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Construction industry workers' compensation injury claims due to slips, trips, and falls – Ohio, 2010–2017

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Abstract

Problem: Compared to other industries, construction workers have higher risks for serious fall injuries. This study describes the burden and circumstances surrounding injuries related to compensable slip, trip, and fall (STF) claims from private construction industries covered by the Ohio Bureau of Workers' Compensation.

Methods: STF injury claims in the Ohio construction industry from 2010–2017 were manually reviewed. Claims were classified as: slips or trips without a fall (STWOF), falls on the same level (FSL), falls to a lower level (FLL), and other. Claim narratives were categorized by work-related risk and contributing factors. Demographic, employer, and injury characteristics were examined by fall type and claim type (medical-only (MO, 0–7 days away from work, DAFW) or lost-time (LT, ≥8 DAFW)). Claim rates per 10,000 estimated full-time equivalent employees (FTEs) were calculated.

Results: 9,517 Ohio construction industry STF claims occurred during the 8-year period, with an average annual rate of 75 claims per 10,000 FTEs. The rate of STFs decreased by 37% from 2010 to 2017. About half of the claims were FLL (51%), 29% were FSL, 17% were STWOF, and 3% were "other." Nearly 40% of all STF claims were LT; mostly among males (96%). The top three contributing factors for STWOF and FSL were: slip/trip hazards, floor irregularities, and ice/snow; and ladders, vehicles, and stairs/steps for FLL. FLL injury rates per 10,000 FTE were highest in

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Declaration of Competing Interest

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these industries: Foundation, Structure, and Building Exterior Contractors (52); Building Finishing Contractors (45); and Residential Building Construction (45). The highest rate of FLL LT claims occurred in the smallest firms, and the FLL rate decreased as construction firm size increased.

Discussion and Practical Applications: STF rates declined over time, yet remain common, requiring prevention activities. Safety professionals should focus on contributing factors when developing prevention strategies, especially high-risk subsectors and small firms.

Keywords

Construction workers; Workers' compensation claims; Occupational injuries or Work-related; injuries; Slips, trips, or falls

1. Introduction

Fall injuries are a leading cause of morbidity and mortality among workers in the United States, with the construction industry and construction workers bearing a disproportionate burden. The U.S. construction industry currently employs more than 10 million workers (BLS, 2022). Although this is less than 5% of the U.S. workforce, it accounts for 21% of the nation's work-related deaths (BLS, 2021a), which disproportionately affects Hispanic construction workers (Dong et al., 2009). Within the construction industry, slips, trips, and falls (STFs) are the leading cause (37%) of work-related deaths (BLS, 2021a; Socias-Morales et al., 2018) and the second most common cause (29%) of nonfatal injuries involving days away from work (BLS, 2021b). When nonfatal work-related STFs occur in the construction industry, they are frequently severe (Konda et al., 2016). Across all industries, 64% of all lost workday STFs resulted in more than 5 days away from work (BLS, 2021c). As a group, STFs are the most expensive category of injuries in direct U.S. workers' compensation costs (Liberty Mutual Insurance, 2022).

Large national surveillance systems administered and summarized by the Bureau of Labor Statistics (BLS) are valuable in documenting national and state-level counts, rates, and trends in work-related injuries and fatalities. However, additional information for prevention may be found by exploring the surveillance capabilities of other systems like workers' compensation (WC) claims databases (Utterback et al., 2012). WC claims provide more detail about the nonfatal injury circumstances, including cost, severity, source, and nature of injury, as well as narratives of events and exposures leading to injury. Companies have been found to be particularly interested in using WC claims as an outcome measure to evaluate safety interventions, for example, because claims are so closely tied to cost for companies, either directly or indirectly (Asuquo et al., 2021; Bell et al., 2009; Bell et al., 2019; Moore et al., 2018; Utterback et al., 2012; Wurzelbacher et al., 2022; Wurzelbacher et al., 2014).

