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RESEARCH ARTICLE

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# Fatal work-related falls in the United States, 2003-2014

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**Background:** Falls are the second leading cause of work-related fatalities among US workers. We describe fatal work-related falls from 2003 to 2014, including demographic, work, and injury event characteristics, and changes in rates over time.

**Methods:** We identified fatal falls from the Bureau of Labor Statistics (BLS), Census of Fatal Occupational Injuries and estimated rates using the BLS Current Population Survey.

**Results:** From 2003 to 2014, there were 8880 fatal work-related falls, at an annual rate of 5.5 per million FTE. Rates increased with age. Occupations with the highest rates included construction/extraction (42.2 per million FTE) and installation/maintenance/repair (12.5 per million FTE). Falls to a lower level represented the majority ($n$ = 7521, 85%) compared to falls on the same level ($n$ = 1128, 13%).

**Conclusions:** Falls are a persistent source of work-related fatalities. Fall prevention should continue to focus on regulation adherence, Prevention through Design, improving fall protection, training, fostering partnerships, and increasing communication.

KEYWORDS
falls, fatalities, occupational Injury

## 1 | INTRODUCTION

Historically, falls have been a leading cause of work-related injury and fatality.[1–3] Falls continue to result in a substantial proportion of lost workday injuries and fatalities among all workers.[4,5] In 2014, falls became the second highest cause of both work-related nonfatal injury and fatality in the United States, resulting in over 300 000 non-fatal injuries[5] and 818 traumatic deaths.[6] In 2007 and 2008, falls were identified as the leading cause of work-related traumatic brain injuries (TBIs), surpassing TBIs caused by motor-vehicle related events and violent acts.[7] Fatal work-related falls typically involve men, construction workers,[8,9] and older workers.[10,11] Certain work-related activities are well-established hazards for fall injuries, most notably working at heights on ladders,[12] roofs and scaffolds,[13,14] and working in areas with slippery surfaces.[15–17] Specific hazards and fall characteristics are more common among certain worker groups, such as falls on the same level among healthcare workers,[18] falls from roofs among residential construction workers,[13] falls overboard from commercial fishing vessels,[19] falls during tree care operations,[20] or falls among older workers.[11]

For decades, fall prevention efforts have originated from multiple sources: regulation and policy, academic research, and labor and industry groups. The Occupational Safety and Health Administration (OSHA) requires all general industry employers to protect workers from fall hazards under 29 CFR 1910.[21] At a minimum, all states must follow these requirements, which include providing protection against falls from heights and falls into machinery at any height.[22] The National Institute for Occupational Safety and Health (NIOSH) has several programs aimed at preventing fatalities, including the Fatality Assessment and Control Evaluation (FACE) Program. FACE conducts

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investigations to identify risk factors associated with work-related fatalities including those due to falls. NIOSH and participating states create public reports from these investigations which include key recommendations to prevent similar fatalities,[23] particularly in construction.[24] Other fall prevention programs have evolved into sophisticated approaches such as social marketing to reach targeted worker populations,[25] ladder safety applications for smartphones,[26] assessing slippery conditions to choose the best flooring or footwear,[27,28] and focusing on green energy construction and maintenance (which may pose new fall risks or prevention opportunities).[29]

There is still much translational research needed to disseminate effective fall prevention strategies to workers at increased risk.[30,31] Despite established and innovative efforts, falls continue to represent a large proportion of work-related fatal injuries. Although several publications have described the burden of fall injuries among construction workers, there have been no recent descriptive studies of fatal work-related falls nationally, to understand the current burden. The purpose of this study was to describe fatal work-related falls from 2003 to 2014 and to examine differences among worker groups and fall events. Using national level data on fatal work-related falls, our objective was to identify differences in fatality rates across worker demographics, occupation and industry groups, and describe changes in fall injury rates over time.

## 2 | METHODS

### 2.1 | Data sources

We analyzed fatal work-related falls from 2003 to 2014 from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) with restricted-access BLS datasets that are provided to the NIOSH Division of Safety Research under a memorandum of understanding. The views expressed here do not necessarily reflect the views of the BLS. The BLS has collected the CFOI annually to characterize all fatal work-related traumatic injuries in the United States since 1992. To identify and confirm fatalities, BLS uses multiple federal, state, and local sources such as death certificates, police reports, and workers' compensation reports, as well as publicly available news sources and obituaries. For a death to be recorded as "work-related" the decedent must have been employed at the time of the incident, working as a volunteer in the same capacity as a paid employee, or present at a site as a job requirement.[32] CFOI includes all public and private sector workers regardless of age, but excludes fatalities occurring during a normal commute and deaths related to occupational diseases (eg, lung disease).

BLS developed the Occupational Injury and Illness Classification System (OIICS) in 1992 and revised it in 2010. BLS uses this system to classify fatalities from CFOI by four separate hierarchical category structures: event or exposure, nature, body part injured, and primary and secondary injury source. Each structure uses a four digit coding scheme that increases detail with each digit. The BLS OIICS defines event or exposure as "the manner in which the injury or illness was produced or inflicted by the source of injury or illness." Nature of injury as the "principal physical characteristic(s) of the injury or illness" and the body part as that which "is directly affected by the nature of injury or illness." Primary and secondary sources are the "objects, substances, equipment, and other factors that were responsible for the injury or illness incurred by the worker or that precipitated the event or exposure."[33]

### 2.2 | Outcomes of interest

Fatal falls for 2003 through 2014 were classified into three major injury event categories consistently across both versions of OIICS used in CFOI: falls to a lower level, falls to the same level, and all other falls.[33,34] From 2003 to 2010, falls were identified as cases with a one-digit event code of "1," based on OIICS version 1.0.[34] Falls to a lower level were identified as "11," falls on the same level as "13" and other falls as "10 fall, unspecified," "12 jump to a lower level," or "19 fall, not elsewhere classified (n.e.c.)." From 2011 to 2014, falls were identified as cases with a one-digit code of "4," based on OIICS version 2.0.[33] Falls to a lower level were identified as "43," falls on the same level as "42" and other falls as "40 fall, slip, or trip, unspecified," "41 slip or trip without a fall," "44 jumps to lower level," "45 fall or jump curtailed by personal fall arrest system," or "49 fall, slip, trip, n.e.c."[33] For this study, we analyzed data for all falls, falls to a lower level, and falls on the same level separately. "Other falls" were included in the "all falls category" but a separate analysis was not conducted since the category includes nonspecific fall events. "Slips or trips without a fall" were re-categorized from "215" within the "Bodily Reaction and Exertion" category in 2010 and moved under "Falls, slips, trips" beginning in 2011. Fatalities due to slips or trips without a fall represented less than 0.5% of fatal falls in any year. For both versions of OIICS, jumps are reported as part of the "other" category. Of note, falls involving moving vehicles are not included in this analysis because they are categorized as Transportation Accidents (OIICS v1.0) and Transportation Incidents (OIICS v2.0).

