HHS Public Access

Author manuscript

Am J Ind Med. Author manuscript; available in PMC 2020 September 11.

Published in final edited form as:

Am J Ind Med. 2019 September ; 62(9): 733–741. doi:10.1002/ajim.23021.

Suicide and drug-related mortality following occupational injury

Katie M. Applebaum, ScD[1], **Abay Asfaw, PhD**[2], **Paul K. O'Leary, PhD**[3], **Andrew Busey, BS**[4], **Yorghos Tripodis, PhD**[5], **Leslie I. Boden, PhD**[6]

[1]Department of Environmental and Occupational Health, Milken Institute School of Public Health, George Washington University, Washington, District of Columbia

[2]Economic Research and Support Office, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Washington, District of Columbia

[3]Office of Retirement and Disability Policy, US Social Security Administration, Washington, District of Columbia

[4]Department of Economics, Boston University, Boston, Massachusetts

[5]Department of Biostatistics, Boston University School of Public Health, Boston, Massachusetts

[6]Department of Environmental Health, Boston University School of Public Health, Boston, Massachusetts

Abstract

Correspondence: Leslie I. Boden, PhD, Department of Environmental Health, Boston University School of Public Health, 715 Albany Street, Boston, MA 02118. lboden@bu.edu.

AUTHOR CONTRIBUTIONS

KMA, AA, and YT participated in the (a) analysis and interpretation of data for the work; (b) drafting the work and revising it critically for important intellectual content; (c) final approval of the version to be published; and (d) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

PKO participated in the (a) acquisition, analysis, and interpretation of data for the work; (b) drafting the work and revising it critically for important intellectual content; (c) final approval of the version to be published; and (d) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

LIB participated in the (a) conception or design of the work; (b) acquisition, analysis, and interpretation of data for the work; (c) drafting the work and revising it critically for important intellectual content; (d) final approval of the version to be published; and (e) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

DISCLOSURE BY AJIM EDITOR OF RECORD

John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

INSTITUTION AND ETHICS APPROVAL AND INFORMED CONSENT

The work was performed at Boston University School of Public Health and SSA. Human subjects' institutional review and approval were given by the Boston University Institutional Review Board for protection of human subjects and the National Institute for Occupational Safety and Health Institutional Review Board. Both waived the requirement for informed consent because (a) the research involves no more than minimal risk to the subjects, (b) the waiver will not adversely affect the rights and welfare of the subjects, (c) the research could not practicably be carried out without the waiver or alteration; and (d) whenever appropriate, the subjects will be provided with additional pertinent information after participation.

Publisher's Disclaimer: DISCLAIMERS

Publisher's Disclaimer: The opinions, findings, and conclusions expressed in this article are those of the authors and do not necessarily reflect the opinions of the SSA or the State of New Mexico or the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

Institutions at which the work was performed: Boston University School of Public Health and U.S. Social Security Administration

Background: Drug overdoses and suicides have been rising since 2000 and are major contributors to a 3-year decline in US life expectancy. Studies suggest that injured workers have elevated rates of depression and opioid use, but no studies have measured excess mortality related to these risks.

Materials and methods: We linked New Mexico workers' compensation data for 100 806 workers injured in 1994 through 2000 with Social Security Administration earnings and mortality data through 2013 and National Death Index cause of death data. We then estimated the association between receiving lost-time workers' compensation benefits and mortality hazard ratios (HRs) and 95% confidence intervals (CIs) based on Fine and Gray cause-specific subdistribution hazards for common causes of death and for drug-related, suicide, and alcohol-related mortality.

Results: There was almost a 3-fold increase in combined drug-related and suicide mortality hazard among women (HR = 2.63, 95% CI = 1.91–3.64) and a substantial increase among men (HR = 1.42, 95% CI = 1.13–1.79). Circulatory disease mortality hazard was elevated for men (HR = 1.25, 95% CI = 1.05–1.50).

Conclusion: Workplace injuries severe enough to require more than a week off work may impair workers' long-term health and well-being. Drug-related deaths and suicides may be important contributors to the long-term excess mortality of injured workers. Improved workplace conditions, improved pain treatment, better treatment of substance use disorders, and treatment of postinjury depression may substantially reduce mortality consequent to workplace injuries.

Keywords

disability; mortality; occupational safety and health; opioids; suicide

1 | BACKGROUND

Drug overdoses and suicides have been rising since 2000 and are major public health concerns. Age-adjusted mortality rates in the United States from opioid poisoning in 2015 were about 2.5 times as high as in 2000,[1] and they increased by 13% between 2015 and 2016.[2] Suicide rates in 2016 were 30% higher than in 1999.[3] These causes of death, called "deaths of despair" by Case and Deaton[4] have largely driven the recent 3-year decline in US life expectancy.[5]

Prospective studies have documented that work-related injuries may affect long-term physical and mental health and well-being, including factors associated with mortality. For instance, injuries may lead to decreased physical activity and increased weight gain.[6,7] In addition, workers who suffered injuries may also have enduring disabilities.[8–10] Leigh et al[11] have estimated that 34% of compensated injuries involving more than 1 week off work lead to the payment of permanent disability benefits.

