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RESEARCH ARTICLE

# Uninvestigated fatal workplace injuries in the United States

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## Abstract

**Background:** Approximately 5000 people are killed by an injury at work every year, but the U.S. Occupational Safety and Health Administration (OSHA) only investigates 25%–35% of these deaths. The aim of this study was to identify industry, geographic, and worker demographic disparities in the proportion of fatal workplace injuries that are investigated by OSHA.

**Methods:** This cross-sectional analysis drew from 2 years of public data (2014–2015) from the Census of Fatal Occupational Injuries and investigation data from OSHA. Differences by worker age and sex, geographic region, industry, and State Plan- versus Federal Plan-state were examined.

**Results:** Nationally, OSHA investigated about one in four (27.5%) of the 9657 fatal workplace injuries that occurred. Higher odds of uninvestigated fatalities were observed for female workers compared to male workers (odds ratio, 2.35; 95% confidence interval, 1.89, 2.93), for workers over age 65 compared to those aged 18–24 (3.05; 2.44, 3.82), for worker deaths occurring in State Plan states compared to Federal Plan states (1.64; 1.49, 1.79), among other differences.

**Conclusions:** Although some of the disparities could be explained by OSHA jurisdiction restrictions, other areas of potential reform were identified, such as investigating a greater number of workplace violence deaths and increasing focus in industries with a low proportion of investigations but a high number of fatalities, such as transportation and warehousing. Consideration should be given to adapt policies, expand OSHA jurisdiction, and to increase OSHA resources for conducting both fatality investigations and proactive investigations that can identify and abate hazards before a worker is injured.

KEYWORDS
health disparities, health policy, workplace fatalities

## 1 | INTRODUCTION

### 1.1 | Fatal occupational injuries in the United States

In 2015, 4836 men, women, and children died from a fatal injury at work in the United States (U.S.), averaging 13 deaths per day.[1] Fortunately the number of US workers who die from a fatal injury has fallen dramatically over the last century: the rate of fatal workplace injuries declined approximately 94% over the course of the 20th century.[2] This decline can be primarily attributed to a decrease in employment in hazardous industries such as agriculture and mining, increased effort and advocacy for safer workplaces from both workers and management, and an increase in occupational health and safety oversight and regulation nationally.[2] Despite significant advances in reducing the number of fatal occupational

  

injuries, U.S. workers still experience greater risk than workers in many other high-income nations. The U.S. fatal occupational injury rate for 2015 (4.8 per 100,000 workers) was double that of Spain's (2.3 per 100,000 workers) and six times higher than the United Kingdom's (0.8 per 100,000 workers).[1,3]

## 1.2 | Surveillance and investigation of fatal occupational injuries

### 1.2.1 | Bureau of Labor Statistics surveillance

Currently, the Bureau of Labor Statistics (BLS) in the U.S. Department of Labor conducts national surveillance of fatal occupational injuries in the Census of Fatal Occupational Injuries (CFOI).[4] The agency works with partner organizations in individual states to identify and document fatal occupational injuries.[5] Fatal occupational injuries are identified through source documents collected through both federal- and state-level agreements with other governmental agencies. Such source documents may include death certificates, workers' compensation records, medical examiner reports, media articles, OSHA investigation documents, police reports, among others. The CFOI is considered to be comprehensive.

### 1.2.2 | OSHA investigations

The U.S. Occupational Health and Safety Administration (OSHA) investigates a minority of fatal injuries that occur in the workplace. Approximately one-fourth to one-third of all fatal workplace injuries that occur each year in the United States are investigated by local investigators and reported to the federal OSHA office.[4,6] Three primary reasons why OSHA does not investigate the remaining fatal injuries are special issues, jurisdiction restrictions, and practical limitations (such as a limited number of investigators). Special issues include fatalities that occur at work but are due to natural causes (such as heart attacks), and those that involve workplace violence, although the local area OSHA director can use their discretion and may choose to investigate.[7] OSHA cannot investigate fatalities that occur on public roadways unless it occurred in a construction work zone.[7] They also cannot investigate deaths in federal, state, or local government agencies, unless the death occurs in a state with an OSHA State Plan. Deaths in home-based businesses, on agricultural operations with 10 or fewer employees, and those occurring in mining or quarrying operations are also outside of OSHA's jurisdiction.

