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Fatal falls and PFAS use in the construction industry: Findings from the NIOSH FACE reports

Xiuwen Sue Dong[a,*], **Julie A. Largay**[a], **Sang D. Choi**[b], **Xuanwen Wang**[a], **Chris Trahan Cain**[a], and **Nancy Romano**[c]

[a]CPWR – The Center for Construction Research and Training, 8484 Georgia Ave, Suite 1000, Silver Spring, MD 20910, United States

[b]University of Wisconsin-Whitewater, Department of Occupational & Environmental Safety & Health, Hyland Hall 3509, 800 West Main St., Whitewater, WI 53190, United States

[c]National Institute for Occupational Safety and Health, Division of Safety Research, 1095 Willowdale Rd., Room 1714, Morgantown, WV 26505, United States

Abstract

This study analyzed the Construction FACE Database (CFD), a quantitative database developed from reports of the Fatality Assessment and Control Evaluation (FACE) program conducted by the National Institute for Occupational Safety and Health (NIOSH). The CFD contains detailed data on 768 fatalities in the construction industry reported by NIOSH and individual states from 1982 through June 30, 2015. The results show that falls accounted for 42% (325) of the 768 fatalities included in the CFD. Personal fall arrest systems (PFAS) were not available to more than half of the fall decedents (54%); nearly one in four fall decedents (23%) had access to PFAS, but were not using it at the time of the fall. Lack of access to PFAS was particularly high among residential building contractors as well as roofing, siding, and sheet metal industry sectors (~70%). Although the findings may not represent the entire construction industry today, they do provide strong evidence in favor of fall protection requirements by the Occupational Safety and Health Administration (OSHA). In addition to stronger enforcement, educating employers and workers about the importance and effectiveness of fall protection is crucial for compliance and fall prevention.

Keywords

Construction industry; Fatality Assessment and Control Evaluation; Fall hazards; Fall height; Fall protection; Personal fall arrest systems

1. Introduction

Occupational fatality statistics in the U.S. construction industry continue to highlight the risks and hazards associated with construction work. Data for 2014 show there were more

*Corresponding author at: Data Center Director, CPWR – The Center for Con struction Research and Training, 8484 Georgia Ave, Silver Spring, MD 20910, United States. sdong@cpwr.com (X.S. Dong).

fatalities in construction than in any other major industry in the U.S., and the annual number of construction fatalities has increased since 2011, which coincides with the recent economic recovery (U.S. Bureau of Labor Statistics, 2016). Moreover, fatal injuries caused by falls have remained the leading cause of fatalities in construction since 1992 (CPWR, 2013; U.S. Bureau of Labor Statistics, 2016).

Fall protection is an essential part of preventing fall injuries. The Occupational Safety and Health Administration (OSHA), which sets and enforces standards to ensure safe work conditions in the United States, requires that each employee on a walking or working surface (horizontal and vertical) with an unprotected side or edge that is 6 feet (1.8 m) or more above a lower level must be protected from falling by the use of guardrail systems, safety net systems, or a personal fall arrest system (PFAS) (OSHA, 2010). However, until 2010, these requirements did not apply to the residential construction industry. According to OSHA case reports of fatalities between 2005 and 2010 (prior to the change in requirements), there was little or no appropriate fall protection used in residential roofing (Moore and Wagner, 2014). Earlier studies found that more than 40% of fall injuries from scaffolding, staging, or floor openings could be attributed to non-compliant scaffolds and unguarded openings (Chi et al., 2005). Falls from ladders also account for a large proportion of workplace injuries related to falls from heights (DiDomenico et al., 2013), although fall protection is not required on portable ladders (29 CFR 1926.1053). In addition, a 1997 study found a significant relationship between injury severity and height of fall (Gillen et al., 1997). Despite improvements in OSHA standards, lack of fall protection remained at the top of OSHA’s most frequently cited construction standards in 2014 (OSHA, 2015b).

Although a comprehensive understanding of the causal factors in fatal falls is important for injury intervention, the existing literature appears to lack a scientific review of falls from height (Nadhim et al., 2016). Data collection on the height of falls was just initiated in 2011 by the Census of Fatal Occupational Injuries (CFOI), which is the primary data source for occupational safety and health surveillance of fatalities. Information on usage of PFAS is even scarcer in the existing databases and literature.

To improve understanding of fatal incidents and provide recommendations for avoiding similar events in the future, NIOSH has maintained the Fatality Assessment and Control Evaluation (FACE) program since 1982. In addition to the demographic and employment data collected on decedents, FACE has reported information on height of falls since inception of the program. Information on fall protection status was also collected, including whether the decedent was wearing fall protection when the incident occurred; had access to fall protection (such as the equipment was provided to the decedent prior to the incident or was available on site), but did not use it; or no fall protection was provided. FACE investigators also made recommendations on how the incident may have been prevented based on the incident circumstances. These detailed incident descriptions and recommendations can be critical for designing injury prevention measures, including safety policies and procedures, engineering controls, and other aspects of the safety climate (Higgins et al., 2001; Menendez et al., 2012).