Studies have shown that occupational injuries are associated with acute and chronic pain.[6,12] These injured workers often receive powerful prescription pain medication, including opioids. In one prospective study, 42% of workers with back injuries were prescribed opioids within a year after injury; in addition, approximately 16% of those prescribed

opioids continued taking them for four quarters, with doses increasing substantially over time.[13] Other studies of work-related injuries and opioid prescriptions have reported similar findings.[14–17] As in the general population, opioid prescriptions for injured workers have grown over time.[14]

Depression is among the most well-documented long-term health consequences of workplace injury. In prospective studies, injured workers have been more likely to suffer from depression than uninjured workers.[18–20] Work-related injuries, when compared with injuries outside of work, are more strongly associated with depression.[19,21] The impact on depression from work-related injuries may be due to a combination of the financial burden of the injury, the difficulty involved with pursuing workers' compensation claims, chronic pain, and occupational injuries' typically being more severe and involving longer recovery than nonoccupational injuries.[19,22]

A recent study asked whether nonfatal workplace injuries and illnesses influenced long-term mortality, linking workers' compensation data from New Mexico to Social Security Administration (SSA) and National Death Index (NDI) data on earnings and mortality. In that study, lost-time injuries were associated with over a 20% increase in mortality hazard for both men and women, excluding deaths directly caused by the injury and controlling for industry and preinjury earnings.[23] This finding raised questions about how lost-time injuries may hasten death and if there are specific causes of death that are more likely to be affected. In particular, prior research suggests a focus on mortality related to drug use and depression.[13–21,24] In the present study, we further explore the relationship between occupational injuries and long-term mortality by examining specific causes of death affected by nonfatal workplace injuries. We investigate this using the administrative dataset of workers' compensation claims in New Mexico linked with SSA earnings and mortality data and NDI cause of death data, allowing up to 19.5 years of follow-up.

2 | METHODS

2.1 | Data

2.1.1 | Injured worker population—We have previously described methods of identifying injured workers and assessing mortality follow-up,[23] which we explain here in brief. We obtained injury data from the state of New Mexico Workers' Compensation Administration (WCA), including information on characteristics of the injured worker, the injury and the employer, compensated time lost from work, and benefits paid for injuries occurring between 1994 and 2000 (N = 157 073 injuries). Our exposed group consisted of workers with injuries involving more than 7 calendar days off work or permanent disability benefits ("lost-time" injuries). These workers received benefits to cover medical expenses and replace lost wages. The comparison group was workers who lost 7 or fewer days from work and received only workers' compensation medical benefits ("medical-only" injuries). We restricted our sample to subjects aged 15 to 80 years of age. We included the first lost-time injury but no subsequent injuries, because a first injury may causally affect subsequent injury. This left a sample size of 107 533 workers.

For the analysis, we excluded subjects if they were missing covariate data, affecting 6407 workers missing industry at the time of injury, 68 with unspecified gender, and four with missing information about lost time. The actual analytical timeline began 6 months after each worker's injury, an approach intended to limit the possibility that injury directly resulted in death. As a result, we also excluded 248 workers who did not live until the study baseline. Our sample thus included 100 806 workers, of which 36 034 (35.8%) had lost-time injuries (exposed) and 64 772 (64.2%) had medical-only injuries (comparison).

2.1.2 | Social security earnings data—We linked subjects identified from New Mexico workers' compensation data to Social Security earnings data after validating the New Mexico Social Security Numbers (SSNs) using Social Security's enumeration validation system. We based validation on each worker's SSN, name, date of birth, and sex. We converted preinjury earnings to 2007 dollars using the Southwest Consumer Price Index for All Urban Consumers.

2.1.3 | Follow-up mortality data—We used SSA's Numerical Identification System (NUMIDENT) and Vital Status System to identify 8313 (8%) of our cohort who were classified as "known to be deceased" as of 31 December 2013. We linked a stratified random sample of subjects identified as dead by the SSA to the National Center for Health Statistics' NDI data to verify the vital status and obtain the cause of death. The sampling was necessary since it was cost prohibitive to link all deaths to the NDI. The sample included all women with lost-time injuries (n = 939) and 1200-person random samples each of men with lost-time injuries and women and men in the comparison group. Among these, we verified that 929, 1193, 1190, and 1172, respectively, were deceased. The overall match rate between subjects classified as dead by the SSA and the NDI on vital status was 98.8%. As a check on the accuracy of SSA's death data, we submitted a random sample of 400 subjects classified as living by the SSA and found none were present in the NDI; in a sample of 1000 subjects classified as of unknown vital status by the SSA, 6 (0.6%) were found in the NDI. Where vital status differed between the two sources, we used the NDI vital status. To identify dates and causes of death of injured workers, we used the NDI Plus service, which contained causes according to the International Classification of Disease (ICD)9 and ICD10. The NDI data have information on the underlying cause of death and up to 11 contributing causes of death.

We submitted the SSA vital status sample to the NDI before we dropped observations with missing gender, preinjury earnings, or industry. We then deleted these cases from the sample verified as dead by the NDI, reducing the number of deceased workers with the cause of death information from 4484 to 4247.