Previous WC research reports describe the injury experience of workers in the construction industry. Lipscomb et al. (2006) examined over 4,000 injury claims that occurred during the building of the Denver International Airport. Calkins et al. (2019) focused on heat exposure and injury risk to outdoor workers in Washington State. Kaur et al. (2021) looked specifically at musculoskeletal disorders related to overexertion in Ohio. Wurzelbacher et al. (2021) summarized and compared all industries (including construction) represented in

the Ohio Bureau of Workers' Compensation (OHBWC) database. The latter two papers document overexertion injuries as being the most frequent cause of lost-time injuries in the Ohio construction industry, at 33% of the total. STFs ranked a very close second at 31% of total lost-time claims but were not examined in detail.

The objective of this study was to use WC claims to quantify and describe the burden and contributing factors of STFs in the Ohio construction industry. This information can guide prevention resources toward reducing the most common and severe nonfatal fall risks, not only for the state of Ohio, but for the U.S. construction industry.

2. Methods

The OHBWC is the exclusive state-based provider of WC insurance in the state of Ohio, providing insurance for roughly two-thirds of public and private workers in 2022 (OHBWC, 2022). Exclusive refers to "state-sponsored workers' compensation insurance in jurisdictions where private insurance is not allowed" (Utterback et al., 2014). OHBWC compensable claims (i.e., accepted claims) were shared with the National Institute for Occupational Safety and Health (NIOSH) Center for Workers' Compensation Studies as part of a longstanding, collaborative research partnership. Compensable or accepted claims are those that have gone through an investigative determination process to confirm that they are work-related and covered under workers' compensation policies (OHBWC, 2023; Utterback et al., 2014). Roughly 88% of claims were accepted, and therefore shared with NIOSH (OHBWC, 2019). Each claim in the OHBWC database includes demographic, employer, and injury characteristics, for example, diagnoses, and claim type: medical-only (MO, 0–7 days away from work) or lost-time (LT, ≥8 days away from work), along with a brief injury narrative. Generally, OHBWC transfers claims data for a given calendar year no sooner than two years after the year ended. It is common when analyzing workers' compensation claims to allow the claims to 'mature' for at least a year or longer. The most recent year of claims available at the start of this study for manual review to assign injury event codes and contributing factors, and analysis was 2017. This study involved the analysis of coded WC administrative claims data. Use of these data as part of this research partnership was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted consistent with applicable federal law and CDC policy. (See e.g., 45 C.F.R. part 46; 21 C.F.R. part 56; 42 U.S.C.§241(d), 5 U.S.C. §552a, 44 U.S.C. §3501 et seq).

We used machine learning assisted coding to flag all probable slip, trip, or fall claims for further manual review (Meyers et al., 2018; Wurzelbacher et al., 2016). Machine learning relies on a 'gold standard' set of manually coded claims. For this study we used two manually coded outcome variables and statistical models to identify claims probably caused by slips, trips, or falls. First, the simple causation variable included three levels: (1) slips, trips, or falls; (2) musculoskeletal disorders caused by ergonomic hazards; and (3) all other causes (Bertke et al., 2012). Second, the more detailed variable had 49 levels based on 2-digit codes based on the second version of the Occupational Injury and Illness Classification System (OIICS) from the BLS (Bertke et al., 2016; BLS, 2012) and is furthered described in section 2.2.

The machine learning algorithms used two variables to assign probabilities for each level, diagnosis category (N = 57) (Meyers et al., 2018) and the narrative description. For each causation variable, the level with the highest probability was selected as the probable cause. Naïve Bayes was used for the simple causation auto-coder and logistic regression was used for the two-character OIICS model. Detailed statistical methods for the two models are available elsewhere (Bertke et al., 2012; Bertke et al., 2016; Meyers et al., 2018).

Recent advances in computing power and artificial intelligence have reduced the need to manually code all records from administrative databases. For occupational epidemiology, unstructured narrative data have become a powerful tool for preventing injuries and understanding causation patterns. Taking the time to invest in developing a robust, manually-coded training set makes it practical to analyze large administrative databases. The narrative data associated with each workers' compensation claims are invaluable. NIOSH collaborates on auto-coding with other government, academic, and insurance organizations; contact the NIOSH Center for Workers' Compensation (cwcs@cdc.gov) for consultation or assistance with using the machine-assisted coding methods described in this paper.