The Construction FACE Database (CFD), a numeric database covering all FACE reports in the construction industry published from 1982 to June 30, 2015, facilitates the use of the rich data included in the FACE reports (more information on the CFD creation and contents is reported separately). This study examined characteristics of fall fatalities and fall protection use in the construction industry by analyzing the CFD. The study attempts to fill certain research gaps, given the shortage of information on the height of falls and use of PFAS in the construction industry in the existing literature.

2. Materials and methods

The fatal cases involving falls were identified from the CFD. Height of these fatal falls, and access to and use of PFAS when the fall occurred, were examined and compared among the decedents with different demographic and employment characteristics. Heights of falls were grouped into four major categories: (1) less than 6 feet, (2) 6–15 feet, (3) 16–30 feet, and (4) more than 30 feet. These categories were based on OSHA's regulations and requirements (OSHA, 2014). To identify whether the decedent was wearing fall protection, or if not, whether fall protection was present at the incident site, PFAS status was categorized as: (1) present, in use; (2) present, not in use; (3) not present; and (4) unknown. Construction industry subsectors were coded according to the Standard Industrial Classification (SIC) system. Occupations were classified based on the 1990 Census Occupational Classification System. Only major construction occupations were reported in this study due to too few cases among smaller occupations and those with a lower risk of falls.

Trend analysis was conducted to examine changes in FACE fall investigations and the use of PFAS over a 33-year period (1982–2015). The characteristics of fall decedents, including age, employment status (i.e., wage-and-salary, self-employed, and other), occupation, and job tenure (i.e., tenure with the employer when the fatal incident occurred) were examined by height of falls and PFAS status. Information on the decedent's employer, such as industry sector and size of the employer, were stratified by height of fall and PFAS status. Fall height and PFAS status were also explored by type of fall (e.g., fall through surface, fall from ladder) and incident location (e.g., residential construction site, nonresidential construction site). Information on race and ethnicity was missing for the majority of cases, and was therefore not included in this study. Descriptive statistics, including number of deaths and percent distributions among subcategories, were tabulated and reported. The CFD was analyzed using SAS version 9.4.

3. Results

3.1. General trends

Overall, falls accounted for 325 (42%) of the 768 construction fatalities included in the CFD (Table 1). There was a higher incidence of total fatalities and fatalities from falls among decedents aged 25–44 years than any other age group. Older decedents had a smaller share of overall fatalities, but a higher proportion of fatalities from falls, than younger ones. For those aged 65 and older, 60% of the fatalities were due to falling, compared to 36% of workers younger than 25. By occupation, about 78% of roofer fatalities were caused by falls, compared to 32% for construction laborers and helpers. Decedents having a short job tenure with the employer at the time of the incident were more likely to die from falls. Among decedents who had been on the job for just one week, 54% of all fatalities were from falls, while the proportion was 42% for decedents having five or more years with their employer when the incident occurred. When industry was examined, more than three out of four fatalities that occurred among the roofing, siding, and sheet metal industries were found to be from falls. Additionally, more than half of all the fatalities among employers with 20 or fewer employees were from falls, compared to 37% among those with more than 200 employees.

3.2. Height of falls

Over the study period, fatal falls reported by FACE shifted from falls from higher levels to falls from lower levels. The proportion of fatal falls from more than 30 feet dropped significantly—from 44.4% between 1982 and 1992 to 18.9% between 2004 and 2014 (Fig. 1). In contrast, the proportion of fatal falls from 15 feet or less more than tripled during the same time period (15.8% to 51.4%).

More than one-third (107) of fall fatalities were from heights of more than 30 feet (9 cases without height information were excluded), and seven falls from less than six feet were identified (Table 2). Older decedents had a higher proportion of fatal falls from lower heights, and few fell from over 30 feet. Nearly half of falls among self-employed decedents were from 15 feet or below, double the proportion among wage-and-salary decedents (46.5% vs. 22.7%). Decedents employed as structural metal workers had the highest proportion of falls from more than 30 feet (52.4%), while roofers had the highest proportion of falls from 16 to 30 feet (63.3%). However, no association between the height of falls and job tenure was observed. Among construction subsectors, more than half of falls in the roofing, siding, and sheet metal industry were from 16 to 30 feet, and 97% of falls among residential contractors were below 30 feet. Smaller employers had a larger proportion of falls from lower levels.

In terms of source of falls, almost half of falls from ladders occurred below 15 feet, while the proportion of falls from more than 30 feet was higher among those working on scaffolding, staging, building girders, or other structural steel (Table 3). Some jobsites were more likely to experience falls from specific heights. For example, falls from 6 to 15 feet were more than twice as likely at residential construction sites when compared to all locations (48% vs. 23%).