### 2.3 | Covariates of interest

After selecting cases for inclusion, we examined the following variables: OIICS codes for nature of injury, body part injured, and primary and secondary sources. We also included sex, age, race/ethnicity, nativity, Bureau of Census (BOC) region, industry, and occupation. Exact age at death was categorized into six approximate 10-year age groupings (Table 1), and separately categorized into three major groups (<45, 45-54, ≥55 years). Race/ethnicity was categorized into white (non-Hispanic), black (non-Hispanic), and Hispanic of any race. In order to assure confidentiality, we did not include other race groups. Nativity was categorized into a dichotomous variable of either foreign born or US born (including US territories, such as Puerto Rico, Guam, and the Virgin Islands). BOC region included four major US regions: Northeast, Midwest, South, and West.[35] For occupation, data were coded according to the 2000 Standard Occupational Classification System (SOC) for 2003-2010, and the 2010 SOC was used for

**TABLE 1** Unadjusted and adjusted poisson regression rate-ratio (RR) estimates of fatal work-related fall injuries (*N* = 8880)—United States, 2003-2014, census of fatal occupational injuries

| | All falls (*N* = 8880)[a,b] | | | | | | | Falls to a lower level (*N* = 7521)[c] | | | | | | | Falls on the same level (*N* = 1128)[d] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) |
| Sex | | | | | | | | | | | | | | | | | | | | | |
| Men | 8336 | 8.8 | (8.4, 9.2) | **11.9** | **(9.9, 14.2)[g]** | **4.3** | **(3.9, 4.8)** | 7,290 | 7.8 | (7.4, 8.2) | **24.6** | **(18.5, 32.6)** | **7.2** | **(6.1, 8.5)** | 840 | 0.9 | (0.8, 1.1) | **2.2** | **(1.7, 2.7)** | **1.8** | **(1.6, 2.1)** |
| Women | 544 | 0.7 | (0.6, 0.9) | 1.0 | Ref | 1.0 | Ref | 231 | 0.3 | (0.2, 0.4) | 1.0 | Ref | 1.0 | Ref | 288 | 0.4 | (0.4, 0.5) | 1.0 | Ref | 1.0 | Ref |
| Age groups | | | | | | | | | | | | | | | | | | | | | |
| 16-24 | 510 | 2.8 | (2.4, 3.4) | 0.7 | (0.6, 0.9) | 0.6 | (0.6, 0.7) | 491 | 2.7 | (2.3, 3.3) | 0.8 | (0.6, 0.9) | 0.7 | (0.6, 0.8) | —[h] | — | — | — | — | — | — |
| 25-34 | 1123 | 3.1 | (2.7, 3.4) | 0.8 | (0.7, 0.9) | 0.7 | (0.6, 0.8) | 1,054 | 2.9 | (2.5, 3.2) | 0.8 | (0.7, 0.9) | 0.7 | (0.6, 0.8) | 54 | 0.1 | (0.1, 0.2) | 0.5 | (0.4, 0.8) | 0.5 | (0.4, 0.7) |
| 35-44 | 1572 | 4.0 | (3.6, 4.4) | 1.0 | Ref | 1.0 | Ref | 1,419 | 3.6 | (3.3, 4.0) | 1.0 | Ref | 1.0 | Ref | 112 | 0.3 | (0.2, 0.3) | 1.0 | Ref | 1.0 | Ref |
| 45-54 | 2322 | 5.7 | (5.3, 6.2) | **1.4** | **(1.3, 1.6)** | **1.6** | **(1.5, 1.7)** | 2,045 | 5.1 | (4.6, 5.5) | **1.4** | **(1.2, 1.6)** | **1.6** | **(1.5, 1.8)** | 224 | 0.5 | (0.5, 0.6) | **1.9** | **(1.5, 2.5)** | **1.9** | **(1.5, 2.4)** |
| 55-64 | 1913 | 7.9 | (7.2, 8.6) | **2.0** | **(1.7, 2.3)** | **2.6** | **(2.4, 2.8)** | 1,561 | 6.5 | (5.8, 7.1) | **1.8** | **(1.6, 2.1)** | **2.4** | **(2.2, 2.7)** | 300 | 1.2 | (1.1, 1.4) | **4.5** | **(3.6, 5.7)** | **4.5** | **(3.6, 5.6)** |
| 65+ | 1432 | 24.6 | (22.2, 27.2) | **6.2** | **(5.4, 7.1)** | **8.5** | **(7.9, 9.2)** | 943 | 16.4 | (14.4, 18.6) | **4.5** | **(3.8, 5.4)** | **6.7** | **(6.0, 7.4)** | 424 | 7.1 | (6.5, 7.9) | **26.7** | **(21.3, 33.4)** | **24.9** | **(20.1, 30.9)** |
| Race/ethnicity | | | | | | | | | | | | | | | | | | | | | |
| White, non-Hispanic | 6049 | 5.3 | (5.0, 5.6) | 1.0 | Ref | 1.0 | Ref | 5,005 | 4.4 | (4.1, 4.7) | 1.0 | Ref | 1.0 | Ref | 871 | 0.8 | (0.7, 0.9) | 1.0 | Ref | 1.0 | Ref |
| Black, non-Hispanic | 536 | 3.0 | (2.5, 3.7) | 0.6 | (0.5, 0.7) | 0.7 | (0.7, 0.8) | 407 | 2.3 | (1.8, 2.9) | 0.5 | (0.4, 0.7) | 0.7 | (0.6, 0.8) | 102 | 0.6 | (0.4, 0.9) | 0.8 | (0.5, 1.1) | 0.9 | (0.8, 1.2) |
| Hispanic, all races | 1986 | 8.6 | (7.7, 9.5) | **1.6** | **(1.4, 1.8)** | **1.2** | **(1.1, 1.3)** | 1,855 | 8.1 | (7.2, 9.0) | **1.8** | **(1.6, 2.1)** | **1.2** | **(1.1, 1.3)** | 111 | 0.5 | (0.3, 0.7) | 0.6 | (0.4, 0.9) | 1.0 | (0.8, 1.2) |
| Nativity status | | | | | | | | | | | | | | | | | | | | | |
| US-Born | 6846 | 4.9 | (4.7, 5.2) | 1.0 | Ref | 1.0 | Ref | 5,634 | 4.1 | (3.9, 4.3) | 1.0 | Ref | 1.0 | Ref | 1,010 | 0.8 | (0.7, 0.9) | 1.0 | Ref | 1.0 | Ref |
| Foreign-Born | 2034 | 7.4 | (6.7, 8.1) | **1.5** | **(1.3, 1.7)** | **1.1** | **(1.0, 1.2)** | 1,887 | 6.9 | (6.2, 7.6) | **1.7** | **(1.5, 1.9)** | **1.2** | **(1.1, 1.3)** | 118 | 0.4 | (0.3, 0.6) | 0.6 | (0.4, 0.8) | 0.6 | (0.5, 0.8) |
| Bureau of census region | | | | | | | | | | | | | | | | | | | | | |
| West | 1796 | 4.8 | (4.3, 5.3) | 1.0 | Ref | 1.0 | Ref | 1,491 | 4.0 | (3.5, 4.5) | 1.0 | Ref | 1.0 | Ref | 244 | 0.7 | (0.5, 0.9) | 1.0 | Ref | 1.0 | Ref |

(Continues)