We examined four leading causes of mortality based on the following classifications of the underlying cause of death: malignant neoplasms (ICD10: C00–C97; ICD9: 140–209), diseases of the respiratory system (ICD10: J00–J99; ICD9: 460–519), diseases of the circulatory system (ICD10: I00-I99; ICD9: 390–459), and accidents, excluding those associated with drugs or suicide (ICD10: V00–X39, X46–X57; ICD9: E800–E849, E856–E859, E863–E929). As discussed in the Introduction, because previous research reported workplace injury to be associated with the onset of depression and also subsequent use of

prescription medications, we also examined the following selected underlying causes of death: drug-related causes (ICD10: X40–X44, X60–X64, Y10–Y14; ICD9:E850–E855, E9800–E985) and suicide (ICD10: U03, X60-X84, Y87.0, Y10-Y33; ICD9: E950-E959, E9800-E9899). We analyzed alcohol-related deaths that the Centers for Disease Control and Prevention classified as 100% attributable to alcohol (ICD10: X45, Y15, T51.0, T51.1, T51.9, X65, R78.0, F10.0–F10.9, G62.1, G31.2, G72.1, I42.6,K29.2, K70–K70.4, K70.9, Q86.0, P04.3, O35.4, K86.0; ICD9: 980.0, 980.1, E860.0, E860.1, E860.2, E860.9, 790.3, 291, 305.0, 303.0, 303.9, 357.5, 425.5, 535.3, 571.0–571.3, 655.4, 760.71).[25] We included drug-related cases of intentional and undetermined intent in both drug-related and suicide categories.

The Institutional Review Board at Boston University approved this study. It waived informed consent based on the criteria under 45 CFR 46.116(d). We signed confidentiality agreements with the State of New Mexico for use of the workers' compensation data, and the SSA signed a confidentiality agreement with the National Center for Health Statistics for use of the NDI data.

2.2 | Statistical analysis

We generated baseline characteristics for workers who had experienced a lost-time injury and the comparison group of medical-only injuries, separately for women and men. We examined counts and frequencies for age at injury (<25, 25–34, 35–44, 45–54, 55–64, 65–80 years), annual preinjury earnings category (<$10 000, $10 000–$19 999, $20 000–$29 999, $30 000–$39 999, $40 000–$49 999, $50 000+), and industry (agriculture/forestry/fishing, mining/construction, manufacturing, transportation, wholesale/retail trade, finance, insurance, and real estate, services, health, government, law/education/social).

For each subject, we determined the time in follow-up, with her or his start of follow-up beginning 6 months after the date of injury and continuing until the first of date of death or the end of follow-up (31 December 2013), with person-months serving as our unit of analysis. We plotted cumulative incidence functions for time since injury, adjusted for age at injury, industry, and preinjury earnings, to allow comparison of the hazards for lost-time injuries to medical-only injuries. We estimated separate models for hazard ratios (HRs) and 95% confidence intervals (CIs) for the association between lost-time injuries and underlying cause of mortality using competing risks regression, based on the Fine and Gray subdistribution hazard function. This estimates the hazard of an event due to a particular underlying cause after accounting for all previously occurring deaths from all causes.[26] Separate estimates for men and women controlled for age category, earnings category, and industry at baseline, as well as competing risks from death from other causes. For suicide and drug-related deaths, we ran these models both separately and jointly. This was particularly important because it may be difficult to distinguish between accidental drug overdose and suicide. Because we submitted to NDI a stratified random sample of deaths drawn from SSA's NUMIDENT system, we weighted all analyses by inverse sampling probabilities. To compare our results with standard regression measures, we also re-ran models using Cox proportional hazards regression. Finally, for deaths in 1999 or later coded by the ICD10 classification only, we examined drug-related and suicide deaths further with a

preliminary analysis to examine whether the other cause of death codes indicated specific drugs based on T-codes in ICD10 classification. We used Stata 14 for the statistical analysis.

3 | RESULTS

Table 1 presents the baseline characteristics of the study population by sex and injury type. Women comprised 38% of the study population, and more than half of the participants were between the ages of 25 and 44. Workers with lost-time injuries were relatively older (median age was 39 and 35 years for women and men, respectively) than workers with medical-only injuries (median age was 36 for women and 32 years for men). They also tended to have lower earnings and a different distribution by industry than those with medical-only injuries. For example, women in wholesale and retail trade and men in agriculture, forestry, and fishing had a disproportionate number of lost-time injuries compared with medical-only injuries.

Among women, the median follow-up time was 16.0 years (range, 0.1–19.5) among those with lost-time injuries and 16.8 years (range, 0.1–19.5) among those with medical-only injuries. For men, the median follow-up time was 16.0 years (range, 0.1–19.5) for those with lost-time injuries and 16.9 years (range, 0.1–19.5) for those with medical-only injuries.

Table 1 also shows the number of deaths associated with each mortality category, stratified by sex and injury category. For all workers in our sample, cancer was the underlying cause in 22.4% of deaths, with circulatory, respiratory, and accidental causes involved in 22.2%, 8.1%, and 10.0% of deaths, respectively. Drug-related causes were present in 8.1% of deaths and suicide caused 5.8%. About 55% of suicide deaths for women and about 8% of suicide deaths for men also had drugs listed as a cause of death (data not shown); as a combined category, suicide and drug-related deaths comprised 12.9% of deaths. Alcohol-related causes accounted for 4.9% of deaths.