3.3. Usage of personal fall arrest systems (PFAS)

Fall protection use was examined despite missing data for 17% of cases. Neither the proportion of workers without access to fall protection (i.e., PFAS not present), nor that of workers using fall protection (i.e., PFAS present, in use), had any noteworthy changes over the time period (Fig. 2). Nevertheless, the proportion of workers with PFAS available but not in use dropped from 22% to 15% during this period.

Only 28.6% of decedents had access to PFAS (Table 4). More than half (54.2%) did not have access to PFAS, and records were incomplete for an additional 17.2%. Among those who had access to PFAS, 81% were not using it when the incident occurred. In general, decedents under age 45 had better access to PFAS than older decedents. However, the percentage not using PFAS (when present) or experiencing a PFAS failure was also higher among younger decedents. In addition, the majority of self-employed decedents did not have access to PFAS (68%) or their PFAS status was unknown (29%). As a result, none of the self-employed decedents in the CFD were using PFAS at the time of the fall. By construction subsector, about 70% of decedents in the residential construction industry and roofing, siding, and sheet metal industries had no access to PFAS. However, PFAS status was unknown for 28% of decedents in residential construction. In terms of occupation, about 70% of decedent roofers and laborers and helpers did not have access to PFAS. More than half (54.8%) of decedent structural metal workers had PFAS present but not in use; the proportion of PFAS used but failed was also higher in this occupation than for all fall decedents (66.7% vs. 28.6%). No significant association between job tenure and PFAS use was found from the analysis.

By construction subsector, about 70% of decedents in the residential construction industry and roofing, siding, and sheet metal industries had no access to PFAS (Table 4). However, PFAS status was unknown for 28% of decedents in residential construction. Decedents in small establishments with 20 or fewer employees were less likely to have access to PFAS (59%). Decedents in large establishments (i.e., more than 200 employees) were more likely to have access to PFAS; however, nearly 40% of those decedents had access, but did not use it.

Examined by source of falls, PFAS was found to be unavailable for 73.5% of decedents who fell from a roof edge, and for 66% who fell through a roof surface, existing opening, or skylight (Table 5). PFAS was not present or the status was unknown for 95% of ladder falls. Just 4.7% of ladder falls were reported having PFAS present and not in use compared to 23.1% for all falls combined. By location, fewer decedents at residential construction sites or residential homes (i.e., not new construction) had access to fall protection compared to those at nonresidential construction sites. On residential construction sites, none of the decedents were using PFAS when the incident occurred. Some fall decedents at public buildings and nonresidential construction sites were using PFAS, but PFAS was either damaged, misused, or did not provide adequate protection. When PFAS use was stratified by fall height, less than 16% of decedents who fell from more than 30 feet used PFAS (17 of 107), 41% of those who fell from that height had access to PFAS but did not use it, and another 37% did not even have access to PFAS. Among decedents who were working at the height <30 feet, only one worker was using PFAS when the incident occurred. In fact, just 5.5% (18 cases) of fall fatalities occurred while wearing PFAS; 13 cases wore PFAS but did not tie-off, and the rest of the cases were due to the failure of PFAS (see footnote of Table 5).

4. Discussion

By analyzing the CFD, this study found that falls from over 30 feet accounted for more than one-third of fatal falls. Falls from lower heights were also a fatality risk for workers—25% of fall fatalities were from heights of 15 feet or less. The data showed a higher proportion of fatal falls from heights of 15 feet or less between 2004 and 2014 than in previous years, which may be related to changes in OSHA regulations and NIOSH targets for FACE over time (OSHA, 2010; NIOSH, 2016). Even though this study was unable to assess effectiveness of the OSHA fall protection standard established in 1995, the considerable number of fall fatalities from lower heights provides strong evidence of the need for the OSHA requirement that fall protection be provided at elevations of six feet or more in the construction industry (OSHA, 1995b; 2010). Although the triggering height of fall protection is six feet above walking/working surface, PFAS requires a minimum clearance of 17.5 feet from anchor (i.e., 6-foot lanyard, 3.5-foot shock absorber, 5-foot surface to dorsal D-ring, 1-foot harness stretch, and 2-foot safety factor). Therefore, a PFAS anchor point that is less than 15 feet from the lower level is not effective (Epp, 2007). One alternative for low height fall arrest is the self-retracting lifeline (SRL). Allowing for stretch and the safety factor, the total fall distance to allow for is between 5 and 7.5 feet. While fall fatalities from higher heights frequently occurred among younger decedents, wage-and- salary workers, larger employers, and commercial construction sites, deaths caused by falls from lower heights were more common among older decedents, self-employed workers, smaller employers, and residential construction sites. While the information on decedents' job tenure is incomplete, among decedents who had been on the job for just one week, 54% of all fatalities were from falls. This suggests that providing adequate job and safety training is extremely important for construction workers, especially for new workers.