**TABLE 1** (Continued)

| | All falls ($N = 8880$)[a,b] | | | | | | | Falls to a lower level ($N = 7521$)[c] | | | | | | | Falls on the same level ($N = 1128$)[d] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) |
| Northeast | 1466 | 4.8 | (4.3, 5.4) | 1.0 | (0.9, 1.2) | **1.1** | **(1.0, 1.2)** | 1,235 | 4.1 | (3.6, 4.7) | 1.0 | (0.9, 1.2) | **1.2** | **(1.1, 1.3)** | 192 | 0.7 | (0.5, 0.8) | 1.0 | (0.7, 1.3) | 0.9 | (0.7, 1.1) |
| Midwest | 2007 | 5.4 | (4.9, 6.0) | 1.1 | (1.0, 1.3) | **1.3** | **(1.2, 1.4)** | 1,653 | 4.5 | (4.0, 5.0) | 1.1 | (1.0, 1.3) | **1.4** | **(1.2, 1.5)** | 310 | 0.9 | (0.8, 1.1) | **1.4** | **(1.0, 1.8)** | 1.2 | (1.0, 1.4) |
| South | 3606 | 5.9 | (5.5, 6.4) | **1.2** | **(1.1, 1.4)** | **1.3** | **(1.2, 1.3)** | 3,139 | 5.2 | (4.8, 5.6) | **1.3** | **(1.1, 1.5)** | **1.3** | **(1.2, 1.4)** | 382 | 0.7 | (0.5, 0.8) | 1.0 | (0.7, 1.3) | 0.9 | (0.7, 1.0) |
| Occupation | | | | | | | | | | | | | | | | | | | | | |
| Construction & extraction | 4029 | 42.2 | (39.7, 44.7) | **17.9** | **(15.2, 21.0)** | **8.4** | **(7.5, 9.4)** | 3,906 | 40.9 | (38.4, 43.6) | **23.3** | **(19.2, 28.2)** | **9.2** | **(8.0, 10.5)** | 68 | 0.8 | (0.5, 1.1) | 1.5 | (0.9, 2.3) | **2.3** | **(1.6, 3.5)** |
| Service | 1176 | 4.4 | (4.0, 5.0) | **1.9** | **(1.6, 2.3)** | **4.3** | **(3.8, 4.8)** | 904 | 3.5 | (3.0, 4.0) | **2.0** | **(1.6, 2.5)** | **4.9** | **(4.2, 5.6)** | 243 | 1.0 | (0.8, 1.2) | **2.0** | **(1.4, 2.8)** | **3.0** | **(2.4, 3.8)** |
| Transport & material moving | 864 | 8.4 | (7.4, 9.6) | **3.6** | **(2.9, 4.3)** | **4.1** | **(3.6, 4.6)** | 657 | 6.4 | (5.5, 7.5) | **3.6** | **(2.9, 4.6)** | **4.2** | **(3.6, 4.9)** | 169 | 1.9 | (1.5, 2.4) | **3.6** | **(2.5, 5.1)** | **3.6** | **(2.8, 4.6)** |
| Install, maintain, repair | 798 | 12.5 | (10.9, 14.2) | **5.3** | **(4.3, 6.5)** | **5.5** | **(4.9, 6.2)** | 705 | 11.0 | (9.5, 12.8) | **6.3** | **(5.0, 7.9)** | **6.2** | **(5.4, 7.2)** | 72 | 1.3 | (0.9, 1.8) | **2.4** | **(1.5, 3.6)** | **2.9** | **(1.9, 3.9)** |
| Mgmt, business & finance | 661 | 2.4 | (2.0, 2.7) | 1.0 | Ref | 1.0 | Ref | 489 | 1.8 | (1.5, 2.1) | 1.0 | Ref | 1.0 | Ref | 144 | 0.5 | (0.4, 0.7) | 1.0 | Ref | 1.0 | Ref |
| Professional & related | 374 | 1.0 | (0.8, 1.3) | 0.4 | (0.3, 0.6) | 1.0 | (0.8, 1.1) | 220 | 0.6 | (0.5, 0.8) | 0.4 | (0.3, 0.5) | 0.9 | (0.7, 1.0) | 132 | 0.4 | (0.3, 0.5) | 0.7 | (0.5, 1.0) | 1.0 | (0.8, 1.3) |
| Production | 368 | 3.4 | (2.8, 4.2) | **1.5** | **(1.1, 1.9)** | **2.5** | **(2.1, 2.9)** | 287 | 2.7 | (2.1, 3.4) | **1.5** | **(1.1, 2.0)** | **2.6** | **(2.1, 3.1)** | 70 | 0.7 | (0.5, 1.1) | 1.4 | (0.9, 2.2) | **2.3** | **(1.6, 3.1)** |
| Sales and related | 275 | 1.5 | (1.2, 1.9) | 0.7 | (0.5, 0.9) | 1.0 | (0.9, 1.2) | 144 | 0.8 | (0.6, 1.1) | 0.5 | (0.3, 0.7) | 0.8 | (0.6, 1.0) | 120 | 0.8 | (0.6, 1.1) | **1.5** | **(1.1, 2.2)** | **1.4** | **(1.0, 1.8)** |
| Office & admin support | 163 | 0.8 | (0.6, 1.0) | 0.3 | (0.2, 0.5) | 0.9 | (0.7, 1.1) | 66 | 0.3 | (0.2, 0.5) | 0.2 | (0.1, 0.3) | 0.6 | (0.4, 0.8) | 90 | 0.5 | (0.3, 0.6) | 0.9 | (0.6, 1.4) | 1.3 | (1.0, 1.7) |
| Farming, fishing, forestry | 148 | 12.1 | (8.8, 16.5) | **5.1** | **(3.6, 7.2)** | **2.1** | **(1.7, 2.7)** | 127 | 10.4 | (7.3, 14.8) | **5.9** | **(4.0, 8.8)** | **2.2** | **(1.7, 2.9)** | 19 | 1.9 | (0.9, 3.9) | **3.6** | **(1.7, 7.8)** | **2.4** | **(1.5, 4.1)** |
| Industry | | | | | | | | | | | | | | | | | | | | | |
| Construction | 4217 | 34.9 | (33.1, 36.9) | **12.8** | **(11.7, 14.1)** | **3.2** | **(2.9, 3.5)** | 4,086 | 33.9 | (32.1, 35.8) | **16.2** | **(14.6, 17.9)** | **3.6** | **(3.2, 4.0)** | 75 | 0.7 | (0.5, 1.0) | 1.1 | (0.8, 1.7) | 0.9 | (0.6, 1.3) |
| Services, excl. health care | 2041 | 2.7 | (2.5, 2.9) | 1.0 | Ref | 1.0 | Ref | 1,572 | 2.1 | (1.9, 2.3) | 1.0 | Ref | 1.0 | Ref | 403 | 0.6 | (0.5, 0.7) | 1.0 | Ref | 1.0 | Ref |

(Continues)