Certain practical limitations exist as well. Human resource constraints within OSHA offices, as well as employer reporting issues, may also limit their ability to investigate fatalities when it falls within their jurisdiction and is not a special case. An audit report by the Office of Inspector General in the U.S. Department of Labor found that not all employers reported fatalities and severe injuries as required by law to Federal Plan OSHA offices and that some OSHA offices relied on employers to conduct their own investigations in some cases of severe injury.[8] They found that OSHA had reports of 4185 fatalities from employers from January 2015 through April 2017, but CFOI data report that over 10,000 fatalities occurred in 2015 and 2016 alone.[9] This finding was troubling given that all employers in the United States are required to report a fatal injury to OSHA, even if they fall outside of OSHA's jurisdiction. The report documented staff training issues, lack of human resources, and lack of protocol adherence as negatively affecting how OSHA investigated fatalities and severe injuries.

Lastly, although not a restriction, OSHA's emphasis programs ensure that some industries and occupations are given greater priority for investigations. There are both national and regional emphasis programs, and they "are temporary programs that focus OSHA's resources on particular hazards and high-hazard industries."[10] Industries like shipbreaking, construction, manufacturing, and others are part of OSHA emphasis programs.

### 1.2.3 | Federal versus State OSHA plans

As of 2020, there were 28 states that were "State Plan" states, whereas the remaining states are "Federal Plan" (see Figure 1).[11] State Plan states have OSHA offices that are run and administered by the state-level authorities, and these states must provide the same basic protections and functions as the Federal Plan states, but they can choose to add protections and regulations or expand their jurisdiction. State Plan states also will investigate fatalities that occur in local or state government workplaces, whereas Federal Plan states do not. Twenty-two State plans cover both private-sector workplaces and state and local government workplaces, and the remaining six cover only state and local government workplaces.

### 1.2.4 | Objectives

The primary aim of this study was to examine if differences in fatal workplace injury death investigations exist by OSHA's jurisdiction restrictions. We also sought to examine regional and industry differences and differences by victim demographics in the percentage of fatal injuries that are investigated by OSHA. We hypothesized that significant regional and industry differences would be present and that State Plan states would have a higher proportion of fatalities investigated by OSHA. To date, no peer-reviewed literature has been published on this topic.

## 2 | METHODS

To accomplish our objectives, we conducted a cross-sectional study in which we examined fatalities captured in CFOI from 2014 to 2015 and determined the percent that was investigated by OSHA in the same time period, stratified out by industry, geographic, and demographic characteristics.