While PFAS is not required when climbing portable ladders under current standards (OSHA, 2014), this study revealed that PFAS was not available or not in use for many fall decedents who worked from heights of 16–30 feet, as well as for some of the decedents who fell from more than 30 feet. More than 70% (see Table 2) of decedents in small establishments (i.e., 20 or fewer employees) were working at heights of 16 feet or above when the incident occurred, but PFAS was present or in use for just 22% (see Table 4) of fall decedents in those establishments. In residential construction as well as the roofing, siding, and sheet metal industries, more than two-thirds of the decedents had no access to PFAS (see Table 4), despite the fact that the majority were working at heights of 16 feet or above when the incident occurred (see Table 2). The small number of incidents that occurred while wearing PFAS suggests that fall protection was effective, confirming the results from a recent case study in residential construction (Bethancourt and Cannon, 2015) and supporting OSHA fall protection requirements.

This study also found that PFAS was present but not in use for about 23% of the falls. Nevertheless, the proportion of workers who had access to, but did not use, fall protection has decreased in recent years, indicating a growing awareness of fall hazards and effective ways to prevent them, as well as increases in positive safety culture or leadership in construction. Previous research has shown an association between a better safety climate and the use of fall protection (Dutra et al., 2014; Kaskutas et al., 2013). Although PFAS is effective, details from the FACE reports show that PFAS did not provide adequate protection when used improperly. For example, some workers had only one connection point and fell while disconnecting to relocate on a structure (Missouri FACE Investigation #99MO138). PFAS should have "Y" or double lanyards to allow for 100% tie-off fall protection, so that workers who must move from one anchorage point to another anchorage point connect to the new anchorage prior to disconnecting from the old. In other cases, workers tie-off to other suspended objects instead of a proper anchorage point (NIOSH FACE Investigation #9820;

Colorado FACE Investigation #92CO001) as required by OSHA Regulation 1926.502(d)(15). Finally, some PFAS were damaged or not properly engaged, and were not adequately inspected prior to use (California FACE Investigation #95CA016). These cases confirm that adhering to OSHA requirements would have saved lives. PFAS should not only be provided to workers exposed to fall hazards, but must be inspected before use, and workers must be trained on how to use them correctly (OSHA Regulations 29 CFR 1926.502(d)(21) and 29 CFR 1926.503(a)(2)(iii)).

Workers in residential construction typically work on projects below 30 feet, but the findings show that considerable risk of fatality is possible at lower heights. None of the fall decedents in the residential construction industry were using PFAS when the incident occurred. This could be because workers on residential construction sites often use portable ladders to access heights and PFAS is not required in such cases. Many ladder falls could be prevented if contractors and owners planned ahead for the job; inspected and maintained ladders before use; verified proper set up and use; and considered alternatives to ladders such as aerial lifts and stairways. Additionally, employers should ensure that each employee is properly trained and fully understands the nature of fall hazards in the work area and the correct procedures for using ladders and fall protection systems (Dong et al., 2014). Furthermore, Teran et al. (2015) found that small contractors perceive financial disincentives for implementing fall protection. A survey study by Choi and Carlson (2014) showed that about one-third of residential building contractors did not have any form of safety programs. OSHA developed a series of resources with strategies to improve adherence to fall protection in residential construction, which address the special needs of smaller businesses (OSHA, 2015a). OSHA encourages small employers to contact its On-site Consultation Program for free and confidential occupational health and safety advice (OSHA, 2015c). Other efforts, such as the National Safety Stand-Down, which is part of a broader construction falls prevention campaign sponsored by OSHA, NIOSH, and CPWR – The Center for Construction Research and Training, was initiated in part to reach small employers, providing a wealth of information on fall prevention, and available on websites hosted by OSHA, NIOSH, and CPWR (https://www.osha.gov/SLTC/fallprotection/standards.html; www.cdc.gov/niosh/topics/falls/; www.stopconstructionfalls.com).

The widely accepted hierarchy of fall prevention controls emphasizes engineering controls as more effective than PFAS. Studies have shown that safety practices of construction workers cannot mitigate all occupational hazards. Although PFAS is an important element of fall protection, the first goal on construction sites should be to eliminate fall hazards altogether. For example, guardrails and toeboards to protect openings, skylights, and edges have been proven effective for fall risk mitigation (Fullen and Savage, 2015; Bobick et al., 2010). However, guardrails were not installed at most of the fall incident sites in the FACE reports, and guardrail installation has been frequently recommended by FACE investigators based on the event circumstances. According to OSHA construction industry regulation 29 CFR 1926.502 (Subpart M), one of the conventional fall protection systems is guardrail systems comprising top edge, midrails, and toeboards (OSHA, 1995b). OSHA also requires that "Each employee on walking or working surfaces shall be protected from falling through holes (including skylights) more than 6 feet (1.8 m) above lower levels, by personal fall arrest systems, covers, or guardrail systems erected around such holes" and that "Each employee on a walking/working surface shall be protected from tripping in or stepping into or through holes (including skylights) by covers" (OSHA, 1995a; 29 CFR 1926.501(b)(4)(i)). These OSHA regulations are important to follow for effective fall prevention.