Table 2 presents adjusted estimates for the hazard ratio based on the subdistribution hazard from Fine and Gray competing risks regression models. For the leading causes of death evaluated, hazard ratio estimates for lost-time injuries were elevated compared with medical-only injuries for respiratory disease and alcohol-related mortality for both women and men and for accidents for women, though CIs included the null. For men only, the hazard ratio estimate for the association between lost-time injuries and diseases of the circulatory system was elevated significantly (HR = 1.25, 95% CI = 1.05–1.50).

Experiencing a lost-time injury was associated with a nearly 3-fold increased drug-related mortality hazard compared with medical-only injuries for women (HR = 2.93, 95% CI = 2.04–4.21). The association between lost-time injuries and suicide was elevated for both women and men (women: HR = 1.92, 95% CI = 1.21–3.06; men: HR = 1.72, 95% CI = 1.23–2.40). For mortality from combined drug-related causes and suicides, the association with lost-time injuries remained strong for women and was still evident in men (women: HR = 2.63, 95% CI = 1.91–3.64; men HR = 1.42, 95% CI = 1.13–1.79). We observed similar patterns of direction and magnitude of the association between lost-time injuries and

selected causes of death based on Cox proportional hazards regression models (results not shown).

Cumulative incidence for drug-related and suicide mortality combined, adjusted for age category, earnings category, and industry, is presented in Figures 1 and 2. The cumulative incidence functions are consistently higher for lost-time injuries than for medical-only injuries, and the difference increases with follow-up time.

Table 3 displays a detailed classification of drug-related deaths experienced in our study population. Because there was insufficient specificity in the ICD9 codes, we limit this table to deaths with ICD10 codes (over 95% of drug-related deaths in this cohort). A substantial majority of drug-related deaths were unintentional. Among men, drug-related suicide was much more common for those with lost-time injuries (9.8%) compared with medical-only injuries (3.3%). We determined the proportion of drug overdose cases categorized as opioid-related (ICD10 codes T40.0–T40.4). Overall, in our cohort, opioids caused 57% of drug-related deaths from 1999 through 2013. This number was 61% for lost-time cases and 53% for medical-only cases (Table 3).

4 | DISCUSSION

Lost-time injuries were associated with mortality related to drugs and suicide. Among women, lost-time injuries were associated with a near tripling in the hazard of drug-related deaths and a 92% increase in mortality hazard due to suicide. For men, the lost-time injury was associated with a 72% increased hazard of suicide and a 29% increase in drug-related mortality hazard, although the increase in drug-related mortality was not statistically significant. HRs were elevated for alcohol-related mortality for both men and women but were not statistically significant. For the more common causes of death evaluated, although power was greater, we only observed a statistically significant association between lost-time injuries and elevated mortality rate for circulatory system diseases among men.

Misclassification of drug-related deaths and suicides can occur when coding of causes of death fail to incorporate findings from medical examiners and coroners in addition to limitations in classifying multidrug use on death certificates.[27] With respect to opioid and specific drug types, merely using cause of death information from death certificates is thought to underestimate the number of deaths related to specific drugs.[28] Now that a relationship between injury and drug-related mortality has been identified, future research in this area should employ strategies aimed at more rigorous classification of these deaths, including using electronic coding systems such as the National Center for Health Statistics' Mortality Medical Data System that account for open text entries on death certificates that state more of the circumstances surrounding the death. With respect to the present analysis, it is unclear whether the type of injury would affect the misclassification of the outcome.

In addition to the potential for misclassification, the available data had inherent limitations. The New Mexico WCA data had information on the industry, sex, and age and SSA data contained information on earnings. These can be powerful predictors of mortality, but others were notably missing, including preinjury smoking, alcohol and drug consumption, body

mass index, and underlying diseases. Researchers have reported that both individual health and behavioral as well as work-related factors may influence the risk of occupational injury.[29,30] In order for these unmeasured factors to act as confounders and explain away the observed associations, they would need to precede the initial injury.

Our period of observation was up to 19.5 years, though the mean follow-up was shorter. Including subjects followed for a longer time would allow more time for behavioral and health changes that may take place after the injury to affect the incidence of common chronic diseases, in particular. As mentioned earlier, previous prospective studies in occupational and nonoccupational populations have found that injuries may reduce physical activity and be associated with subsequent weight gain.[7,31] We did still observe modest increases in HRs for chronic diseases, and the increase in mortality for circulatory disease among men was statistically significant. A longer follow-up period would allow additional time for behavior changes to affect the risk of chronic disease.

From 2000 through 2013, opioid-related deaths averaged 57% of all drug-related deaths in New Mexico.[32] In our data, opioid-related deaths were 53% of drug-related deaths for medical-only cases. However, these were 61% of drug-related deaths for lost-time cases (Table 3).

As described earlier, workplace injuries may lead to the use of prescription pain medicines, sometimes for an extended period of time and with the potential for increasing prescribed dose. This may increase the opportunity for misuse of drugs such as opioids and potential for accidental or intentional overdose. Further, the increased risk of suicide following injury, observed for both women and men, highlights the importance of understanding the impact on mental health following workplace injuries. In addition to the potential for long-term disability[8,33,34] and increased risk of reinjury,[34,35] workplace injuries have been found to reduce earnings,[36–38] yet how each of these affects the mental well-being of injured workers is not understood.