**TABLE 1** (Continued)

| | All falls (*N* = 8880)[a,b] | | | | | | | Falls to a lower level (*N* = 7521)[c] | | | | | | | Falls on the same level (*N* = 1128)[d] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) | No. | Rate[e] | (95% CI) | RR | (95% CI) | Adj RR[f] | (95% CI) |
| Trade | 633 | 2.8 | (2.4, 3.2) | 1.0 | (0.9, 1.2) | 1.1 | (1.0, 1.2) | 400 | 1.7 | (1.5, 2.1) | 0.8 | (0.7, 1.0) | 0.9 | (0.8, 1.1) | 206 | 1.1 | (0.9, 1.3) | **1.8** | **(1.4, 2.3)** | **1.6** | **(1.3, 1.9)** |
| Manufacturing | 561 | 2.9 | (2.5, 3.3) | 1.1 | (0.9, 1.2) | 0.8 | (0.7, 0.9) | 438 | 2.2 | (1.9, 2.6) | 1.1 | (0.9, 1.3) | 0.8 | (0.7, 0.9) | 104 | 0.6 | (0.4, 0.8) | 0.9 | (0.7, 1.3) | 0.8 | (0.6, 1.0) |
| Transport/ warehouse/ utilities | 521 | 5.7 | (4.9, 6.7) | **2.1** | **(1.8, 2.5)** | 1.0 | (0.9, 1.1) | 387 | 4.3 | (3.6, 5.1) | **2.0** | **(1.7, 2.5)** | 0.9 | (0.8, 1.1) | 105 | 1.2 | (0.9, 1.6) | **2.0** | **(1.5, 2.8)** | 1.1 | (0.9, 1.5) |
| Agriculture/ forestry/ fishing | 404 | 14.7 | (12.3, 17.4) | **5.4** | **(4.4, 6.5)** | **3.8** | **(3.3, 4.4)** | 328 | 11.9 | (9.9, 14.4) | **5.7** | **(4.6, 7.0)** | **4.1** | **(3.4, 4.9)** | 63 | 2.5 | (1.7, 3.7) | **4.2** | **(2.8, 6.3)** | **2.2** | **(1.6, 3.0)** |
| Health care/ social services | 177 | 0.9 | (0.7, 1.1) | 0.3 | (0.2, 0.4) | 0.6 | (0.5, 0.7) | 66 | 0.3 | (0.2, 0.5) | 0.2 | (0.1, 0.2) | 0.3 | (0.2, 0.4) | 105 | 0.6 | (0.4, 0.8) | 0.9 | (0.7, 1.3) | 1.1 | (0.9, 1.4) |
| Mining | 155 | 13.7 | (10.3, 18.1) | **5.0** | **(3.8, 6.7)** | **1.7** | **(1.4, 2.1)** | 144 | 12.7 | (9.5, 16.9) | **6.1** | **(4.5, 8.2)** | **1.9** | **(1.5, 2.3)** | —[h] | — | — | — | — | — | — |

[a]Includes Occupational Injury and Illness Classification System (OIICS) codes "1" from 2003 to 2010 and "4" from 2011 to 2014. Total includes "other" falls, such as jumps or unspecified falls.
[b]Total includes workers of unknown age, unknown or other Race/Ethnicity, unknown region, unknown occupation, or unknown industry.
[c]Includes OIICS codes "11" from 2003 to 2010 and "43" from 2011 to 2014.
[d]Includes OIICS codes "13" from 2003 to 2010 and "42" from 2011 to 2014.
[e]Per million (1 000 000) full-time equivalent (FTE, 1 FTE = 2000 hours worked per year). From BLS publication requirements, numbers of deaths are reported for workers of all ages whereas rates are for workers aged ≥16 years. Rates were calculated by CDC based on the number of fatalities from restricted data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries restricted (CFOI) and might differ from estimates published by BLS; the estimated number of primary employment FTE workers from the BLS Current Population Survey, 2003-2014.
[f]Final adjusted Poisson Regression included all variables with categories defined above. Year of death was not included in the model.
[g]Bolded RRs indicate significantly higher compared to the reference group with $P < 0.05$.
[h]Did not meet criteria for publication without compromise of confidentiality.

2011-2014.[36] For industry, the 2002 North American Industrial Classification System (NAICS) was used for 2003-2010, and the 2007 NAICS was used for 2011-2014.[37] Because of the shifts in coding scheme versions, all analyses for this study were limited to the broadest occupation and industry classifications. Although there is some overlap between the industry and occupation, we included both occupation and industry categories because they do not overlap in a consistent manner. For example, workers in "construction and extraction" occupations might work in "construction" or "mining" industries. Conversely, workers in a specific industry could be categorized into multiple occupations. For example, the construction industry includes office and administrative support occupations, professional and related services occupations, and sales and related occupations in addition to construction and extraction occupations. We also wanted to understand if the risk was higher for worker-specific occupations and for industry-specific activities. We included frequencies of fatalities by establishment size. However, denominator data were unavailable from CPS for this variable and we were therefore unable to calculate rates by establishment size and did not include this variable in the model.

### 2.4 | Fatal fall rate calculations

Annual rates were calculated using labor force denominator estimates derived from the BLS Current Population Survey (CPS) for workers aged 16 years and older (2003–2014). The CPS is the principal source of US labor force statistics and is a monthly household survey that collects employment, unemployment, earnings, hours of work, and other indicators from approximately 50 000 households across the United States.[38] Rates are reported as the number of fatal work-related falls per million full-time equivalent (FTE) workers each year, and stratified by covariates of interest. Rates incorporated the FTE composite sample weights from the CPS microdata.[38]

### 2.5 | Statistical analysis

In 2016, we analyzed data from 2003 to 2014. Variable groupings were consistent with BLS confidentiality requirements[32] and previous analyses.[39] Analysis included Poisson regression models using SAS's GENMOD procedure to calculate unadjusted (univariate) and adjusted (multivariate) rate-ratios (RRs) and 95% confidence intervals (CIs). Reference groups were selected based on lower risk and greater numbers to reduce variability of comparisons. The full multivariate model included sex, age, BOC region, race/ethnicity, nativity, industry, and occupation. To examine trends over time, we plotted rates by type of fall over calendar time (Figure 1) by three major age groups for falls to a lower level and falls on the same level (Figures 2A and 2B). We examined the most common fall to lower level events from 2003 to 2010 to understand changes in events associated with falls (Figure 3). We excluded 2011-2014 events because OIICS codes were revised in 2011 and classified fall events by height, not by events. Similar information can be inferred from the primary and secondary injury source categories in OIICS, however, this represents a break in series and the categorizations would not be comparable at a very detailed level.[33,34] Typically, the source of a fall is the object on which the decedent worker fell (eg, the ground), rather than the object that was involved in causing the fall (eg, a ladder). Data were analyzed using SAS, version 9.4 (SAS Institute, Inc. Cary, NC).

No review was required by NIOSH's Institutional Review Board since the analysis was conducted on existing data collected by other agencies.

## 3 | RESULTS

From 2003 to 2014, there were 8880 fatal work-related falls recorded in CFOI, representing over 14% of all work-related fatalities (Table 1). The annual average rate of fatal work-related falls during the time period was 5.5 per million FTE. Falls to a lower level represented the majority with 7521 fatalities (85%) compared to falls on the same level (1128 fatalities; 13%) and "all other types of falls" (231 fatalities; 3%).

### 3.1 | Demographics

Most fatal work-related falls over the 12 year period occurred among men ($n$ = 8336; 94%) at a rate of 8.8 per million FTE (Table 1); 4.3 times the rate for women (95%CI 3.9-4.8). The rate of fatal work-related falls increased consistently and substantially with age, even after adjusting for all variables. Most fatal falls occurred among workers aged 45-54 ($n$ = 2322). However, the highest rate was among workers ≥65 years (24.6 per million FTE). The RRs for age significantly increased after adjusting, which did not occur for any other variable examined. The adjusted rate ratio for falls on the same level was the highest for workers ≥65 years old compared to workers 35-44 years old ($RR_{adj}$ = 24.9, 95%CI 20.1-30.9). Hispanics had the highest rate at 8.6 per million FTE which was significantly higher compared to whites ($RR_{adj}$ = 1.2, 95%CI 1.1-1.3). Foreign-born workers had a slightly, yet significantly higher fatality rate compared to US-born workers for falls to a lower level ($RR_{adj}$ = 1.2, 95%CI 1.1-1.3), but not for falls on the same level ($RR_{adj}$ = 0.6, 95%CI 0.5-0.8). The frequency and rate of fatal work-related falls were highest in the South ($n$ = 2874; 5.7 per million FTE), compared to the West ($RR_{adj}$ = 1.3, 95%CI 1.2-1.3).