More and more safety and health professionals have become aware that Prevention through Design (PtD) can be one of the keys to making construction projects safer (Rajendran and Gambatese, 2013). NIOSH's PtD strategy intends to prevent or reduce falls in construction through the inclusion of safety considerations in the initial design. For example, identifying and mitigating hazards by incorporating safety features (e.g., guardrails, PFAS anchor points) into the worksite or designing the permanent structure can promote a safe work environment (NIOSH, 2014; Rajendran and Gambatese, 2013; Dewlaney and Hallowell, 2012; Lingard et al., 2013).

This study has several limitations. First, it should be noted that the FACE program is not nationally representative since only selected states participated. Also, individual states conduct fatality investigations according to self-identified state-level targets in addition to the NIOSH targets. Therefore, the FACE investigation targets do not necessarily represent all occupational fatalities covered by occupational injury surveillance systems (e.g., CFOI). In addition, many cases occurred decades ago, and the reporting states and number of cases also vary from year to year, as do the types of fatalities targeted, and PFAS requirements over time. Therefore, this study only provides characteristics from a subset of fall fatalities in construction, and may not represent current worksite conditions. Moreover, several important data points are not included in the analysis due to missing data. For example, information on Hispanic and foreign-born workers was only available in recent years. Thus, no such demographic analysis could be conducted for this study. Finally, the numeric format of the CFD is convenient for statistical analyses, but the contents of the CFD cannot completely cover the rich information provided in each original, unique, and detailed FACE report. Even if existing coding systems were used where possible in the CFD, misclassifications may be present.

Despite the limitations, the information found in the FACE reports describes the risk of fall fatalities under various circumstances, and sheds light on underutilized PFAS practices in the U.S. construction industry, which can be used to inform further research and targeted interventions. Future studies are needed to verify these findings, including analyses of the recently available CFOI data on heights of falls, and fall inspections in the OSHA inspection databases.

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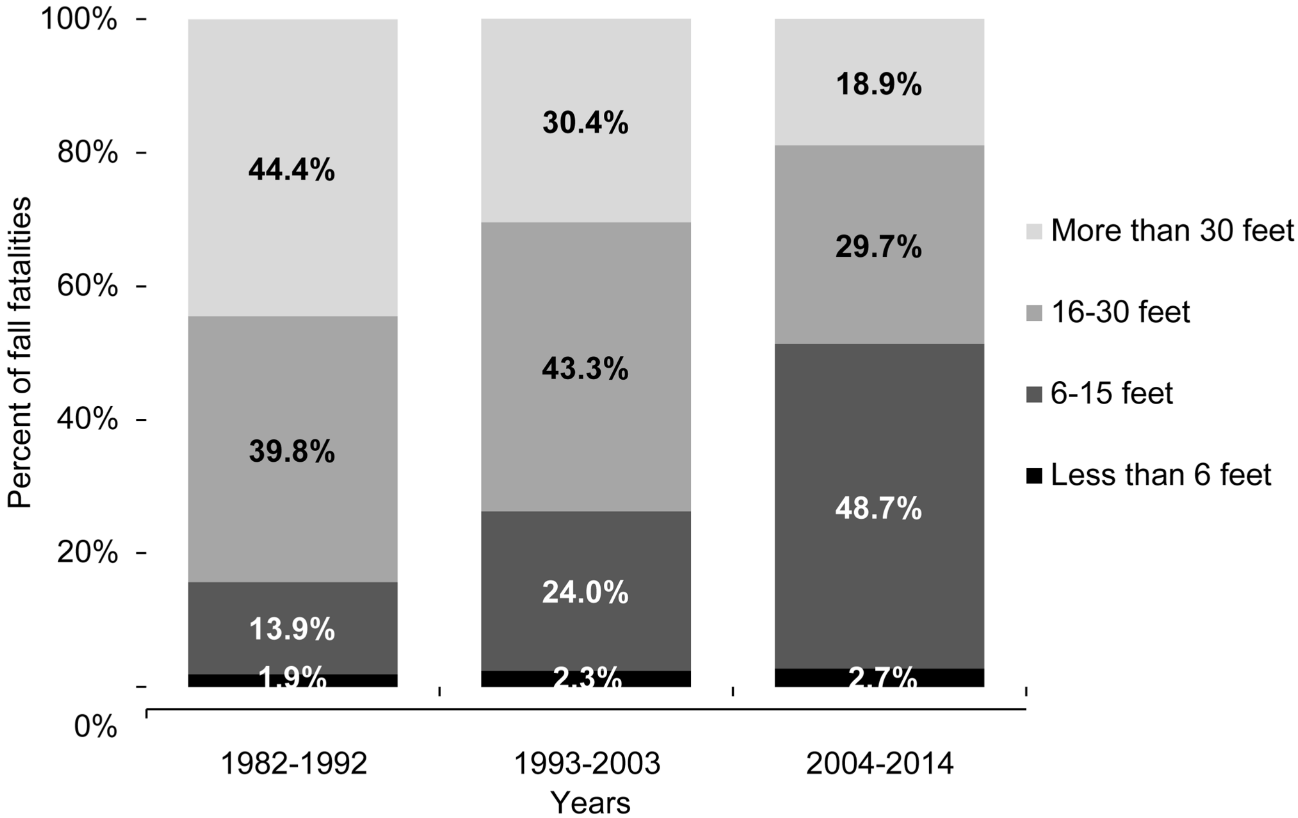