Our results may not be generalizable to other states. New Mexico’s population has higher proportions of Hispanics and Native Americans than the United States as a whole, and its average earnings are lower. Opioid overdose death rates from 1999 to 2017 in New Mexico have been higher than for the United States as a whole.[32] Also, because opioid and suicide death rates have been rising since the late 1990s, our estimates, based on injuries occurring from 1994 through 2000, may underestimate the effects of injuries that occurred more recently.

Further studies should see whether these findings can be replicated in other, preferably larger, study populations, more states, with a longer follow-up period, and with access to race/ethnicity and preinjury confounding data. Nonetheless, this study suggests that workplace injuries resulting in more than a week off work may impair workers’ long-term health and well-being. Further, there is a need for more research looking at intermediate factors between injury and mortality, such as unnecessary opioid prescriptions and mental health among injured workers, to reduce long-term adverse outcomes.

5 | CONCLUSIONS

Our findings suggest that work-related injuries may contribute to two alarming public health trends over the past two decades: the rapid growth of deaths from both opioids and suicides. These increases are in the face of declining mortality from most other causes of death.[39,40] Case and Deaton[4] have called these "deaths of despair." Injured workers have been shown to have increased risk of depression, have frequently been treated with opioids, and have suffered long-term earnings losses. As a result, they may be an exemplar of these disturbing trends. Although confounding may account for our findings, we hypothesize that hazardous working conditions are one aspect of the structural causes of high mortality rates from drugs and suicide.

Though not conclusive, our analysis suggests that reducing occupational injury rates may affect subsequent mortality from specific causes. It, therefore, seems prudent that public health policies should focus on both preventing workplace injuries and improving health care for injured workers. Improved pain treatment, better treatment of substance use disorders, and treatment of postinjury depression may substantially improve quality of life and reduce mortality from workplace injuries.

ACKNOWLEDGMENT

We thank the State of New Mexico for its generosity in sharing its workers' compensation data. This study was supported by the National Institute for Occupational Safety and Health, Grant/Award Number: R21OH010555.

REFERENCES

1. Dowell D, Arias E, Kochanek K, et al. Contribution of opioid-involved poisoning to the change in life expectancy in the United States, 2000–2015. JAMA. 2017;318(11):1065–1067. [PubMed: 28975295]
2. Seth P, Scholl L, Rudd RA, Bacon S. Overdose deaths involving opioids, cocaine, and psychostimulants—United States, 2015–2016. Am J Transplant (AJT). 2018;18(6):1556–1568.
3. Hedegaard H, Curtin S, Warner M. Suicide rates in the United States continue to increase. NCHS Data Brief. 2018;309:1–8.
4. Case A, Deaton A. Mortality and morbidity in the 21st century. Brookings Pap Econ Act. 2017;2017:397–476. [PubMed: 29033460]
5. National Center for Health Statistics. Health, United States, 2016, With chartbook on long-term trends in health. Washington, D.C.: Government Printing Office; 2017
6. Strunin L, Boden LI. Family consequences of chronic back pain. Soc Sci Med. 2004;58(7):1385–1393. [PubMed: 14759683]
7. Keeney BJ, Fulton-Kehoe D, Wickizer TM, Turner JA, Chan KCG, Franklin GM. Clinically significant weight gain one year after occupational back injury. J Occup Environ Med. 2013;55(3):318–324. [PubMed: 23247606]
8. O'Leary P, Boden LI, Seabury SA, Ozonoff A, Scherer E. Workplace injuries and the take-up of Social Security disability benefits. Soc Secur Bull. 2012;72(3):1–17.
9. Turner JA, Franklin G, Fulton-Kehoe D, et al. Prediction of chronic disability in work-related musculoskeletal disorders: a prospective, population-based study. BMC Musculoskelet Disord. 2004;5(1):14. [PubMed: 15157280]
10. Spector JT, Turner JA, Fulton-Kehoe D, Franklin G. Pre-surgery disability compensation predicts long-term disability among workers with carpal tunnel syndrome. Am J Ind Med. 2012;55(9):816–832. [PubMed: 22392804]