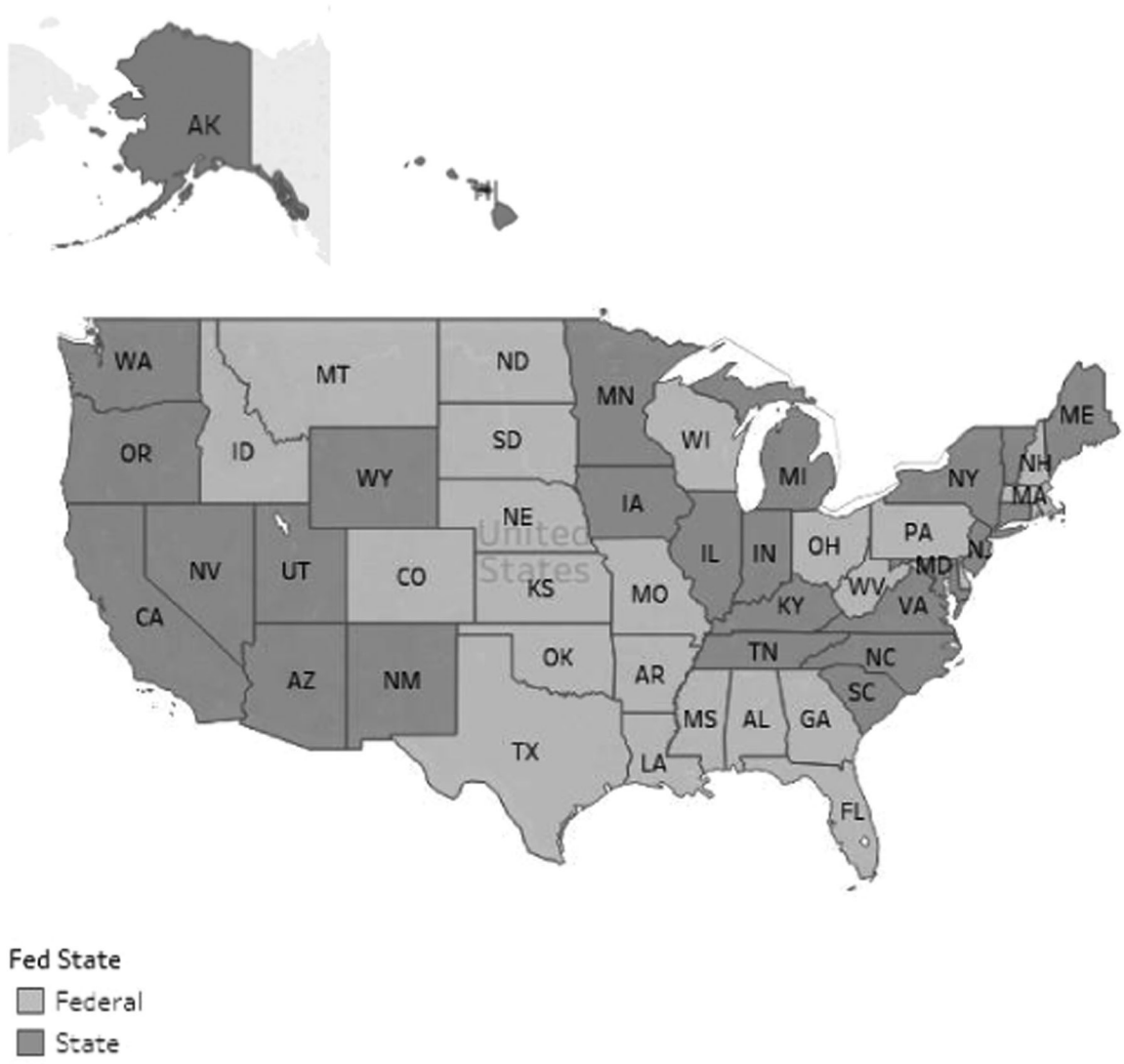


**FIGURE 1** Map of Federal Occupational Safety and Health Administration (OSHA) Plans and State OSHA Plans

Aggregated CFOI data are available publicly from the BLS, which we abstracted from the U.S. Department of Labor website.[9] We used the online query system (https://www.bls.gov/data/) to calculate the number of fatal injuries by sex, age, industry, the state where the fatality occurred, and injury event or exposure for 2014 and 2015.[12] Industry was defined using the two-digit codes from the North American Industrial Classification System. Using the information on the number of fatalities by state, we calculated the number of fatal injury deaths by 2010 U.S. Census regions (West, Midwest, Northeast, South)[13] and by OSHA Region (I–X).[14] Whereas Puerto Rico, Guam, and the U.S. Virgin Islands collect fatality data and submit it to the BLS for the CFOI, U.S. territories are not included in the CFOI data release to the public[15]; therefore, they were excluded from the study.

OSHA data were obtained as individual records for all 50 states during the calendar years of 2014 and 2015 through multiple Freedom of Information Act requests. Both Federal plan data (included fatalities from all Federal plan states, as well as fatalities investigated by federal OSHA offices in states with a State Plan) and State Plan data (fatalities investigated by State Plan offices) were obtained and merged. During that time period, 28 states were State-Plan OSHA states. OSHA data included the same variables described above for CFOI including sex, age, industry, and U.S. state, except for the event or exposure that led to the injury. OSHA reported injury information as the cause of the injury (i.e., shock, caught in/between, struck by, etc.) and the nature of the injury (i.e., cut or laceration, asphyxia, or fracture), whereas public CFOI data categorize information about the injury as the event/exposure (i.e., transportation incidents, fires, and explosions, etc.). On the basis of the OSHA data available to the researchers, it was not possible to create a comparable event/exposure category with OSHA data for direct comparison to CFOI data.

## 2.1 | Data analysis

Descriptive statistics were calculated for purposes of describing the frequency of fatal occupational injuries across worker demographic,

industry, and geographic differences. For purposes of examining the proportion of fatalities that were investigated within a group, we conducted within-group frequencies and proportions (e.g., proportion of female worker deaths that were investigated). We then calculated unadjusted odds ratios (ORs) and 95% confidence intervals (CI) for comparisons between major groups (e.g., males vs. females). For each category, the group with the highest proportion of deaths investigated by OSHA was selected as the reference group, and uninvestigated deaths were treated as the exposed group.

To identify plausible explanations as to why OSHA may investigate substantially more or fewer deaths in the industry, age group, or sex category, we examined the injury events/exposures in those categories as reported by CFOI. Injury event/exposure was selected as this may provide insight into why a death was not investigated because of jurisdiction restrictions (as in the case of deaths that occur on public roadways) or special cases (such as deaths due to violence). Cross-tabulations of the number and proportion of deaths due to the various injury events/exposures were calculated by major industry groups, by worker age group, and by worker sex. All data analyses were conducted using Stata version 15.[16]

As these data were limited to publicly available data and FOIA data from OSHA on deceased persons, IRB approval was not necessary for this study.