2.1. STF case definition

First, we limited claims for study inclusion to the construction industry from 2010-2017 identified by the North American Industry Classification System (NAICS) 6-digit codes beginning with 23 (Fig. 1). We identified STF injuries from two algorithm-generated codes where injuries were classified as either: (1) "STF" according to the three-option coding scheme, or (2) coded as 40, 41, 42, 43, 44, 45, or 49 according to the OIICS event/exposure coding scheme.

2.2. Event classification and manual review of claims

All construction claims included in this study were manually reviewed by trained coders for accuracy of auto-coded event/exposure codes to ensure that only falls were captured in the study. Three coders were familiarized with the NIOSH/BLS OIICS and code assignment decision-making. The first coder reviewed claims from 2010–2013; the second coder reviewed claims from 2014–2017; the third coder was previously trained directly by BLS and reviewed all years (2011–2017) of claims included in this study. Any discrepancies between the coders were discussed with the first and second authors of the paper to achieve consensus. Specifically, each trained coder reviewed the claims and compared the auto-coded two-digit OIICS event/exposure code to the narrative and other contextual variables. If the auto-coded assigned code did not match the information available from the narrative, the trained coder provided a new accurate code.

Claims were classified into four categories by type of STF (Fig. 1) and presented by the order of the OIICS codes. Slips or trips without a fall (STWOF, OIICS = '41') were classified from injuries occurring when a worker tripped on an obstacle but did not fall to the ground, and similar events. Falls on the same level (FSL, OIICS = '42') were classified based on a fall without height, such as falling on an icy parking lot. Falls to a lower level (FLL, OIICS = '43') were classified based on a fall involving any height, such as a fall down a flight of stairs. Other types of falls include those that did not fit the other preceding

categories (other, OIICS = 40 ‘Fall, slip, trip, unspecified’ 44’Jumps to lower level,’ 45 ‘Fall or jump curtailed by personal fall arrest system,’ 49 ‘Fall, slip, trip, not elsewhere classified’).

2.3. Contributing factor classification

Researchers reviewed the OIICS coding manual for assigning primary and secondary injury/illness sources and adapted the source of injury categories to be more informative for prevention purposes specific to falls. Because our assignments do not match the OIICS definition of “source of injury,” we refer to these assignments as “contributing factors.” The third OIICS-trained coder mentioned in Section 2.2 who reviewed all event codes, also reviewed all narratives to assign a text description of the primary and secondary contributing factor (rather than an OIICS source of injury code). After secondary review by the research team, the text descriptions were grouped into 15 detailed categories (Tables 1-3). STWOF are assigned an OIICS primary source code of “injured worker” when the nature of injury is a musculoskeletal injury. For this study, when information was available, we identified primary contributing factor(s) for the injury beyond the injured worker unless the injured worker was the only factor. In the absence of any other information, we assigned a walking surface as the primary contributing factor (e.g., roof, floor irregularity, vehicle). If a specific hazard was identified, we prioritized that hazard over the walking surface (e.g., if a worker slipped on an icy roof, we prioritized the ice as the contributing factor).

2.4. Occupation classification and manual review of claims

Claims were internally submitted to the NIOSH Industry and Occupation Computerized Coding System (NIOCCS) to classify the text occupation of the worker associated with each claim (NIOSH, 2022a). Occupations were then manually reviewed for accuracy. The 2010 Standard Occupational Classification system (BLS, 2018) was used to assign codes to text entry occupations at a broad level (5-digit) from a combination of NIOCCS and manual review by the first author who was trained in decision-making to assign industry and occupation codes.

2.5. Diagnosis classification

Diagnosis codes were categorized into 57 mutually exclusive clinical diagnosis groups using the International Classification of Diseases, Ninth and Tenth Revision, Clinical Modification (ICD-9-CM, ICD-10-CM) diagnosis codes. Each clinical diagnosis group was counted once per claim, but a claim can have more than one distinct diagnosis group assigned (e.g., knee sprain or tear and fracture of upper extremity). In this study, clinical diagnosis groups that represented < 1% of all LT claims clinical diagnosis groups were collapsed into “all other injuries and illnesses” group. Distribution of LT clinical diagnosis groups were presented by STF type.