11. Leigh JP. Economic burden of occupational injury and illness in the United States. Milbank Q. 2011;89(4):728–772. [PubMed: 22188353]
12. Frank JW, Kerr MS, Brooker A-S, et al. Disability resulting from occupational low back pain: part I: what do we know about primary prevention? A review of the scientific evidence on prevention before disability begins. Spine. 1996;21(24):2908–2917. [PubMed: 9112716]
13. Franklin GM, Rahman EA, Turner JA, Daniell WE, Fulton-Kehoe D. Opioid use for chronic low back pain: a prospective, population-based study among injured workers in Washington state, 2002–2005. Clin J Pain. 2009;25(9):743–751. [PubMed: 19851153]
14. Bernacki EJ, Yuspeh L, Lavin R, Tao XG. Increases in the use and cost of opioids to treat acute and chronic pain in injured workers, 1999 to 2009. J Occup Environ Med. 2012;54(2):216–223. [PubMed: 22267188]
15. Cifuentes M, Webster B, Genevay S, Pransky G. The course of opioid prescribing for a new episode of disabling low back pain: opioid features and dose escalation. Pain. 2010;151(1):22–29. [PubMed: 20705393]
16. Dembe A, Wickizer T, Sieck C, Partridge J, Balchick R. Opioid use and dosing in the workers' compensation setting. A comparative review and new data from Ohio. Am J Ind Med. 2012;55(4):313–324. [PubMed: 22068830]
17. Volinn E, Fargo JD, Fine PG. Opioid therapy for nonspecific low back pain and the outcome of chronic work loss. Pain. 2009;142(3):194–201. [PubMed: 19181448]
18. Asfaw A, Souza K. Incidence and cost of depression after occupational injury. J Occup Environ Med. 2012;54(9):1086–1091. [PubMed: 22929794]
19. Kim J Depression as a psychosocial consequence of occupational injury in the US working population: findings from the medical expenditure panel survey. BMC Public Health. 2013;13(1):303. [PubMed: 23560685]
20. Dersh J, Mayer T, Theodore BR, Polatin P, Gatchel RJ. Do psychiatric disorders first appear preinjury or postinjury in chronic disabling occupational spinal disorders? Spine. 2007;32(9):1045–1051. [PubMed: 17450081]
21. Dong XS, Wang X, Largay JA, Sokas R. Long-term health outcomes of work-related injuries among construction workers—findings from the National Longitudinal Survey of Youth. Am J Ind Med. 2015;58(3): 308–318. [PubMed: 25678458]
22. Grant GM, O'Donnell ML, Spittal MJ, Creamer M, Studdert DM. Relationship between stressfulness of claiming for injury compensation and long-term recovery: a prospective cohort study. JAMA Psychiatry. 2014;71(4):446–453. [PubMed: 24522841]
23. Boden LI, O'Leary PK, Applebaum KM, Tripodis Y. The impact of nonfatal workplace injuries and illnesses on mortality. Am J Ind Med. 2016;59(12):1061–1069. [PubMed: 27427538]
24. O'Hara NN, Pollak AN, Welsh CJ, et al. Factors associated with persistent opioid use among injured workers' compensation claimants. JAMA Network Open. 2018;1(6):e184050–e184050. [PubMed: 30646268]
25. Centers for Disease Control and Prevention. Alcohol and Public Health: Alcohol-Related Disease Impact (ARDI). Alcohol-Related ICD Codes. https://nccd.cdc.gov/DPH_ARDI/Info/ICDCodes.aspx. Accessed 5/1/2019.
26. Fine JP, Gray RJ. A proportional hazards model for the subdistribution of a competing risk. J Am Stat Assoc. 1999;94(446):496–509.
27. Rockett IR, Hobbs G, De Leo D, et al. Suicide and unintentional poisoning mortality trends in the United States, 1987–2006: two unrelated phenomena? BMC Public Health. 2010;10(1):705. [PubMed: 21083903]
28. Slavova S, O'Brien DB, Creppage K, et al. Drug overdose deaths: let's get specific. Public Health Rep. 2015;130(4):339–342. [PubMed: 26345488]
29. Schulte PA, Pandalai S, Wulsin V, Chun H. Interaction of occupational and personal risk factors in workforce health and safety. Am J Public Health. 2012;102(3):434–448. [PubMed: 22021293]
30. Nkyekyer EW, Fulton-Kehoe D, Spector J, Franklin G. Opioid and benzodiazepine use before injury among workers in Washington State, 2012 to 2015. J Occup Environ Med. 2018;60(9):820–826. [PubMed: 29668527]

31. Butowicz CM, Dearth CL, Hendershot BD. Impact of traumatic lower extremity injuries beyond acute care: movement-based considerations for resultant longer term secondary health conditions. Adv Wound Care. 2017;6(8):269–278.
32. Kaiser Family Foundation. Opioid Overdose Death Rates and All Drug Overdose Death Rates per 100,000 Population (Age-Adjusted). https://www.kff.org/other/state-indicator/opioid-overdose-death-rates/?activeTab=graph&currentTimeframe=0&startTimeframe=18&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D. Accessed August 1, 2018.
33. Welch LS, Haile E, Boden LI, Hunting KL. Impact of musculoskeletal and medical conditions on disability retirement—a longitudinal study among construction roofers. Am J Ind Med. 2010;53(6):552–560. [PubMed: 20112256]
34. Galizzi M On the recurrence of occupational injuries and workers' compensation claims. Health Econ. 2013;22(5):582–599. [PubMed: 22539203]
35. Ruseckaite R, Collie A. Repeat workers' compensation claims: risk factors, costs and work disability. BMC Public Health. 2011;11(1):492. [PubMed: 21696637]
36. Seabury SA, Scherer E, O'Leary P, Ozonoff A, Boden L. Using linked federal and state data to study the adequacy of workers' compensation benefits. Am J Ind Med. 2014;57(10):1165–1173. [PubMed: 25223516]
37. Woock C Earnings losses of injured men: reported and unreported injuries. Industrial Relations: A Journal of Economy and Society. 2009; 48(4):610–628.
38. Boden LI, Galizzi M. Income losses of women and men injured at work. J Hum Resour. 2003;38(3):722–757.
39. Case A, Deaton A. Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century. Proc Natl Acad Sci USA. 2015;112(49):15078–15083. [PubMed: 26575631]
40. Bound J, Geronimus AT, Rodriguez JM, Waidmann TA. Measuring recent apparent declines in longevity: the role of increasing educational attainment. Health Aff. 2015;34(12):2167–2173.