Fig. 1.

NIOSH FACE reports: fatal falls in construction, by height of fall, 1982–2014. Height of fall is missing for 9 of 325 cases.

Source: NIOSH and State FACE Reports for Construction.

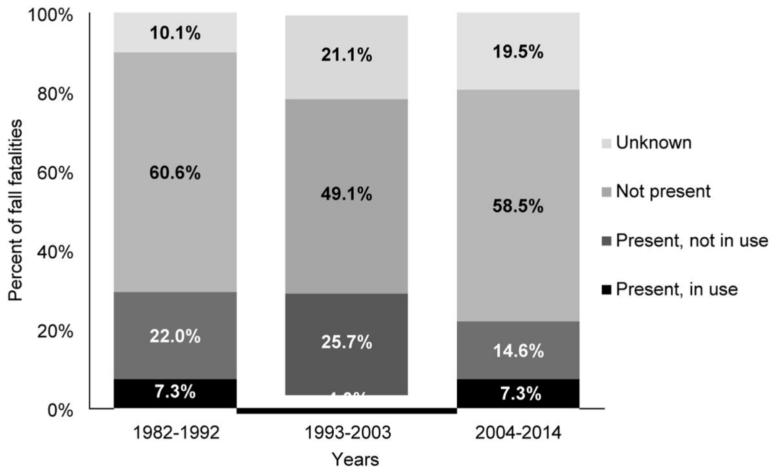

Fig. 2.

NIOSH FACE reports: fatal falls in construction, by Personal Fall Arrest System (PFAS) status, 1982–2014.

Source: NIOSH and State FACE Reports for Construction.

Table 1

Characteristics of FACE fatalities, all fatalities vs. fatal falls.

Characteristics	All Fatalities Number	Fatal Falls	
		Number	% of all Fatalities
Age			
Less than 25 years	126	45	35.7%
25–44 years	375	169	45.1%
45–64 years	189	88	46.6%
65+ years	25	15	60.0%
Not reported	53	8	15.1%
Employment Status			
Wage-and-salary	666	278	41.7%
Self-employed	71	31	43.7%
Other/Not reported	31	16	51.6%
Occupation			
Construction laborers, helpers	186	60	32.3%
Structural metal workers	61	42	68.9%
Supervisors, construction	98	40	40.8%
Carpenters	55	34	61.8%
Roofers	40	31	77.5%
Other, n.e.c.	328	118	36.0%
Job Tenure			
Up to 1 week	67	36	53.7%
>1 week to 2 months	82	42	51.2%
>2 months to 6 months	71	33	46.5%
>6 months to 2 years	105	47	44.8%
>2 years to 5 years	82	36	43.9%
>5 years	163	69	42.3%
Unknown/Not reported	198	62	31.3%
Industry			
General Building Contractors – Residential	53	32	60.4%
General Building Contractors – Nonresidential	70	35	50.0%
Roofing, Siding, & Sheet Metal Work	76	58	76.3%
Structural Steel Erection	53	38	71.7%
Special Trade Contractors, n.e.c.	288	118	41.0%
Other, n.e.c.	228	44	19.3%
Employer Size			
Up to 20 employees	338	172	50.9%
21 to 200 employees	212	83	39.2%
More than 200 employees	89	33	37.1%
Unknown/Not reported	93	37	39.8%
Total	768	325	42.3%

Table 2

Height of falls, selected characteristics.