## 3 | RESULTS

### 3.1 | CFOI/OSHA comparison

Nationally, OSHA investigated a little more than one in four fatal workplace injuries. During 2014–2015, a total of 9657 fatal workplace injuries occurred, and OSHA investigated 2652 (27.5%) of them (Table 1). OSHA investigated a much lower proportion of fatal injuries that occurred among female workers (14.5%) compared to male workers (28.4%). Female worker deaths had 2.35 (95% CI, 1.89, 2.93) times higher odds of being uninvestigated by OSHA compared to male worker deaths. Workers at or over the age of 65 had the lowest proportion of fatalities investigated by OSHA, with just 14.2% of deaths investigated while workers aged 18–24 years had the highest proportion (33.5%). Of the 46 child worker fatalities that occurred, 21.7% ($n = 10$) were investigated by OSHA.

States with State OSHA Plans had a substantially higher odds of fatalities being uninvestigated compared to states with Federal OSHA Plans (OR, 1.64; 95% CI, 1.49, 1.79). On the basis of the U.S. Census regions, the Midwest had the lowest proportion of fatalities investigated (22.4%) and the West had the highest (32.3%). All other regions (Midwest, South, Northeast) had significantly higher odds of uninvestigated fatalities compared to the West census region (reference group), with the Midwest region experiencing the greatest disparity (OR, 1.65; 95% CI, 1.44, 1.90). Relatively small but statistically significant differences by the OSHA region were observed. Region IX (Arizona, California, Hawaii, Nevada) had the highest proportion of investigations (38.1%) and was selected as the reference group. The largest disparity in investigations was observed in Region VII (Iowa, Kansas, Missouri, Nebraska), which had 2.32 (95% CI, 1.83, 2.96) times the odds of uninvestigated fatalities and Region VIII (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming), which had 2.19 (95% CI, 1.71, 2.82) times the odds of uninvestigated fatalities compared to Region IX.

The proportions of fatalities investigated by industry showed wide differences. Utilities had the highest proportion of fatalities investigated (87.2%) but only had a total of 39 fatalities, so construction, which had the second-highest proportion (52.1%) was selected as the reference group. The lowest proportions of fatal workplace injuries that were investigated by OSHA were in public administration (7.4%), transportation and warehousing (12.3%), leisure and hospitality (14.7%), and education and health care services (15.4%). The low proportion of investigated fatalities in public administration and transportation and warehousing may be largely explained by limitations on the jurisdictions of OSHA.[7] Public administration (OR, 13.60; 95% CI, 10.37, 18.02) and transportation and warehousing (OR, 7.71; 95% CI 6.43, 9.25) had the highest odds of uninvestigated fatalities compared to construction. The leisure and hospitality industry also had significantly higher odds of uninvestigated fatalities (OR, 6.28; 95% CI, 4.73, 8.43) compared to construction, and no clear jurisdiction restriction explains this disparity.

### 3.2 | Injury events/exposures by subgroups

The injury event/exposure by industry according to CFOI data differed substantially (see Table 2). Transportation-related incidents were higher in industries with lower proportions of OSHA investigations. Over half (58.5%) of fatal injuries in trade, transportation, and utilities were transportation-related. Education and health services also had a higher proportion of deaths related to transportation (48.9%) as compared to all industries (41.8%), whereas construction had the lowest proportion (25.6%). Deaths due to violence, which may be considered a special case by OSHA represented 15.2% of deaths in all industries. The highest proportions of deaths due to violence were in the leisure and hospitality industry (38.8%), other services (25.8%), and in education and health services (22.7%).

#### 3.2.1 | Older workers

Older workers aged 65 years and older had the lowest proportion of fatalities investigated compared to other age groups. Per the CFOI data, the highest proportions of fatalities among this group occurred in agriculture, forestry, fishing, and hunting (26.6%), transportation and warehousing (13.9%), and construction (12.4%) (data not shown). Older worker deaths were concentrated in the agriculture, forestry, fishing, and hunting industry, as this age group represented nearly a third (30.8%) of all fatal injury deaths in the industry. The injury event/exposure for workers in this age group (see Table 3) were