2.6. Analysis

Demographic, employer, and injury characteristics were examined among construction industry STF claims by claim types (MO and LT) and by the type of STF. We calculated rates by 4-digit NAICS industry and establishment size. Claim rates per 10,000 estimated

full-time equivalent employees (i.e., FTE = 2,000 hours/year) were calculated using the employee counts from Ohio unemployment insurance (UI) data with the data from the BLS Labor Productivity, and Costs program (Wurzelbacher et al., 2016). To get estimated FTEs, the UI employee counts were multiplied by the number of employees and by their estimated hours per week per worker, then divided by 40. Linking of databases and other general data processing details can be found in Wurzelbacher et al. (2016). For rate calculations,158 construction STF claims were excluded because no matching employee counts could be reliably derived for the corresponding policy-year. As a result, only 9,359 claims were included in the rate calculations out of the total of 9,517 construction STF claims. The denominator includes the number of workers by year, establishment size, and industry. Data available do not allow for calculation of rates by age group, gender, occupation, or other demographic variables (Wurzelbacher et al., 2016).

3. Results

After manual review of auto-coded claims over the 8-year period, 9,517 claims were ascertained to be STFs, at a rate of 75 claims per 10,000 FTEs (Fig. 1). Yearly rates of STF claims decreased by about 37% over the 8-year period; 39% of STF claims were LT claims (Fig. 2). After classifying the claims by type of STF (Tables 1-3), 17% were STWOF, 29% were FSL, about half of the fall claims were FLL, and 3% were all other. Regardless of type of STF, most claims involved males. Information on contributing factors was extracted from 93% of the claim narratives (8,822).

3.1. Slips or trips without a fall (STWOF; OIICS='41')

About 17% of STF claims involved a STWOF, at a rate of 13 per 10,000 FTE. Rates decreased by 48% during the 8-year period (see Fig. 3). About 31% of STWOF events were LT claims (Fig. 1). The largest proportion of claims was among the 25–54 year age range, which is the age range containing the majority of the workforce. Contributing factors for STWOF claims included tripping and slipping hazards (such as wood, pipe, cable, hose, bucket, tools, etc.), floor irregularities (such as hole, manhole, pothole, rut, cracks on floor, ditch, etc.), solid contaminants (such as mud, gravel, dirt, etc.), and liquid contaminants (such as water, oil, and grease). The most numerous occupations represented in STWOF claims included construction laborers (14.6%); carpenters (6.6%); and pipelayers, plumbers, pipefitters, and steamfitters (6.6%) (Table 1).

3.2. Falls on the same level (FSL; OIICS='42')

FSL events comprised 29% of STF claims, at a rate of 22 per 10,000 FTE. Rates decreased by half during the 8-year period (see Fig. 3). About 31% of FSL events were LT claims similar to STWOF (Fig. 1). Most FSL claims were in the middle age group (68%), similar to STWOF claims. Contributing factors for FSL also included floor irregularities, tripping and slipping hazards, and solid contaminants. The most numerous occupations represented in FSL claims included construction laborers (14.1%); pipelayers, plumbers, pipefitters, (7.1%); and electricians (6.9%) (Table 2).

3.3. Falls to a lower level (FLL; OIICS='43')

FLL events comprised over half (51%) of STF claims at a rate of 38 per 10,000 FTE. Rates decreased by 23% during the 8-year period (see Fig. 3). Nearly half (47%) of FLL events were LT claims, a larger proportion compared to other STFs (Fig. 1). Most claims were also in the middle age group (72%). FLL claims included more variety in injuries, such as sprains, fractures, and contusions (Table 3). Roughly 38% of the claims included a ladder as a contributing factor. Other contributing factors included vehicles (e.g., missing a step, slipping, or falling off of a truck or trailer), liquid and solid contaminants, floor irregularities, and tripping and slipping hazards. The most numerous occupations represented in FLL claims included construction laborers (12.6%), electricians (8.8%), and carpenters (8.4%) (Table 3).

3.4. Industry, and establishment size

For industry (Table 4), the highest rates were in the highway, street, and bridge construction industry for both STWOF and FSL. However, the foundation, structure, and building exterior contractors had the highest industry rates for FLL. This industry sector includes roofing contractors. Generally, the rate of STWOF increased as construction firms became larger, and the same was true for falls on the same level. However, the opposite was true for falls to a lower level. The rate of falls to a lower level was higher for smaller construction firms, with the highest rate for firms with 10 or fewer workers.