Characteristics	Height of Falls				Total Falls[1] (Number) %
	Less than 6 Feet	6–15 Feet	16–30 Feet	More than 30 Feet	
	Percent	Percent	Percent	Percent	
Total	(7) 2.2%	(74) 23.4%	(128) 40.5%	(107) 33.9%	(316) 100%
Age					
Less than 25 years	2.3%	23.3%	37.2%	37.2%	(43) 100%
25–44 years	0.6%	18.9%	43.3%	37.2%	(164) 100%
45–64 years	3.4%	28.7%	39.1%	28.7%	(87) 100%
65+ years	13.3%	53.3%	33.3%	0.0%	(15) 100%
Not reported	0.0%	0.0%	28.6%	71.4%	(7) 100%
Employment Status					
Wage-and-salary	1.5%	21.2%	41.0%	36.3%	(273) 100%
Self-employed	3.6%	42.9%	39.3%	14.3%	(28) 100%
Other/Not reported	13.3%	26.7%	33.3%	26.7%	(15) 100%
Occupation					
Construction laborers, helpers	1.7%	29.3%	51.7%	17.2%	(58) 100%
Structural metal workers	0.0%	9.5%	38.1%	52.4%	(42) 100%
Supervisors, construction	5.1%	17.9%	43.6%	33.3%	(39) 100%
Carpenters	0.0%	54.5%	39.4%	6.1%	(33) 100%
Roofers	0.0%	23.3%	63.3%	13.3%	(30) 100%
Other, n.e.c.	3.5%	18.4%	28.9%	49.1%	(114) 100%
Job Tenure					
Up to 1 week	0.0%	30.6%	38.9%	30.6%	(36) 100%
>1 week to 2 months	0.0%	17.1%	48.8%	34.1%	(41) 100%
>2 months to 6 months	6.3%	18.8%	40.6%	34.4%	(32) 100%
>6 months to 2 years	2.2%	22.2%	35.6%	40.0%	(45) 100%
>2 years to 5 years	0.0%	26.5%	29.4%	44.1%	(34) 100%
>5 years	1.5%	30.9%	45.6%	22.1%	(68) 100%
Unknown/Not reported	5.0%	16.7%	40.0%	38.3%	(60) 100%

Characteristics	Height of Falls				Total Falls[1] (Number) %
	Less than 6 Feet	6–15 Feet	16–30 Feet	More than 30 Feet	
	Percent	Percent	Percent	Percent	
Industry					
General Building Contractors – Residential	0.0%	48.4%	48.4%	3.2%	(31) 100%
General Building Contractors – Nonresidential	2.9%	28.6%	42.9%	25.7%	(35) 100%
Roofing, Siding, & Sheet Metal Work	0.0%	26.3%	54.4%	19.3%	(57) 100%
Structural Steel Erection	0.0%	8.3%	47.2%	44.4%	(36) 100%
Special Trade Contractors, n.e.c.	3.5%	21.1%	32.5%	43.0%	(114) 100%
Other, n.e.c.	4.7%	16.3%	30.2%	48.8%	(43) 100%
Employer Size					
Up to 20 employees	1.2%	27.5%	44.3%	26.9%	(167) 100%
21 to 200 employees	2.4%	18.1%	38.6%	41.0%	(83) 100%
More than 200 employees	3.0%	24.2%	21.2%	51.5%	(33) 100%
Unknown/Not reported	6.1%	15.2%	45.5%	33.3%	(33) 100%

[1] Height of fall is missing for 9 of 325 cases.

Table 3

Case characteristics by height of fall.

Characteristics	Height of Fall				
	Less than 6 Feet Percent	6–15 Feet Percent	16–30 Feet Percent	More than 30 Feet Percent	Total Falls[1] (Number) %
Total	(7) 2.2%	(74) 23.4%	(128) 40.5%	(107) 33.9%	(316) 100%
Type of Fall					
Fall through floor opening/surface	0.0%	21.7%	43.5%	34.8%	(23) 100%
Fall through roof surface, existing opening, or skylight	0.0%	7.5%	67.9%	24.5%	(53) 100%
Fall from roof edge	0.0%	22.9%	52.1%	25.0%	(48) 100%
Fall from scaffold, staging, building girders, or other structural steel	2.2%	22.5%	24.7%	50.6%	(89) 100%
Fall from ladder	7.7%	41.0%	46.2%	5.1%	(39) 100%
Fall to lower level, n.e.c.	3.1%	28.1%	26.6%	42.2%	(64) 100%
Location					
Nonresidential construction site	3.8%	16.8%	42.7%	36.6%	(131) 100%
Residential construction site	2.0%	48.0%	40.0%	10.0%	(50) 100%
Industrial places & premises	0.0%	20.0%	45.7%	34.3%	(35) 100%
Residential home	0.0%	26.5%	61.8%	11.8%	(34) 100%
Public building	3.6%	32.1%	21.4%	42.9%	(28) 100%
Other, n.e.c.	0.0%	7.9%	23.7%	68.4%	(38) 100%

[1] Height of fall is missing for 9 of 325 cases.

Table 4

Personal Fall Arrest System (PFAS) status, selected characteristics.