### 3.2 | Injury characteristics

For nature of injury, most fatal work-related falls resulted in intracranial injuries ($n$ = 3981, 45%) or multiple traumas ($n$ = 3037, 34%). This was consistent with body part categorization, where most injuries involved the head ($n$ = 4015, 45%) or multiple body parts ($n$ = 3089, 35%). The primary injury source for most falls was a structure/surface ($n$ = 7339, 83%). Secondary injury sources ($n$ = 5817) that were involved in the largest number of fatalities included structure/surface ($n$ = 2576, 44%), tools/instruments/equipment ($n$ = 1074, 18%), and machinery ($n$ = 453, 8%).

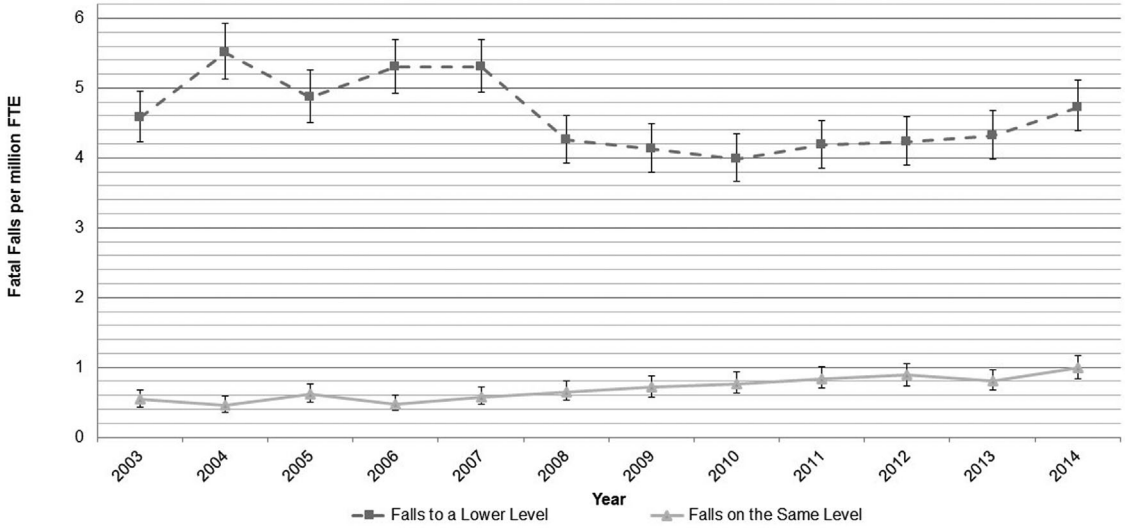


**FIGURE 1** Rates[a] of fatal work-related falls—United States, 2003-2014

### 3.3 | Occupation, industry, and establishment size

By occupation group, construction/extraction workers had the highest rate (42.2 per million FTE) and number ($n = 4029$), representing nearly half (48%) of all fatal falls (Table 1). In adjusted analyses, the rate of fatalities remained more than eight times the reference occupation (management/business/finance, $RR_{adj} = 8.4$, 95%CI 7.5-9.4). Other occupations with comparatively high fatal fall rates included installation/maintenance/repair (12.5 per million FTE, $RR_{adj} = 5.5$, 95%CI 4.9-6.2) and service (4.4 per million FTE, $RR_{adj} = 4.3$, 95%CI 3.8-4.8).

For industry groups, construction had the highest rate (34.9 per million FTE) and number ($n = 4217$) compared to all other industries, representing half of all falls (51%). After adjusting for all other variables, the agriculture/forestry/fishing industry sector had the highest fatality rate at 3.8 times the reference industry (services, 95% CI 3.3-4.4), although the rate ratios for construction ($RR_{adj} = 3.2$, 95% CI 2.9-3.5) and mining ($RR_{adj} = 1.7$, 95%CI 1.4-2.1) were similarly high.

Establishment size was available for approximately 78% of fatal falls to a lower level and 77% of fatal falls on the same level, which was similar to establishment size for all other fatalities (77%). Over 45% ($n = 3408$) of falls to a lower level occurred among workers in establishments with 10 or fewer employees. During the time period, this percentage increased from 44% in 2003 to 53% in 2014. Interestingly, 24% ($n = 275$) of falls on the same level involved workers in establishments with 10 or fewer employees, which increased from 18% in 2003 to 27% in 2014. By comparison, about 36% of all other types of fatalities (non-falls) involved workers in establishments with 10 or fewer employees. This percentage also rose from 33% in 2003 to 42% in 2014. The number of fatalities involving workers in establishments with 10 or fewer employees has risen over the time period, but it is consistently about 10% higher for fatal falls to a lower level.

### 3.4 | Rates over time

From 2003 to 2014 the rate of fatal work-related falls showed a modest but non-significant decrease over time. The rate for falls to lower levels, which mirrored the rates for all falls, also decreased non-significantly (Figure 1). However, the annual rate for falls on the same level increased significantly from 2003 to 2014, although not linearly. Figure 1 shows the slight reduction in rates over time for falls to a lower level compared to falls on the same level which experienced low, steady rates until 2006 when the rates began a sustained increase through 2014. Figure 2 shows the changes in rates of falls over time for three major age groups: workers ≥55 years had a significantly higher fatal fall rate each year compared to younger workers, for both types of falls. None of the age groups had a significant increase, but for falls on the same level, the fatality rate trended upward (Figure 2B). Among all falls to a lower level, falls from ladders, roofs, nonmoving vehicles, and scaffolds had the highest rates across the time period (Figure 3). Fatal falls from scaffolds decreased slightly over time, whereas rates over time for other events remained fairly consistent.

## 4 | DISCUSSION

Falls are a persistent, diverse source of work-related fatal injury in the United States and remain a priority for prevention efforts. Our results for 2003-2014 show increasing fatal falls, which is consistent with current literature, especially among construction workers,[8,40] as well as research from 40 years ago.[1] We found that falls remain of highest concern for men, older workers, Hispanic workers, and workers in the construction industry and construction/extraction occupations. In the context of fatal work-related falls across the nation, nearly half (45%) involved construction and extraction occupations. Our results also

