AOR	95% CI
Occupational injury-caused condition	1.33***	1.21–1.46
Sex (reference: female)	1.02	0.94–1.11
Age category (reference: 18–29 yr), yr		
30–44	1.16*	1.01–1.33
45–64	1.22**	1.06–1.40
65+	0.79**	0.66–0.94
Race and ethnicity (reference: non-Hispanic White)		
Hispanic	0.90	0.80–1.00
Non-Hispanic Black	1.04	0.94–1.16
Non-Hispanic other	0.92	0.78–1.08
Marital status (reference: married)		
Widowed	0.92	0.79–1.09
Divorced	1.04	0.93–1.16
Separated	1.05	0.82–1.35
Never married	0.82***	0.73–0.91
Education (reference: bachelor's degree or higher)		
Less than high school diploma	1.64***	1.42–1.91
High school diploma	1.56***	1.38–1.76
Some college	1.40***	1.23–1.58
Working during the survey year (reference: no)	0.83***	0.75–0.92
Current smoker	1.38***	1.25–1.52
One or more comorbidities	1.13*	1.01–1.26
Physically active	0.86***	0.79–0.93
Health insurance (reference: private)		
Public	1.30***	1.17–1.44
Uninsured	0.94	0.81–1.09
Family poverty status (reference: high income)		
Poor	1.09	0.95–1.26
Near poor	1.14	0.95–1.37
Low income	1.07	0.94–1.22
Middle income	1.07	0.96–1.20
Region (reference: Northeast)		
Midwest	1.18*	1.02–1.35
South	1.35***	1.18–1.54
West	1.13	0.98–1.29
Year-fixed effects (reference: 2010)		

Variable	AOR	95% CI
2011	1.09	0.95–1.26
2012	1.03	0.88–1.20
2013	0.84*	0.73–0.98
2014	0.92	0.79–1.07
2015	0.92	0.79–1.07
2016	0.65***	0.56–0.75
2017	0.56***	0.48–0.66
2018	0.65***	0.54–0.77

AOR, adjusted odds ratio; CI, confidence interval.

*$P < 0.10$

**$P < 0.05$

***$P < 0.01$.

TABLE 3.

Marginal[a] (or Incremental) Effects for the Combined Logistic Regression and GLM Parts of the 2-Part Model: Opioid Supply Days

Variable	Opioid Supply Days	95% CI
Occupational injury-caused condition	6.0***	4.4–7.6
Sex (reference: female)	1.0	−0.3 to 2.2
Age category (reference: 18–29 yr), yr		
30–44	3.1***	1.6 to 4.6
45–64	5.1***	3.5 to 6.7
65+	−1.1	−3.0 to 0.7
Race and ethnicity (reference: non-Hispanic White)		
Hispanic	−2.5***	−4.0 to −0.9
Non-Hispanic Black	−2.1***	−3.4 to −0.9
Non-Hispanic other	−1.2	−3.6 to 1.2
Marital status (reference: married)		
Widowed	−0.1	−2.4 to 2.3
Divorced	0.7	−1.0 to 2.5
Separated	−0.2	−2.9 to 2.5
Never married	−2.1***	−3.6 to −0.7
Education (reference: bachelor’s degree or higher)		
Less than high school diploma	3.5***	1.5 to 5.5
High school diploma	3.3***	2.0 to 4.6
Some college	3.4***	2.0 to 4.7
Working during the survey year (reference: no)	−7.5***	−9.0 to −6.0
Current smoker	4.6***	3.1 to 6.2
One or more comorbidities	3.3***	2.0 to 4.6
Physically active	−2.3***	−3.4 to −1.3
Health insurance (reference: private)		
Public	5.6***	3.8 to 7.3
Uninsured	2.1	0.0 to 4.1
Family poverty status (reference: high income)		
Poor	0.2	−1.7 to 2.2
Near poor	1.4	−1.1 to 3.9
Low income	−0.3	−1.9 to 1.3
Middle income	1.4*	−0.1 to 2.8
Region (reference: Northeast)		
Midwest	1.9**	0.3 to 3.5
South	3.5***	1.9 to 5.0

Variable	Opioid Supply Days	95% CI
West	1.8**	0.2 to 3.5
Year-fixed effects (reference: 2010)		
2011	2.9**	0.6 to 5.3
2012	2.0	−0.4 to 4.5
2013	0.4	−1.7 to 2.5
2014	2.7*	0.3 to 5.1
2015	0.3	−1.8 to 2.4
2016	0.4	−1.6 to 2.5
2017	0.3	−1.8 to 2.3
2018	−0.2	−2.4 to 2.1
2019	0.1	−2.5 to 2.7

CI, confidence interval; GLM, generalized linear model.

*$P < 0.10$

**$P < 0.05$

***$P < 0.01$.

[a]Marginal changes (dy/dx) for factor levels is the discrete change from the base level.

TABLE 4.

Marginal[a] (or Incremental) Effects for the Combined Logistic Regression and GLM Parts of the 2-Part Model: Opioid Cost

Variable	Opioid Cost, 2020 US$	95% CI
Occupational injury-caused condition	29***	16 –43
Sex (reference: female)	14**	3 to 26
Age category (reference: 18–29 yr), yr		
30–44	12	−3 to 26
45–64	23**	4 to 42
65+	−9	−29 to 11
Race and ethnicity (reference: non-Hispanic White)		
Hispanic	−24***	−35 to −13
Non-Hispanic Black	−18***	−32 to −5
Non-Hispanic other	−12	−31 to 6
Marital status (reference: married)		
Widowed	−18**	−34 to −2
Divorced	4	−12 to 20
Separated	−17**	−30 to −3
Never married	−3	−18 to 12
Education (reference: bachelor’s degree or higher)		
Less than high school diploma	14*	−1 to 30
High school diploma	19**	4 to 35
Some college	24***	11 to 37
Working during the survey year (reference: no)	−45***	−60 to −30
Current smoker	11*	0 to 23
One or more comorbidities	5	−12 to 21
Physically active	−13**	−23 to −2
Health insurance (reference: private)		
Public	22**	4 to 39
Uninsured	0	−13 to 12
Family poverty status (reference: high income)		
Poor	−2	−18 to 13
Near poor	21	−5 to 48
Low income	5	−9 to 20
Middle income	2	−11 to 15
Region (reference: Northeast)		
Midwest	−18	−39 to 4
South	1	−22 to 24
West	−12	−33 to 9

Variable	Opioid Cost, 2020 US$	95% CI
Year-fixed effects (reference: 2010)		
2011	−3	−28 to 22
2012	0	−29 to 30
2013	−6	−35 to 23
2014	−8	−35 to 18
2015	−14	−37 to 9
2016	−9	−34 to 16
2017	−4	−33 to 25
2018	−17	−44 to 9
2019	−11	−39 to 17

CI, confidence interval; GLM, generalized linear model.

*$P < 0.10$

**$P < 0.05$

***$P < 0.01$.

[a]Marginal changes (dy/dx) for factor levels is the discrete change from the base level.