**TABLE 1** Within-group assessment of percent of fatal workplace injuries investigated by OSHA, 2014–2015

| Characteristic (*n* = total number of fatalities) | Fatal injuries reported by CFOI (*n* = 9657) | Proportion of CFOI reported fatal injuries investigated by OSHA (*n* = 2652; 27.5%) | Odds of OSHA not investigating fatality, OR (95% CI) |
|---|---|---|---|
| Sex of worker[a] | | | |
| Male (ref) | 8946 | 2544 (28.4) | Reference group |
| Female | 711 | 103 (14.5) | 2.35 (1.89, 2.93) |
| Age of worker, years[a] | | | |
| Under 18 | 46 | 10 (21.7) | 1.18 (0.86, 4.17) |
| 18–24 (ref) | 713 | 239 (33.5) | Reference group |
| 25–44 | 3235 | 1030 (31.8) | 1.07 (0.91, 1.29) |
| 45–64 | 4329 | 1166 (26.9) | 1.37 (1.15, 1.63) |
| 65 or more | 1334 | 189 (14.2) | 3.05 (2.44, 3.82) |
| OSHA plan type[b] | | | |
| Federal (ref) | 4867 | 1572 (32.3) | Reference group |
| State | 4783 | 1080 (22.6) | 1.64 (1.49, 1.79) |
| US Region[c] | | | |
| West (ref) | 1885 | 609 (32.3) | Reference group |
| Midwest | 2331 | 523 (22.4) | 1.65 (1.44, 1.90) |
| Northeast | 1320 | 378 (28.6) | 1.19 (1.02, 1.39) |
| South | 4114 | 1142 (27.8) | 1.24 (1.10, 1.40) |
| Major industry group | | | |
| Construction (23) | 1836 | 956 (52.1) | Reference group |
| Agriculture, forestry, fishing (11) | 1154 | 201 (17.4) | 5.15 (4.30, 6.18) |
| Mining, oil, and gas (21) | 303 | 71 (23.4) | 3.55 (2.66, 4.77) |
| Utilities (22) | 39 | 34 (87.2) | 0.16 (0.05, 0.41) |
| Manufacturing (31–33) | 702 | 364 (51.9) | 1.0 (0.84, 1.21) |
| Wholesale and retail trade (42, 44–45) | 907 | 191 (21.1) | 4.07 (3.37, 4.92) |
| Transportation and warehousing (48–49) | 1531 | 189 (12.3) | 7.71 (6.43, 9.25) |
| Professional and scientific services (51, 53–56) | 1179 | 400 (33.9) | 2.12 (1.81, 2.47) |
| Educational and health services (61–62) | 285 | 44 (15.4) | 5.95 (4.24, 8.51) |
| Leisure and hospitality (71–72) | 441 | 65 (14.7) | 6.28 (4.73, 8.42) |
| Other services (81) | 388 | 71 (18.3) | 4.85 (3.67, 6.46) |
| Public administration (92) | 892 | 66 (7.4) | 13.60 (10.37, 18.02) |
| OSHA Region[d] | | | |
| I | 307 | 88 (28.7) | 1.53 (1.15, 2.04) |
| II | 661 | 211 (31.9) | 1.31 (1.06, 1.62) |
| III | 829 | 220 (26.5) | 1.70 (1.39, 2.09) |
| IV | 2017 | 535 (26.5) | 1.70 (1.44, 2.00) |
| V | 1584 | 371 (23.4) | 2.01 (1.69, 2.39) |
| VI | 1708 | 489 (28.6) | 1.53 (1.30, 1.81) |
| VII | 612 | 128 (20.9) | 2.32 (1.83, 2.96) |
| VIII | 525 | 115 (21.9) | 2.19 (1.71, 2.82) |
| IX | 1022 | 389 (38.1) | Reference group |
| X | 385 | 106 (27.5) | 1.62 (1.25, 2.12) |

Abbreviations: CFOI, Census of Fatal Occupational Injuries; CI, confidence interval; OR, odds ratio; OSHA, Occupational Safety and Health Administration.

[a]Five OSHA deaths did not have sex recorded and 18 OSHA deaths did not have the age of the worker recorded.

[b]Federal Plan States: ID, MT, CO, ND, SD, NE, KS, OK, TX, MO, AR, LA, WI, MS, AL, GA, FL, OH, WV, DC, DE, PA, RI, MA, NH. State Plan States: AK, WA, OR, CA, HI, NV, UT, AZ, NM, WY, MN, IA, IL, IN, TN, MI, KY, SC, NC, VA, MD, NJ, CT, NY, ME, VT, VI.

[c]On the basis of U.S. Census Regions. West: WA, OR, CA, AZ, NM, CO, UT, NV, ID, MT, WY, AK, HI. Midwest: ND, SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, OH. Northeast: ME, NH, VT, NY, PA, NJ, RI, CT, MA South: DE, MD, DC, WV, VA, NC, SC, GA, FL, AL, MS, TN, KY, AR, LA, TX, OK.

[d]OSHA Regions: I: VT, NH, ME, MA, RT, CT. II: NY, NJ. III: PA, WV, VA, DE, DC, MD. IV: KY, TN, MS, AL, GA, FL, SC, NC. V: MN, WI, IL, IN, OH, MI. VI: AR, LA, OK, TX, NM. VII: NE, KS, IA, MO. VIII: CO, UT, WY, MT, ND, SD. IX: AZ, NV, CA, HI. X: AK, WA, OR, ID.