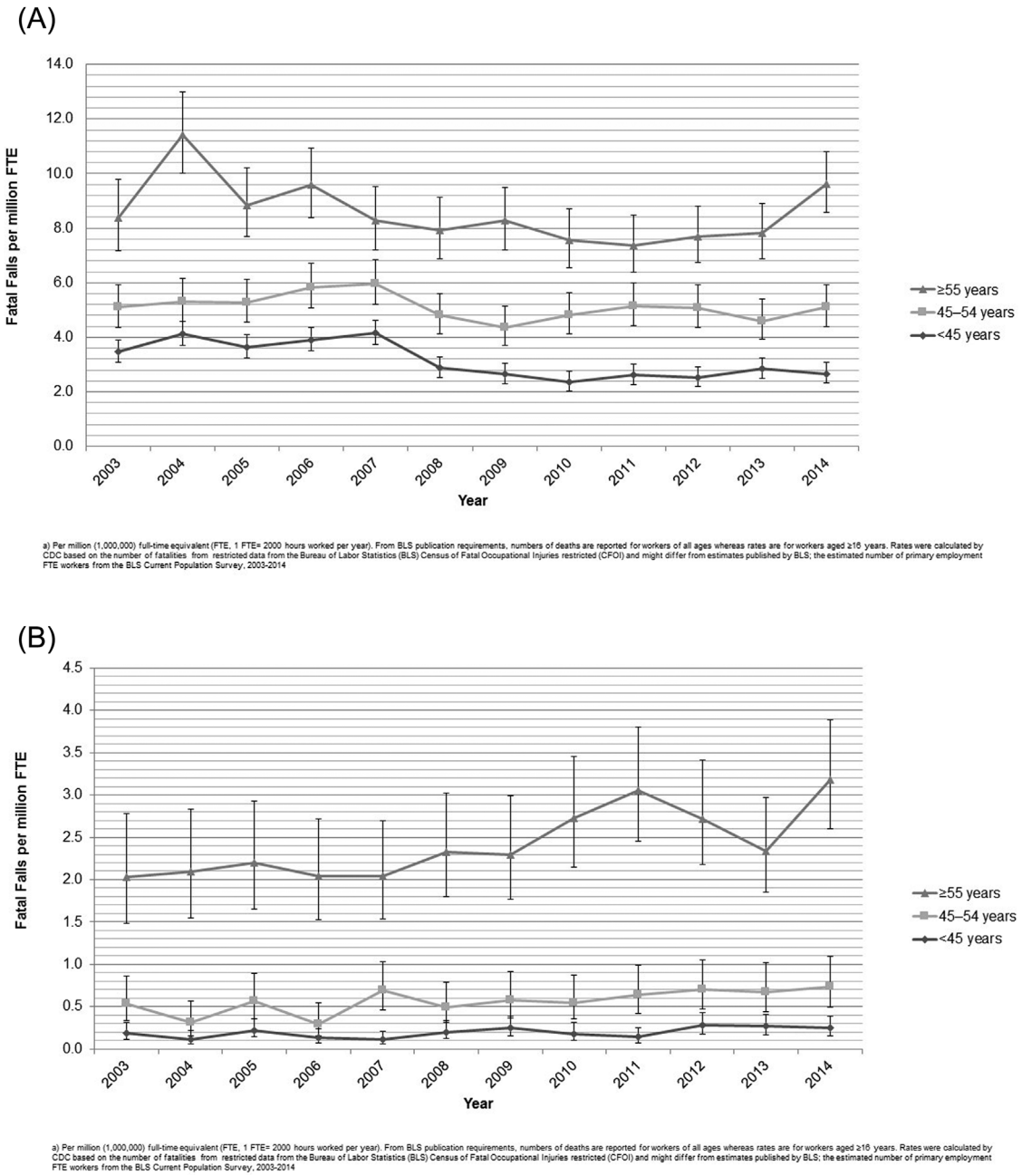


**FIGURE 2** A, Rates[a] of fatal work-related falls to a lower level by age—United States, 2003-2014. B, Rates[a] of fatal work-related falls on the same level by age—United States, 2003-2014

indicate that agriculture/forestry/fishing and mining industries, and installation/maintenance/repair occupations experienced higher fatal fall rates. Many fatal falls to a lower level (45%) were associated with a small business employer (10 or fewer employees) compared to fatalities of all other events or falls on the same level. Several differences were highlighted between the two main types of fatal falls.

Most fatal work-related falls were falls to a lower level, which emphasizes the hazards of working at heights, especially on ladders, roofs, and scaffolds. In line with OSHA standards for both general[21] and high-risk industries,[41] injury prevention efforts typically focus on employers providing fall protection, such as guardrails on a roof edge,[42] safety nets atop large openings, or personal fall arrest systems.[41,43] Partnership, communication, Prevention through Design, and training are important to ensure effective injury prevention approaches are available to workers on site and to ensure workers know how to properly incorporate injury prevention approaches in practice.[41] NIOSH regularly engages OSHA and The Center for Construction Research and Training (CPWR) to promote fall prevention and safety through the National Falls Prevention Campaign, including an annual Safety Stand-Down to give employers, especially small construction contractors, the opportunity to discuss fall risks and prevention with workers.[44,45] General prevention guidelines from the

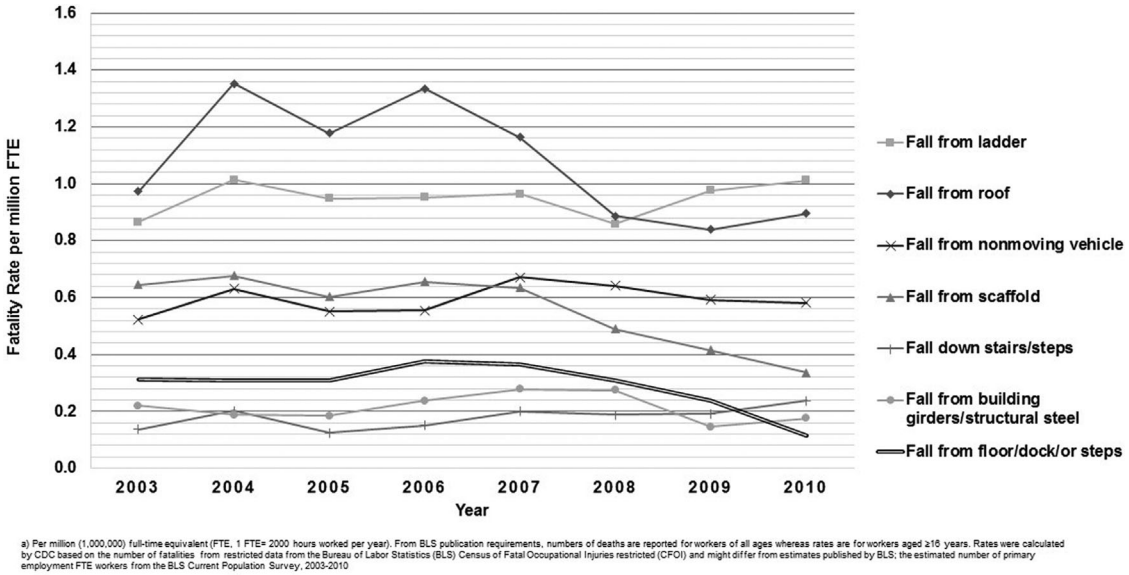


**FIGURE 3** Rates[a] of fatal work-related falls to a lower level by event—United States, 2003-2010

campaign encourage employers to plan ahead to reduce or remove fall hazards if possible; provide the right equipment when working at heights of six feet or more[42]; and train everyone on fall hazards and the correct use of safety equipment.[44] Simple, innovative methods for safety communication have been developed recently, such as the NIOSH ladder safety smartphone application which provides convenient, quick access to safety information for ladders.[26] Although previous research on safety climate has not focused specifically on falls, general safety and injury prevention should focus on improving safety climate,[46] improving worker potential to influence safety practices, and communication between employers and workers.[47,48] Continued efforts should promote leading (rather than lagging) indicators, and proactive and cost-effective approaches to safety. As an example, Prevention through Design concepts include engineering safety features in building design, such as fall protection anchors or use of parapet walls,[49,50] or removing the need to work at heights rather than fall protection only.[31] More is known about falls in the context of construction workers,[51] but few proven interventions exist.[52] Researchers should continue to develop and evaluate fall prevention programs and other interventions in construction, and prioritize interventions with simple solutions to reduce fatalities in small businesses in construction and other industries/occupations.