3.5. Diagnosis groups

From the 9,517 distinct claims included in the study, there were a total of 18,674 clinical diagnosis groups after removing duplicates; the mean clinical diagnosis groups per claim is 1.97 (SD = 1.41). Of these, a little over half, or 52.7%, were LT clinical diagnosis groups (n = 9,842) and 47.3% were medical only. In Table 5, we included the distribution of LT clinical diagnosis groups by type of STF. Ten percent (10%) of claim diagnosis groups involved a STWOF. The most common of these diagnoses were identified as sprains (55.5%), followed by diseases of musculoskeletal and connective tissue (18.1%) and fractures (9.3%). Twenty percent (20%) of the claim diagnosis groups involved FSL. The most common of these diagnoses were identified as sprains (38.6%), followed by diseases of musculoskeletal and connective tissue (17.7%) and contusion with intact skin surface (13.6%). About two thirds (67.1%) of the LT claim diagnosis groups were FLL with a more even distribution among different types of diagnoses groups and a higher percentage of fractures. The most common of these diagnoses were identified as sprains (27.1%), followed by fractures (24.2%), and diseases of musculoskeletal and connective tissue (12.1%). All other types of falls represented less than 3% of clinical diagnosis groups.

4. Discussion

This study used detailed information provided by workers' compensation injury claims to identify specific circumstances associated with STFs among construction workers. Most claims involved male workers, which is not surprising given that males comprise nearly 90% of construction industry workers (BLS, 2022). Contributing factors for STWOF and FSL identified in this study resembled previous research (see below) such as floor irregularities,

ice/snow, and tripping hazards. Ladders and vehicles were identified as leading contributing factors for nonfatal FLL. However, ladders, scaffolds, and roofs are also often noted as contributing factors in fatal FLL research. The findings highlight the need for multi-faceted prevention efforts along the lines of the NIOSH hierarchy of controls (NIOSH, 2022b), such as hazard elimination, and improvements to planning, intervention implementation, and safety management systems.

4.1. STWOF and FSL

A substantial proportion of LT claims in the Ohio construction industry were due to what could be considered “surface conditions” at the interface of the foot and supporting surface, such as ice and snow, floor irregularities, liquid and solid contaminants, and general slipping and tripping hazards. Similar results showing a preponderance of walking surface hazards in construction were found in Lipscomb et al. (2006) in their review of over 4,000 injury claims incurred during the building of the Denver International Airport. These findings warrant attention be given to surface conditions and preventive measures like keeping surfaces clean and dry, when possible, eliminating clutter and tripping hazards such as construction debris, and promoting footwear with tread that is slip-resistant (particularly in outdoor conditions) and not worn down (Bell et al., 2019; Sundaram et al., 2020; Verma et al., 2014; Whitson et al., 2018).

Selecting footwear for use by construction workers can be challenging. Footwear that effectively prevents slipping injuries in indoor environments with predominantly smooth surfaces (Bell et al., 2019; Jones et al., 2018; Verma et al., 2014) will have characteristics different from footwear designed for outdoor use in cold, rough, and muddy environments (Bagheri et al., 2022; Kocher et al., 2020). If workers routinely work at length in both environments, a change of footwear before starting work might be necessary. Regardless of whether work takes place indoors or out, sole wear has been found to a risk factor for slipping, so footwear should be replaced when the tread is worn (Beschorner et al., 2020; Bagheri et al., 2022).

The Center for Construction Research and Training (CPWR) offers a variety of communication resources, such as toolbox talks related to falls on walking/working surfaces (CPWR, 2022a). Many of the other recommendations for reducing FSL developed for other industries can be adapted to the construction environment (Bell et al., 2010; Nasarwanji et al., 2021). The recommendation to keep walkways and working surfaces clean and free of clutter can apply indoors through cleanup of water, grease, cleaning products, and removal of tools, buckets, bags or tubes of product. Working to keep surfaces and walkways clear in the outdoor environment would be similar and could include ice and snow removal, use of sawdust or hay to reduce the slipperiness of mud, and removing stones, tools, and construction debris. Higher-level measures could address some of these conditions, including safety climate and safety leadership training as well as greater use and implementation of prevention through design principles throughout the construction industry (NIOSH, 2014).