Characteristics	PFAS Status				Total Falls (Number) %
	Present, in Use Percent	Present, not in Use Percent	Not Present Percent	Unknown Percent	
Total	(18) 5.5%	(75) 23.1%	(176) 54.2%	(56) 17.2%	(325) 100%
Age					
Less than 25 years	8.9%	22.2%	53.3%	15.6%	(45) 100%
25–44 years	4.1%	26.0%	52.1%	17.8%	(169) 100%
45–64 years	4.6%	21.6%	58.0%	15.9%	(88) 100%
65+ years	0.0%	6.7%	66.7%	26.7%	(15) 100%
Not reported	37.5%	12.5%	37.5%	12.5%	(8) 100%
Employment Status					
Wage-and-salary	6.5%	24.8%	52.5%	16.2%	(278) 100%
Self-employed	0.0%	3.2%	67.7%	29.0%	(31) 100%
Other	0.0%	31.3%	56.3%	12.5%	(16) 100%
Occupation					
Construction laborers, helpers	1.7%	13.3%	70.0%	15.0%	(60) 100%
Structural metal workers	11.9%	54.8%	26.2%	7.1%	(42) 100%
Supervisors, construction	0.0%	25.0%	55.0%	20.0%	(40) 100%
Carpenters	2.9%	8.8%	55.9%	32.4%	(34) 100%
Roofers	3.2%	12.9%	71.0%	12.9%	(31) 100%
Other, n.e.c.	8.5%	22.9%	50.9%	17.8%	(118) 100%
Job Tenure					
Up to 1 week	8.3%	16.7%	52.8%	22.2%	(36) 100%
> 1 week to 2 months	2.4%	26.2%	59.5%	11.9%	(42) 100%
>2 months to 6 months	0.0%	24.2%	45.5%	30.3%	(33) 100%
>6 months to 2 years	10.6%	25.5%	46.8%	17.0%	(47) 100%
>2 years to 5 years	11.1%	25.0%	61.1%	2.8%	(36) 100%
>5 years	0.0%	20.3%	56.5%	23.2%	(69) 100%
Unknown/Not reported	8.1%	24.2%	54.8%	12.9%	(62) 100%
Industry					

Characteristics	PFAS Status				Total Falls (Number) %
	Present, in Use Percent	Present, not in Use Percent	Not Present Percent	Unknown Percent	
General Building Contractors – Residential	0.0%	3.1%	68.8%	28.1%	(32) 100%
General Building Contractors – Nonresidential	2.9%	25.7%	51.4%	20.0%	(35) 100%
Roofing, Siding, & Sheet Metal Work	3.5%	12.1%	70.7%	13.8%	(58) 100%
Structural Steel Erection	13.2%	44.7%	36.8%	5.3%	(38) 100%
Special Trade Contractors, n.e.c.	3.4%	26.3%	47.5%	22.9%	(118) 100%
Other, n.e.c.	13.6%	22.7%	56.8%	6.8%	(44) 100%
Employer Size					
Up to 20 employees	2.9%	18.6%	58.7%	19.8%	(172) 100%
21 to 200 employees	6.0%	27.7%	47.0%	19.3%	(83) 100%
More than 200 employees	9.1%	39.4%	51.5%	0.0%	(33) 100%
Unknown/Not reported	13.5%	18.9%	51.4%	16.2%	(37) 100%

Table 5

Case characteristics by Personal Fall Arrest System (PFAS) status.

Characteristics	Personal Fall Arrest System				Total Falls (Number) %
	Present, in Use Percent	Present, not in Use Percent	Not Present Percent	Unknown Percent	
Total	(18[1]) 5.5%	(75) 23.1%	(176) 54.2%	(56) 17.2%	(325) 100%
Type of Fall					
Fall through floor opening/surface	0.0%	25.0%	58.3%	16.7%	(24) 100%
Fall through roof surface, existing opening, or skylight	0.0%	22.6%	66.0%	11.3%	(53) 100%
Fall from roof edge	6.1%	18.4%	73.5%	2.0%	(49) 100%
Fall from scaffold, staging, building girders, or other structural steel	11.1%	34.4%	43.3%	11.1%	(90) 100%
Fall from ladder	0.0%	4.7%	41.9%	53.5%	(43) 100%
Fall to lower level, n.e.c.	7.6%	22.7%	51.5%	18.2%	(66) 100%
Location					
Nonresidential construction site	8.2%	25.4%	52.2%	14.2%	(134) 100%
Residential construction site	0.0%	11.3%	64.2%	24.5%	(53) 100%
Industrial places & premises	0.0%	25.0%	52.8%	22.2%	(36) 100%
Residential home	2.9%	8.8%	76.5%	11.8%	(34) 100%
Public building	10.7%	21.4%	46.4%	21.4%	(28) 100%
Other, n.e.c.	7.5%	42.5%	35.0%	15.0%	(40) 100%
Height of Fall					
Less than 6 feet	0.0%	0.0%	57.1%	42.9%	(7) 100%
6–15 feet	1.4%	5.4%	63.5%	29.7%	(74) 100%
16–30 feet	0.0%	20.3%	60.9%	18.8%	(128) 100%
More than 30 feet	15.9%	41.1%	37.4%	5.6%	(107) 100%

[1] About 13 decedents wore PFAS but did not tie-off.