**TABLE 2** Injury event/exposure by private sector industry from the Census of Fatal Occupational Injuries (CFOI) 2014–2015 ($n = 8765$)

| Injury event/exposure | Natural resources and mining, *n* (%) | Construction, *n* (%) | Manufacturing, *n* (%) | Trade, transportation, and utilities, *n* (%) | Professional and scientific services, *n* (%) | Education and health services, *n* (%) | Leisure and hospitality, *n* (%) | Other services, *n* (%) |
|---|---|---|---|---|---|---|---|---|
| Violence and other injuries caused by persons or animals | 87 (6.0) | 78 (4.3) | 78 (11.1) | 451 (18.2) | 216 (18.4) | 64 (22.7) | 171 (38.8) | 100 (25.8) |
| Transportation incidents | 701 (47.8) | 470 (25.6) | 181 (25.9) | 1450 (58.5) | 406 (34.6) | 138 (48.9) | 136 (30.8) | 108 (27.9) |
| Fires and explosions | 54 (3.7) | 31 (1.7) | 42 (6.0) | 47 (1.9) | 7 (0.6) | – | 13 (2.9) | 26 (6.7) |
| Falls, slips, trips | 105 (7.2) | 723 (39.3) | 112 (16.0) | 192 (7.7) | 258 (22.0) | 39 (13.8) | 55 (12.5) | 48 (12.4) |
| Exposure to harmful environments or substances | 73 (5.0) | 260 (14.2) | 84 (12.0) | 116 (4.7) | 119 (10.2) | 37 (13.1) | 44 (10.0) | 36 (9.3) |
| Contact with objects or equipment | 432 (29.4) | 273 (14.9) | 203 (29.0) | 215 (8.7) | 166 (14.2) | 4 (1.4) | 22 (5.0) | 69 (17.8) |
| Overexertion | 16 (1.1) | 1 (0.05) | – | 7 (0.3) | – | – | – | – |

*Note:* Dashes in cells indicate that the data were suppressed in the CFOI.

primarily due to transportation incidents (43.5%) and falls, slips, and trips (26.0%).

### 3.2.2 | Younger workers

Relatively few workers under the age of 18 were killed at work ($n = 46$), but any number of deaths in this very young and vulnerable age group merits special consideration. Twelve of these deaths did not have an industry recorded, but among the 34 cases with a known industry, 85.3% occurred in the agriculture, forestry, fishing, and hunting industry (data not shown). This may partially explain the limited number of investigations in this age group as OSHA cannot investigate if the business had 10 or fewer employees, although it was not possible to determine which cases occurred with employers who had 10 or fewer employees. Most injury events/exposures for this age group (see Table 3) were due to transportation incidents (76.7%) and contact with objects or equipment (14.0%).

### 3.2.3 | Female workers

Workplace deaths among female workers were largely concentrated in the education and health services industry and the professional services industry (data not shown). Deaths among women in these two industries represented nearly a third (30.6%) of all women killed at work (data not shown). Just 4.8% of female worker fatalities occurred in the public sector. Women had a substantially higher proportion of deaths caused by violence compared to men (27.3% compared to 14.3%, respectively), but other causes of death were similar to or lower in proportion compared to men (see Table 3). Overall, transportation-related incidents were the largest proportion of injury events/exposures (41.7%), but this did not differ substantially from men.

## 4 | DISCUSSION

The large decline in workplace fatalities in the last century is attributed to a number of factors, including changes in industry mix and associated hazards, improvements in medical care, increased unionization, and better transportation safety, but workplace safety research and regulations have also been acknowledged as an important factor in the decline. Coal mine fatal injury rates declined by 50% in the 5 years following the passage of the Federal Coal Mine Health and Safety Act in 1969.[2] Similar declines were observed in other industries in the years following the passage of the Occupational Health and Safety Act in 1970. However, during the past two decades the number of fatal injuries has remained relatively steady, and both the rate and number of fatal injuries has been rising since 2013.[4] During 2014–2015, OSHA investigated just 27.5% of all fatal injuries that occurred on the U.S. worksites, so nearly three out of four fatal injuries had no investigation to determine if workplace

**TABLE 3** Injury event/exposure by age group and sex from the Census of Fatal Occupational Injury (CFOI), 2014–2015 ($n = 8765$)