4.2. FLL

The injury and fatality burden of falls from heights in the construction industry is well-documented, especially among roofers, and our findings showed consistencies with other studies (BLS, 2021d; CPWR, 2022b; CPWR, 2022c; Robson et al., 2020). We saw that FLL from ladders (Smith et al., 2006; Socias et al., 2014) as well as roofs (Dong et al., 2013) were leading contributing factors; we also found that vehicles were a common contributing factor. Other studies have documented hazards to workers in a variety of industries incurred during vehicle and heavy equipment ingress/egress (Fathallah et al., 2000; Nasarwanji et al., 2018).

Lack of pre-work planning is a key underlying cause of falls from heights in the construction industry, according to the results of a recent survey (CPWR, 2022b). Another study shows that many of the interventions that could be used to prevent falls are not being used or are not used correctly. About 70% of workers in residential roofing, siding and sheet metal construction did not have access to a personal fall arrest systems (Dong et al., 2017). Recent efforts have focused on improving communication about these issues to employers, safety professionals, and workers using infographics (CPWR, 2018). This is further supported by the most common Occupational Safety and Health Administration (OSHA) citations, which include violations related to fall protection (29 CFR 1926.501), scaffolding (29 CFR 1926.451), use of ladders (29 CFR 1926.1053), and fall protection training (29 CFR 1926.503) (CPWR, 2022c; OSHA, 2021).

4.3. Limitations

The results of this study should be interpreted in the context of several limitations. WC claims data include administrative information, but typically do not include worker demographics and risk factors such as race/ethnicity, languages spoken, number of days on the job, and other factors that can inform prevention efforts. The results are specific to Ohio and may not be generalizable to construction workers in other states. Additionally, each state has specific reporting and compensability requirements that may limit the generalizability of these results (Wurzelbacher et al., 2016). Calculating rates of injuries can be difficult due to limitations of denominator and coverage differences between employers. Further, we were unable to calculate rates for sub-categories of workers, such as rates by age, gender, race/ethnicity, and other factors. Ohio BWC does not cover all employees, including self-employed workers and many contingent workers (Wurzelbacher et al., 2016), but WC data still represents most workers, depending on the state (Murphy et al., 2021).

A notable limitation of this study is the inability to estimate non-WC claims. The WC claims analyzed in this study do not include any disapproved claims, any injuries that were not reported by workers, and claims from self-insured employers, which represent about one-third of Ohio workers. A recent study suggests that over a third of work-related injury claims may be billed to non-WC payers, such as other governmental programs or private insurance (Sears et al., 2017). Filing differences may vary by race/ethnicity and other factors associated with health inequities in the worker populations. Moreover, workers may not file a claim for WC because of fear of retaliation from employers or lack of understanding of the WC system (Azaroff et al., 2002).

4.4. Practical applications

Despite the limitations, it's important to note the contribution of our results to understanding STF injuries within the construction industry. Prevention activities should continue to focus on the top contributing factors and the highest risk subsectors. The rate of both STWOF and FSL LT claims increased with the size of the construction firm. Conversely, the highest rate of FLL LT claims was for the smallest firms (10 or fewer workers), with the rate of FLL decreasing as construction firms became larger. The high rates of FLL claims among small firms may in part be due to a lack of dedicated safety staff or adequate fall prevention equipment. One study points to the balance that small construction business owners face between worker safety and survival of their business (Cunningham & Jacobson, 2018). In comparison, larger employers may have more resources to devote to fall prevention systems. There are likely also differences in reporting between larger and smaller firms that impact the data presented in this work. Future studies exploring the relationship between different types of STF injuries among firms with the smallest number of employees, and the differences in rates by establishment size, may be helpful in better focusing prevention efforts.

Forward progress can be made if research continues to assess the efficacy of interventions to reduce STFs among construction workers. OHBWC provides funding to eligible Ohio businesses to purchase safety equipment each year. A recent review of this grant program by Lowe et al. (2020), has shown that the OHBWC safety grants program led to safer work environments and documented savings from improved productivity and reductions in cost and absenteeism among construction businesses (OHBWC, 2022, p 42).