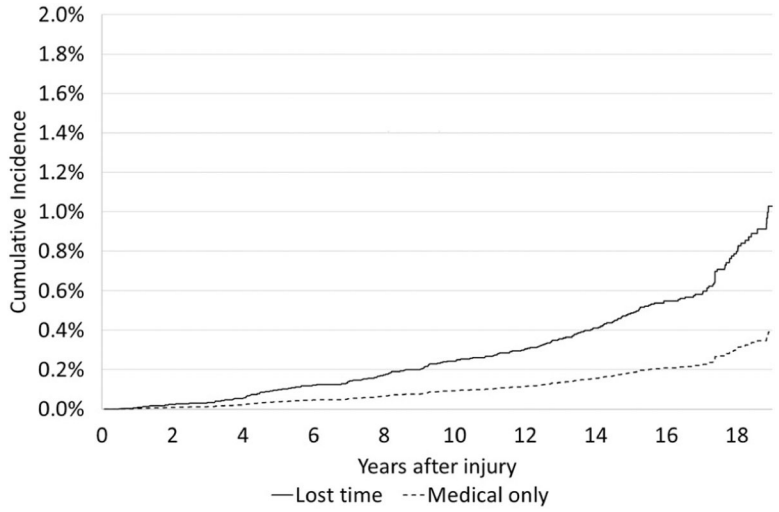

FIGURE 1.

Cumulative incidence of drug-related and suicide deaths through 2013, New Mexico, women with workers' compensation injuries (1994–2000). Note: Fine and Gray competing risks estimates adjusted for age and industry at the time of injury and earnings in the year before injury

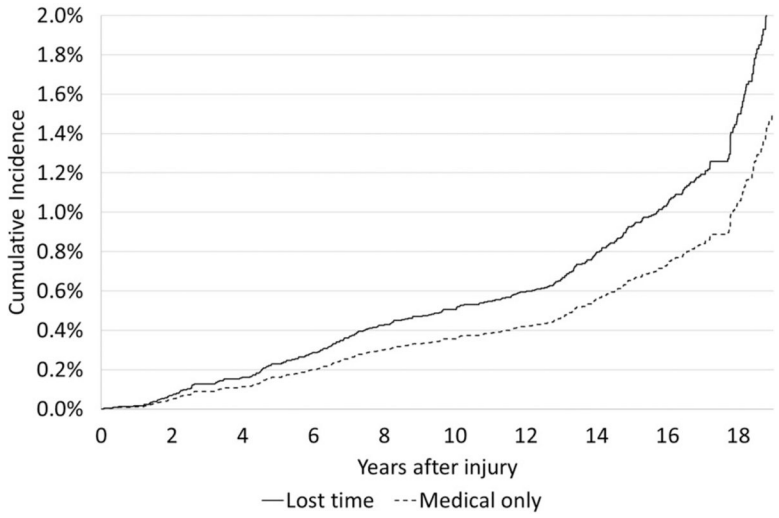

FIGURE 2.

Cumulative incidence of drug-related and suicide deaths through 2013, New Mexico, men with workers' compensation injuries (1994–2000). Fine and Gray competing risks estimates adjusted for age and industry at the time of injury and earnings in the year before injury

Am J Ind Med. Author manuscript; available in PMC 2020 September 11.

TABLE 1

Characteristics of New Mexico workers receiving workers' compensation benefits from 1994 to 2000 and followed through 2013

		Women		Men	
	All injuries N = 100 806	**Lost-time injury N = 12 347**	**Medical-only injury N = 25 982**	**Lost-time injury N = 23 687**	**Medical-only injury N = 38 790**
Baseline characteristics					
Age (y), %					
<25	19.8	12.1	18.9	16.4	24.8
25–34	29.0	24.2	26.6	29.5	31.7
35–44	27.2	31.1	28.1	29.0	24.5
45–54	16.4	21.6	18.7	16.6	13.0
55–64	6.6	9.2	6.7	7.3	5.3
65+	1.0	1.8	0.9	1.2	0.7
Annual preinjury earnings, 2007$, %					
Less than $10 000	27.0	34.2	29.9	24.1	24.4
$10,000–$19 999	25.0	31.9	28.0	23.4	21.8
$20,000–$29 999	20.0	18.3	19.7	21.0	20.0
$30,000–$39 999	12.4	8.2	11.2	13.9	13.6
$40,000–$49 999	7.2	4.0	5.9	8.1	8.5
$50 000+	8.5	3.4	5.4	9.5	11.6
Industry, %					
Agriculture, forestry, & fishing	5.7	1.5	1.4	10.7	7.0
Mining & construction	13.7	2.0	3.2	22.8	18.8
Manufacturing	8.8	6.5	6.7	9.4	10.6
Transportation	7.9	6.3	7.7	10.2	7.3
Wholesale & retail trade	23.4	30.3	23.1	20.2	23.6
Finance, insurance, & real estate	1.9	2.6	3.2	1.4	1.2
Services	11.0	12.0	10.2	10.5	11.4
Health	7.3	16.0	15.0	2.0	2.7
Government	7.3	5.1	7.2	5.9	9.0
Law, education, & social	12.9	17.6	22.6	7.0	8.6
Characteristics at end of follow-up					