Fatal falls on the same level were less frequent than falls to a lower level, but the rate gradually increased over the ten year period. This increase is consistent with a reported increase in the nonfatal injury rate for falls on the same level.[53] In general, falls on the same level result in death less frequently because they tend to be less severe compared to falls to a lower level. However, falls on the same level are more common and therefore more costly overall. Prevention efforts for this type of fall focus on a comprehensive work design approach, including improved lighting, walkway environment, and friction characteristics of flooring and footwear.[15–17,54] Falls on the same level are usually associated with severe nonfatal injuries among older, female workers.[15,54,55] In our analysis, the rates of same level fatal falls remained higher among men (RR = 1.8, 95%CI 1.6, 2.1).

## 4.1 | Strengths and limitations

To our knowledge, no other study has recently examined the status of fatal work-related falls across all US-workers. Our analysis shows a dramatic increase in fatal fall rates by age and also a large burden of fatal falls among construction workers. This finding is supported by researchers at the CPWR, who have consistently examined falls and other injuries and illnesses among construction workers.[56] We included frequencies and rates of fatal work-related falls over time and within demographic, occupational, and industry subgroups. By including rates, we likely accounted for changes in the economy, such as the 2008-2009 downturn, although we did not examine economic risk factors in this study. While an examination of the impact of the economy was beyond our study goals, the influence of the economy on injuries and fatalities can be broad and may have an important impact for the construction industry.[40]

Study limitations include changes in primary coding systems for classifying data and differences in data systems to calculate rates. For example, lack of denominator data for job tenure and employer size did not allow these risk factors to be investigated in the adjusted model. Similarly, specific fall-related events were limited to 2003-2010 (Figure 3) and due to cells with sparse data, we were unable to examine detailed occupation or industry trends over time.

Fall injuries are well documented among construction workers[8,9,13,40,57–59] but future studies should examine individual occupations or age groups, with a focus on small business. We could not assess the impact of OSHA standards in relation to fatal falls, because OSHA standards vary by state, are often dictated by whether the state is a Federal OSHA state, and because we examined national data. Although one review of construction-related interventions suggested that

regulations are not sufficient to reduce falls in construction workers,[52] future studies might evaluate state-level regulations or standards as they are introduced. Finally, CFOI does not provide a description of the cause of a fall injury, but rather includes classifications of events and sources. Other studies have provided more detailed causation explanations, specifically among construction workers[60] and personal fall arrest system use among construction workers.[24]

## 5 | CONCLUSIONS

Prevention of work-related falls remains a challenge among US workers and our results indicate that work-related falls continue to be a problem, especially among certain worker groups. The lack of a substantial decrease in rates of fatal work-related falls suggests a continued need for collaboration of regulators and industry leaders, professional associations and labor unions, employers and employees, safety professionals and researchers. These partnerships will foster development and dissemination of effective fall prevention strategies including improving the work environment, implementing new prevention and protection technologies, and improving work safety culture through continuous education of employers and the workforce.

### AUTHORS' CONTRIBUTIONS

Dr Socias-Morales contributed to all aspects of the work, including conception/design, analysis and interpretation, drafting and revising, final approval of the version to be published and agreement to be accountable for all aspects of the work. Dr Chaumont Menendez contributed to conception/design, analysis and interpretation, revising, and final approval of the version to be published. Ms Marsh contributed to conception/design, analysis and interpretation, revising, and final approval of the version to be published.

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No review was required by the CDC/NIOSH Institutional Review Board since the analysis was conducted on existing data collected by other agencies, shared through a cooperative agreement. Data did not include any personal identifiers.

### DISCLOSURE (AUTHORS)

The authors declare no conflicts of interest.

### DISCLOSURE BY AJIM EDITOR OF RECORD

Steven B. Markowitz declares that he has no conflict of interest in the review and publication decision regarding this article.

### DISCLAIMER

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### REFERENCES

1. Snyder RG. *Occupational Falls*. Morgantown, West Virginia: The University of Michigan, Highway Safety Research Institute, NIOSH; 1977.
2. National Institute for Occupational Safety and Health. Fatal Injuries to Workers in the United States, 1980–1989: A Decade of Surveillance National Profile, 93–108. Cincinnati, Ohio: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health 1993.
3. Bureau of Labor Statistics. Census of Fatal Occupational Injuries All Worker Profile. Table: All Workers—Fatal occupational injuries by selected characteristics: State of incident, employee status, sex, age, race, event or exposure, source, secondary source, nature, part of body, worker activity, location, occupation, and industry, 1992–2002. 2005; http://www.bls.gov/iif/oshwc/cfoi/cftb0186.pdf 2015.
4. National Institute for Occupational Safety and Health. Research and practice for fall injury control in the workplace: Proceedings of International Conference on Fall Prevention and Protection. Paper presented at: Morgantown, WV: US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2012-103; 2011; https://www.cdc.gov/niosh/docs/2012-103/pdfs/2012-103.pdf
5. Bureau of Labor Statistics. Query of Nonfatal cases involving days away from work: selected characteristics, Falls, Slips, Trips (4XXXXX). 2016; http://data.bls.gov/cgi-bin/dsrv?cs
6. Bureau of Labor Statistics. Census of Fatal Occupational Injuries (revised data), Table A-7. Fatal occupational injuries by worker characteristics and event or exposure, all United States, 2014. 2016; https://www.bls.gov/iif/oshwc/cfoi/cftb0292.pdf