| Injury event/exposure | Under 18 years ($n = 43$), $n$ (%) | 18–24 years ($n = 703$), $n$ (%) | 25–44 years ($n = 3180$), $n$ (%) | 45–64 years ($n = 4325$), $N$ (%) | 65+ years ($n = 1330$), $n$ (%) | Male workers ($n = 8941$), $n$ (%) | Female workers ($n = 710$), $n$ (%) |
|---|---|---|---|---|---|---|---|
| Violence and other injuries caused by persons or animals | 2 (4.7) | 128 (18.2) | 593 (18.6) | 618 (14.3) | 126 (9.5) | 1274 (14.3) | 194 (27.3) |
| Transportation incidents | 33 (76.7) | 325 (46.2) | 1277 (40.2) | 1825 (42.2) | 579 (43.5) | 3742 (41.9) | 296 (41.7) |
| Fires and explosions | 1 (2.3) | 13 (1.8) | 101 (3.2) | 101 (2.3) | 31 (2.3) | 244 (2.7) | 14 (2.0) |
| Falls, slips, trips | – | 61 (8.8) | 418 (13.1) | 793 (18.3) | 346 (26.0) | 1518 (17.0) | 100 (14.1) |
| Exposure to harmful environments or substances | 1 (2.3) | 78 (11.1) | 334 (10.5) | 311 (7.2) | 39 (2.9) | 759 (8.5) | 55 (7.7) |
| Contact with objects or equipment | 6 (14.0) | 98 (13.9) | 457 (14.4) | 666 (15.4) | 209 (15.7) | 1389 (15.5) | 48 (6.8) |
| Overexertion | – | – | – | 5(0.2) | – | 15 (0.2) | 3 (0.4) |

*Note:* Dashes in cells indicate that the data were suppressed in the CFOI.

safety standards were violated. According to the OSHA Manual of Field Operations, "all fatalities and catastrophes will be thoroughly investigated in an attempt to determine the cause of the event."[17] Though OSHA cannot investigate fatalities outside of its jurisdiction, it is extremely unlikely that nearly three-fourths of workplace deaths are outside of OSHA jurisdiction. The limited resources and restricted jurisdiction of OSHA may be contributing to increased workplace hazards for certain groups of U.S. workers. Few Americans would consider it acceptable for police to conduct an investigation of just a fourth of homicides or traffic deaths that occur each year. The association between the increased number of workplace fatalities and decreased enforcement actions has been documented through extensive research undertaken by the National Employment Law Project, which has found declining numbers of OSHA inspectors and enforcement activities since 2016.[18]

Contrary to our hypothesis, State Plan states did not have a greater proportion of fatalities investigated by OSHA, even though they have increased jurisdiction compared to Federal Plan states. State Plan states had significantly higher odds of uninvestigated fatalities (OR, 1.64; 95% CI, 1.49, 1.79) compared to Federal Plan states. This is a concerning finding given that State Plan states should theoretically investigate a greater proportion as they are able to investigate public sector deaths. Significant differences were also observed by Census and OSHA region, findings which were also not anticipated by the authors. Further research into why such geographic disparities were observed, in conjunction with regional and local OSHA offices, could potentially resolve this question.

As anticipated, differences in investigations between industries were highly varied. The services sector generally had much lower proportions of investigated fatalities compared to the goods-producing sectors of mining, construction, and manufacturing (Agriculture, forestry, fishing, and hunting was the only goods-producing sector that had a lower proportion of investigated fatalities than the all-industry proportion). More than half of fatalities in construction and manufacturing were investigated by OSHA in 2014–2015, a positive finding gave the high number of fatalities that occur in these industries every year. However, less than one in five fatalities were investigated in the transportation and warehousing, education and health services, and leisure and hospitality industries. These findings are concerning, especially in light of the current pandemic, as the majority of workers in the sectors with the lowest proportions of investigated fatalities have now been categorized as "critical infrastructure workers," or essential workers, and face additional hazards because of COVID-19.[19] Though jurisdiction restrictions and the low-hazard nature of some of these industries historically have translated into a more limited OSHA presence, it is becoming increasingly critical that OSHA inspectors visit these worksites as workers become hospitalized or die from COVID-19 infections. Workplace health and safety researchers, advocates, and policymakers need to more closely examine OSHA presence in health care workplaces, warehouses, farms, and in foodservice locations using current data as workers experience greater risk to their health and safety due to exposure to COVID-19.

Important but unexpected findings were the significant differences by sex and age of workers in the proportion of fatalities that were investigated. For female workers, industry differences and the corresponding OSHA jurisdiction restrictions did not appear to be a cause of the higher odds of uninvestigated fatalities, as deaths among female workers were largely concentrated in the private sector service industries of education, health care, and leisure and hospitality, where no OSHA jurisdiction restrictions apply as they would for mining or the public sector. Female workers did have a higher proportion of deaths due to violence compared to male workers (27.3% vs. 14.3%, respectively), and this could be a potential factor in the investigation disparity.