In addition to the safety intervention grants, OHBWC also promotes an annual safety stand-down to prevent falls (OHBWC, 2022, p 46) as part of the National Stand-down to prevent falls in May each year, led by OSHA in partnership with NIOSH and CPWR (Bunting et al., 2017; OSHA, 2015; NIOSH, 2015; NIOSH, 2022c). During this time, OHBWC provides additional resources to employers to promote safety and fall prevention. Each year, the collaborative campaign focuses on specific factors that contribute to falls (Bunting et al., 2017; NIOSH, 2015). According to NIOSH Director John Howard, M.D.: "Employers can set aside time on the job to reinforce the knowledge, training and resources that are available for creating safer workplaces and preventing fatalities and injuries related to falls" (NIOSH, 2022c). A wealth of research evidence-based communication products and other resources are already available on many topics related to falls, such as preventing FLLs involving vehicles and FSLs involving surface contamination. CPWR provides accessible resources on their website, https://www.stop-constructionfalls.com to businesses of all sizes and industries. Efforts to assess the efficacy of these types of interventions will be important to prevention of injuries and fatalities from all types of falls in the construction industry.

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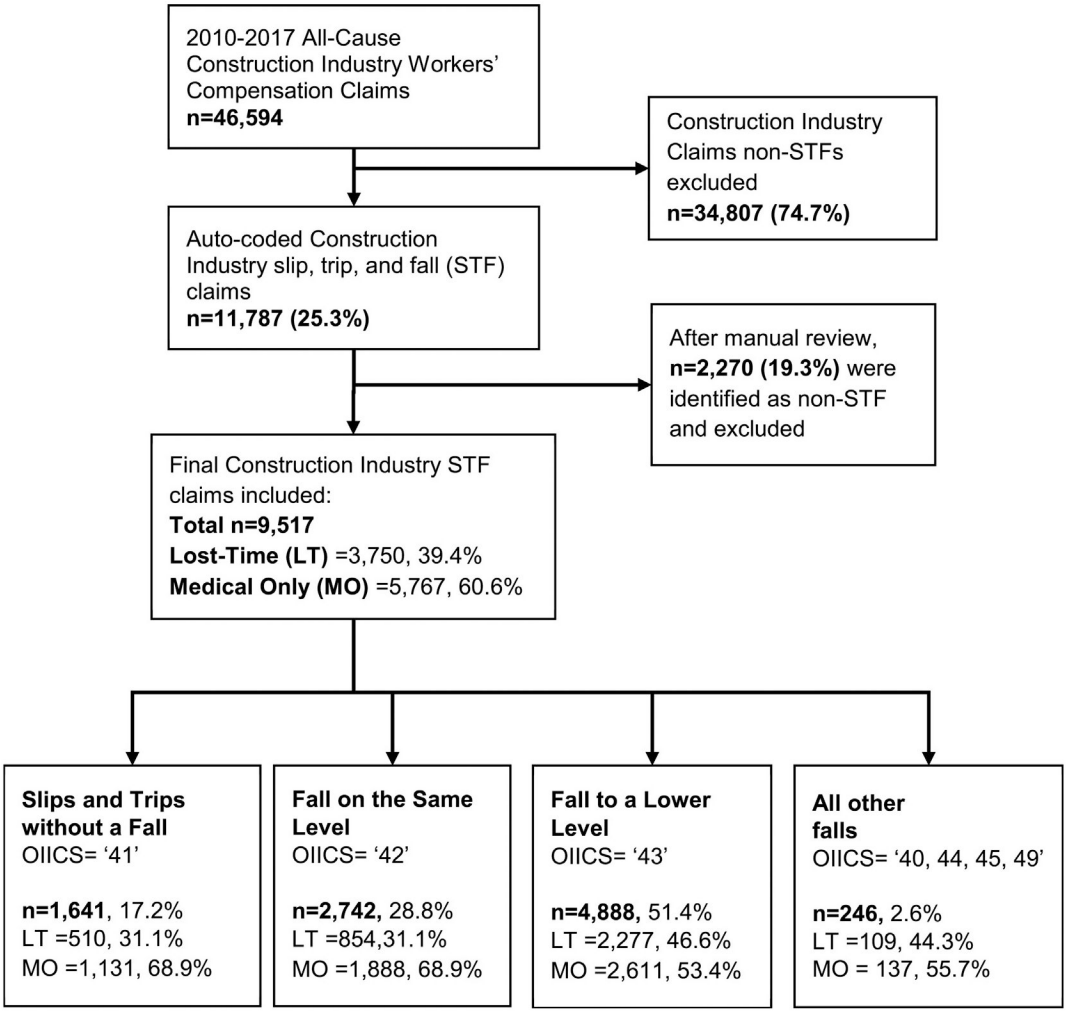


Fig. 1.