		Women		Men	
	All injuries N = 100 806	**Lost-time injury N = 12 347**	**Medical-only injury N = 25 982**	**Lost-time injury N = 23 687**	**Medical-only injury N = 38 790**
Years follow-up, median	16.6	16.0	16.8	16.0	16.9
Total deaths	7755	936	1265	2,601	2,953
Cause-specific deaths, %					
Malignant neoplasm	22.4	27.7	30.0	18.8	20.7
Circulatory disease	22.2	19.3	21.7	23.8	22.0
Respiratory disease	8.1	9.0	15.3	6.8	5.8
Accidents	10.0	5.1	5.8	10.8	12.6
Drug-related causes	8.1	10.5	5.6	7.7	8.7
Suicide	5.8	3.8	3.3	7.1	6.4
Drug-related causes or suicide[a]	12.9	11.9	7.2	13.9	14.8
Alcohol-related causes	4.9	2.8	2.5	6.0	5.7

Note: All numbers in this table except the cause-specific deaths describe the study population before linking to the NDI and are unweighted.

We determined specific causes of death based on the underlying cause of death, and these numbers are weighted to account for sampling. Accidents do not include suicides or drug or alcohol overdoses. We converted preinjury earnings to 2007 dollars using the Southwest Consumer Price Index for all urban consumers. Comparison of characteristics for lost-time vs medical-only injury for women and men separately indicated all comparisons had $P < .01$.

[a]The number of deaths for drug-related and suicide combined does not equal the sum of the number for each because we included drug-related cases with undetermined intent in both categories.

TABLE 2

Association between the lost-time injury in New Mexico 1994 to 2000 and cause-specific mortality through 2013

	Women				Men			
Cause of death	**Lost-time N = 12 347 Percent of subjects**	**Medical-only N = 25 982 Percent of subjects**	**HR**	**95% CI**	**Lost-time N = 23 687 Percent of subjects**	**Medical-only N = 38 790 Percent of subjects**	**HR**	**95% CI**
Malignant neoplasm	2.14	1.51	1.12	0.95–1.32	2.08	1.59	1.02	0.84–1.23
Circulatory system	1.46	1.06	1.07	0.87–1.30	2.61	1.67	1.25	1.05–1.50
Respiratory disease	0.68	0.40	1.23	0.90–1.67	0.75	0.44	1.32	0.94–1.86
Accidents	0.39	0.28	1.32	0.89–1.97	1.18	0.96	1.21	0.93–1.56
Drug-related	0.79	0.27	2.93	2.04–4.21	0.84	0.66	1.29	0.95–1.76
Suicide	0.29	0.16	1.92	1.21–3.06	0.78	0.48	1.72	1.23–2.40
Drug-related or suicide[a]	0.90	0.35	2.63	1.91–3.64	1.52	1.12	1.42	1.13–1.79
Alcohol-related causes	0.21	0.12	1.62	0.92–2.83	0.65	0.43	1.39	0.98–1.96

Note: Hazard ratio estimates are based on subdistribution hazards estimated with Fine & Gray competing risks regression models, adjusting for age and industry at the time of injury and earnings in the year before the injury, and accounting for competing risks of all other causes combined. We identified specific causes of death based on the underlying cause of death. Percentages are the percent of all subjects in the column who died from the specific cause by the end of the observation period. All observations except for the Ns are weighted to account for the sampling of death cases before submission to the NDI.

Abbreviations: CI, confidence interval; HR, hazard ratio; NDI, National Death Index.

[a]The percentage for drug-related and suicide mortality combined does not equal the sum of the percentages for each because we included drug-related cases with undetermined intent in both categories.

TABLE 3

Drug-related deaths through 2013 using ICD10, New Mexico workers receiving worker's compensation benefits 1994 to 2000

	Women		Men		Total	
	Lost-time N = 91	**Medical-only N = 61**	**Lost-time N = 90**	**Medical-only N = 80**	**Lost-time N = 181**	**Medical-only N = 141**
Cause of death[a]						
Unintentional %	75.5	69.9	87.0	91.3	83.2	86.6
Suicide %	17.4	22.7	9.8	3.3	12.3	7.5
Homicide %	0.0	0.0	0.0	0.0	0.0	0.0
Undetermined intent %	6.1	6.4	1.1	0.0	2.8	1.8
Type of opioid indicated[b]						
Opium %	0.0	0.0	0.0	0.0	0.0	0.0
Heroin %	3.1	4.9	8.7	14.2	6.9	12.2
Natural and semisynthetic opioids %	37.6	30.6	46.7	28.5	43.7	29.0
Methadone %	10.2	8.1	8.7	14.4	9.2	13.1
Synthetic opioids other than methadone %	10.2	4.9	7.6	3.3	8.5	3.6
Total opioid-related mortality %	56.0	43.6	63.1	56.2	60.8	53.4

Note: Percentages are of total drug-related mortality in each column. Percentages in this table are all weighted to reflect sampling; Ns are unweighted NDI deaths.

Abbreviations: ICD, International Classification of Disease; NDI, National Death Index.

[a]ICD10 codes are: unintentional, X40–X44; suicide, X60–X64; homicide, X85; undetermined intent, Y10–Y14. T-codes for specific opioids are: opium, T40.0; heroin, T40.1; natural and semisynthetic opioids, T40.2; methadone, T40.3; synthetic opioids other than methadone, T40.4. Categories of types of drug-related mortality will not sum to total because some were not specified.

[b]Total opioid-related mortality is less than the sum of categories because more than one drug can be indicated on the death certificate.