The low proportion of investigated fatalities among child workers does appear to be largely due to OSHA jurisdiction restrictions. Deaths among child workers were largely concentrated in the agriculture, forestry, fishing, and hunting industry (85.3%), where OSHA has limited reach. Although not unexpected, this finding highlights how current policy may restrict OSHA from investigating dangerous

work conditions for America's youngest workers. The potential causes of the low investigation proportion (14.2%) for workers 65 years of age and older are less clear. These workers did not have a disproportionately high burden of transportation-related deaths or public sector deaths. More than one in four (26.6%) of deaths in this age group occurred in the agriculture, forestry, fishing, and hunting industry, which could be a factor in the low investigation proportion but cannot be the only factor. As fatality investigations are discretionary, some offices may view older worker deaths as more likely to be attributed to natural causes or as less preventable and may instead choose to focus limited resources on the deaths of younger adult workers or on deaths that occurred due to more obvious hazards, rather than those that could possibly be attributed to personal health conditions.

Violence was the third leading injury event/exposure for fatal workplace injuries in 2014–2015. Industries with a higher proportion of deaths due to violence, including leisure and hospitality, other industries, and education and health care, had lower proportions of investigations. Women also disproportionately suffered from deaths due to violence and had a significantly lower proportion of investigated deaths compared to male workers. An analysis of workplace homicides among women in the United States from 2003 to 2008 found that 39% of cases were due to criminal intent (i.e., the employee was shot during a robbery) and 33% were due to violence perpetrated by a personal relation.[20] Research regarding violence in the workplace has found that the rate of violent incidents increased from 2012 to 2015.[21] As violent incidents increase in the workplace, policymakers should consider urging OSHA to issue a standard related to protecting workers from violence and removing the status of a special case for violence events/exposures in fatality investigations.

OSHA's greatest power when conducting fatality investigations is likely not in the administration of penalties, which tend to be quite low in comparison to other costs, such as litigation or increased workers' compensation premiums, associated with a fatality.[22] Instead, an OSHA presence on the worksite may have the greatest impact by helping to identify and abate significant hazards, educate workers and managers regarding workplace safety, and empower workers to take action when they identify unsafe working conditions on their own. Clear OSHA standards on workplace hazards, along with support from OSHA to implement those standards and the timely enforcement of them, may also help reduce fatalities.[23] Currently, there are only 752 federal OSHA inspectors nationally, an average of 15 per state. Clearly OSHA cannot conduct a much greater number of fatality investigations even if their jurisdiction were expanded due to the limited human resources available, and fatality investigations should displace other OSHA activities.[24] Increased OSHA resources to conduct investigations, train and educate workers and employers, and improve workplace safety culture in cooperation with everyone on the worksite could be beneficial in combating the upward trend of workplace fatality rates that the US is currently facing. After 50 years of existence, it may also be time to re-evaluate OSHA's limitations and jurisdiction restrictions and consider if policies need to be changed and adapted to help mitigate the high numbers of uninvestigated fatalities in growing industries such as transportation and warehousing.

This study has multiple limitations. This study was meant as a precursory examination of possible issues in fatality investigations, and areas where increased policy support and human resources for OSHA may be needed. Further research could seek to gain access to CFOI microdata, which would enable researchers to conduct regression analyses and could adjust for multiple covariates at once to more closely examine associative relationships with the odds of a fatality being uninvestigated by OSHA. We could not determine exactly which fatalities reported in CFOI would fall under OSHA jurisdiction and which would not. This information would have been insightful and could help identify areas where OSHA may have jurisdiction but lack the resources to conduct investigations on all fatalities.

Further research into why disparities were observed in certain regions and industries, and among female workers and older workers, could help identify if OSHA investigators could increase fatality investigations in those areas or if they are prevented from doing so due to jurisdiction restrictions. Evaluative research on the impact of OSHA in industries where the proportion of investigations are high, like construction and manufacturing, would also be helpful, and findings on beneficial activities could be applied to other industries and worker groups. Once high-impact activities have been identified, increased funding for such activities in OSHA would help ensure timely and effective implementation.

## 5 | CONCLUSION

Despite a stated protocol to investigate all workplace fatalities within their jurisdiction, OSHA was only able to investigate 27.5% of fatalities that occurred between 2014 and 2015, and disparities in investigation rates by industry, geographic region, worker age, and worker sex were significant. In many states, such as New York, West Virginia, Wyoming, and Nebraska, the rate of fatal occupational injuries exceeds the homicide mortality rate.[25,26] Dangerous workplaces are a threat to human life in many settings, and serious consideration should be given to reconsidering OSHA policies and jurisdiction restrictions, and to increasing OSHA resources and capacity for conducting fatality investigations as well as for proactive investigations that can identify and abate hazards before a worker is injured.

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### CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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## AUTHOR CONTRIBUTIONS

Bethany Boggess conceived the project, obtained the data, and led the data analysis and writing of the manuscript. Lisa Pompeii assisted in writing, and supervised the project.

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