7. Tiesman HM, Konda S, Bell JL. The epidemiology of fatal occupational traumatic brain injury in the U.S. *Am J Prev Med*. 2010;41:61–67.
8. Dong XS, Wang X, Largay JA, et al. Fatal falls in the U.S. residential construction industry. *Am J Ind Med*. 2014;57:992–1000.
9. Dong XS, Ringen K, Welch L, Dement J. Risks of a lifetime in construction part I: traumatic injuries. *Am J Ind Med*. 2014;57:973–983.
10. Rossignol M. The case-fatality rate of occupational injuries: the effect of aging. *Am J Public Health*. 1994;84:1696–1697.
11. Farrow A, Reynolds F. Health and safety of the older worker. *Occup Med (Oxford)*. 2012;62:4–11.
12. Socias CM, Chaumont Menendez CK, Collins JW, Simeonov P. Occupational ladder fall injuries—United States, 2011. [Erratum appears in MMWR Morb Mortal Wkly Rep. 2014 May 9;63 (18):416]. *MMWR Morb Mortal Wkly Rep*. 2014;63:341–346.
13. Dong XS, Choi SD, Borchardt JG, Wang X, Largay JA. Fatal falls from roofs among U.S. construction workers. *J Safety Res*. 2013;44:17–24.
14. Wade C, Davis J, Weimar WH. Balance and exposure to an elevated sloped surface. *Gait Posture*. 2014;39:599–605.
15. Bell JL, Collins JW, Wolf L, et al. Evaluation of a comprehensive slip, trip and fall prevention programme for hospital employees. *Ergonomics*. 2008;51:1906–1925.
16. Bell JL, Collins JW, Tiesman HM, et al. Slip, trip, and fall injuries among nursing care facility workers. *Workplace Health Safety*. 2013;61:147–152.
17. Courtney TK, Lombardi DA, Sorock GS, et al. Circumstances of slips trips and falls among Hospital workers. *Inj Prev*. 2010;16:A173–A174.
18. Collins JW, Bell JL, Gronqvist RA, et al. Slip, trip and fall (STF) prevention in health care workers. Paper presented at: Proceedings of the 16th World Congress on Ergonomics (IEA2006); July 10–14, 2006; Maastricht The Netherlands.
19. Lucas DL, Lincoln JM. Fatal falls overboard on commercial fishing vessels in Alaska. *Am J Ind Med*. 2007;50:962–968.
20. Centers for Disease Control and Prevention. Work-related fatalities associated with tree care operations–United States, 1992–2007. *MMWR Morb Mortal Wkly Rep*. 2009;58:389–393.
21. Occupational Safety and Health Administration. OSHA Laws and Regulations, 29 Code of Federal Regulations 1910. 2015; https://www.osha.gov/law-regs.html
22. Occupational Safety and Health Administration. OSHA Quick Card: Fall Protection in the General Industry. 2010; https://www.osha.gov/OshDoc/data_Hurricane_Facts/fall_protection_qc.pdf
23. Chaumont Menendez C, Castillo D, Rosenman K, Harrison R, Hendricks S. Evaluation of a nationally funded state-based programme to reduce fatal occupational injuries. *Occup Environ Med*. 2012;69:810–814.
24. Dong XS, Largay JA, Choi SD, Wang X, Cain CT, Romano N. Fatal falls and PFAS use in the construction industry: findings from the NIOSH FACE reports. *Accid Anal Prev*. 2017;102:136–143.
25. Menzel NN, Shrestha PP. Social marketing to plan a fall prevention program for Latino construction workers. *Am J Ind Med*. 2012;55:729–735.
26. Centers for Disease Control and Prevention. Announcement: smartphone application available for extension ladder safety. *MMWR Morb Mortal Wkly Rep*. 2013;62:1037.
27. Li KW, Chen CY, Chen CC, Liu L. Assessment of slip resistance under footwear materials, tread designs, floor contamination, and floor inclination conditions. *Work*. 2012;41:3349–3351.
28. Chang WR, Chang CC, Matz S. Available friction of ladder shoes and slip potential for climbing on a straight ladder. *Ergonomics*. 2005;48:1169–1182.
29. National Institute for Occupational Safety and Health. Workplace Safety & Health Topics: Safe, Green, and Sustainable Construction. 2015; http://www.cdc.gov/niosh/topics/greenconstruction/. Accessed June 25, 2015, 2015.
30. Hamel KD. Identifying same-level slip and fall hazards in the workplace. *Occup Health Safety*. 2014;83:52–53.
31. Francis D. Fall protection vs. fall prevention: a new approach to ladders. *Occup Health Safety*. 2014;83:49–50.
32. Bureau of Labor Statistics. Occupational safety and health statistics. In: BLS handbook of methods. 2013; http://www.bls.gov/opub/hom/pdf/homch9.pdf
33. Bureau of Labor Statistics. Occupational injury and illness classification manual. 2012; http://www.bls.gov/iif/osh_oiics_2010_1.pdf
34. Bureau of Labor Statistics. Occupational injury and illness classification manual. 2007; http://www.bls.gov/iif/oiics_manual_2007.pdf
35. US Census Bureau. Regions and Divisions. 2016; http://www.census.gov/econ/census/help/geography/regions_and_divisions.html. Accessed September 22, 2016.
36. US Census Bureau. Occupation Classification. 2015; http://www.census.gov/cps/files/Occupation%20Codes.pdf. Accessed June 26, 2015.
37. US Census Bureau. North American Industry Classification System. 2015; http://www.census.gov/eos/www/naics. Accessed June 26, 2015.
38. Bureau of Labor Statistics. Current Population Survey Microdata Files. 2016; http://thedataweb.rm.census.gov/ftp/cps_ftp.html. Accessed August 23, 2016.
39. Steege AL, Baron SL, Marsh SM, Menéndez CC, Myers JR. Examining occupational health and safety disparities using national data: a cause for continuing concern. *Am J Ind Med*. 2014;57:527–538.
40. Konda S, Tiesman HM, Reichard AA. Fatal traumatic brain injuries in the construction industry, 2003–2010. *Am J Ind Med*. 2016;59:212–220.
41. Occupational Safety and Health Administration. OSHA Laws and Regulations, 29 Code of Federal Regulations 1926.502. 2015; https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10758
42. Bobick TG, McKenzie EA, Jr, Kau T-Y. Evaluation of guardrail systems for preventing falls through roof and floor holes. *J Safety Res*. 2010;41:203–211.
43. Hsiao H, Friess M, Bradtmiller B, Rohlf FJ. Development of sizing structure for fall arrest harness design. *Ergonomics*. 2009;52:1128–1143.
44. Macario E, Hannon SW, Baker R, Branche CM, Trahan C. Preventing falls in residential construction: effectiveness of engaging partners for a national social marketing campaign. *Am J Ind Med*. 2015;58:809–823.
45. Bunting J, Branche C, Trahan C, Goldenhar L. A national safety stand-down to reduce construction worker falls. *J Safety Res*. 2017;60:103–111.
46. Zohar D. Thirty years of safety climate research: reflections and future directions. *Accid Anal Prev*. 2010;42:1517–1522.
47. Sparer EH, Herrick RF, Dennerlein JT. Development of a safety communication and recognition program for construction. *New Solut*. 2015;25:42–58.
48. Kaskutas V, Buckner-Petty S, Dale AM, Gaal J, Evanoff BA. Foremen's intervention to prevent falls and increase safety communication at residential construction sites. *Am J Ind Med*. 2016;59:823–831.
49. Toole TM, Heckel P, Hallowell M. Policy development: a key factor in promoting PTD. *Prof Saf*. 2013;58:41–47.
50. McKenzie EA, Gillen M, Afanuh S. Preventing Falls from Heights through the Design of Embedded Safety Features. *Workplace Design Solutions* 2014; http://www.cdc.gov/niosh/docs/wp-solutions/2014-124/. Accessed March 3, 2016, 2016.
51. Nadhim EA, Hon C, Xia B, Stewart I, Fang D. Falls from height in the construction industry: a critical review of the scientific literature. *Int J Environ Res Public Health*. 2016;13:638.

52. van der Molen HF, Lehtola MM, Lappalainen J, et al. Interventions to prevent injuries in construction workers. *Cochrane Database Syst Rev*. 2012;12:Cd006251.
53. Economic News Release [press release]. Washington, DC2015.
54. Chang W-R, Leclercq S, Lockhart TE, Haslam R. State of science: occupational slips, trips and falls on the same level. *Ergonomics*. 2016;59:1–64.
55. Yeoh HT, Lockhart TE, Wu X. Non-fatal occupational falls on the same level. *Ergonomics*. 2013;56:153–165.
56. Dong XS, Wang X, Katz R, West G, Bunting J. Quarterly data report: fall injuries and prevention in the construction industry. 2017; http://www.cpwr.com/sites/default/files/publications/Quarter1-QDR-2017.pdf
57. Shishlov KS, Schoenfisch AL, Myers DJ, Lipscomb HJ. Non-fatal construction industry fall-related injuries treated in US emergency departments, 1998–2005. *Am J Ind Med*. 2011;54:128–135.
58. Schoenfisch A, Lipscomb H, Cameron W, Adams D, Silverstein B. Rates of and circumstances surrounding work-related falls from height among union drywall carpenters in Washington State, 1989–2008. *J Safety Res*. 2014;51:117–124.
59. Schoenfisch AL, Lipscomb HJ, Shishlov K, Myers DJ. Nonfatal construction industry-related injuries treated in hospital emergency departments in the United States, 1998–2005. *Am J Ind Med*. 2010;53:570–580.
60. Hale A, Walker D, Walters N, Bolt H. Developing the understanding of underlying causes of construction fatal accidents. *Safety Sci*. 2012;50:2020–2027.

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