Study Inclusion for construction industry workers' compensation injury claims due to slips, trips, and falls—Ohio, 2010–2017.

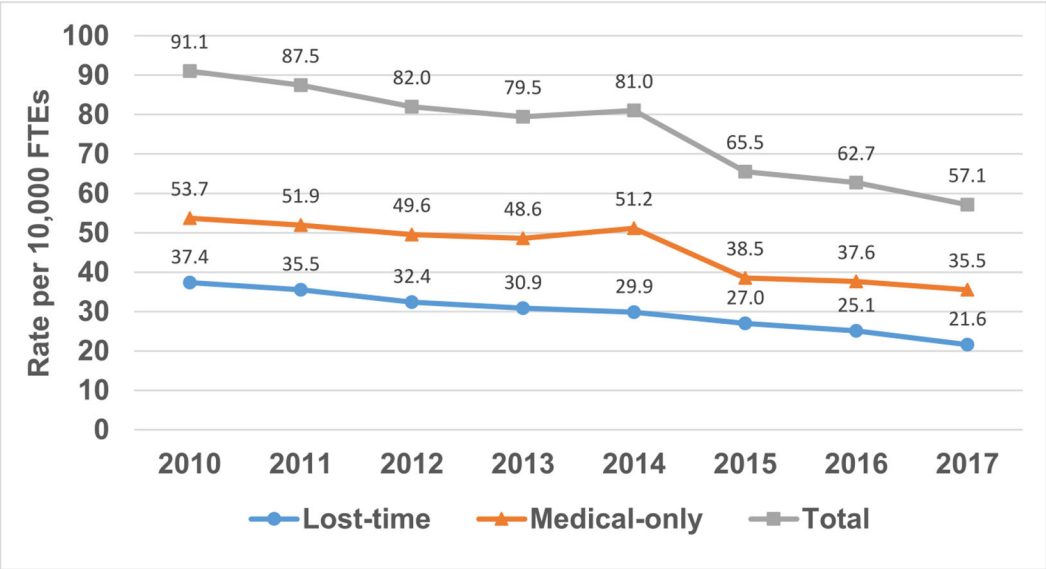
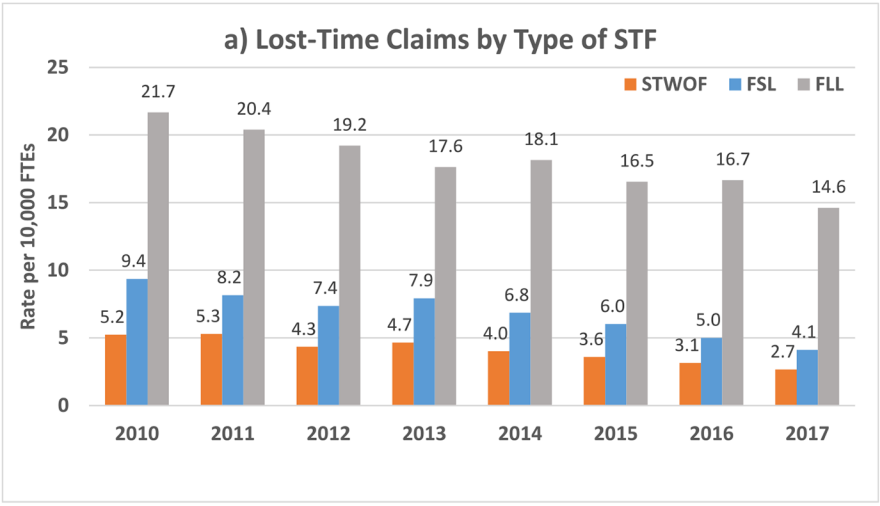


Fig. 2.

Rates of construction industry workers' compensation injury claims involving a slip, trip, or fall (STF), by claim type, Ohio—2010–2017.



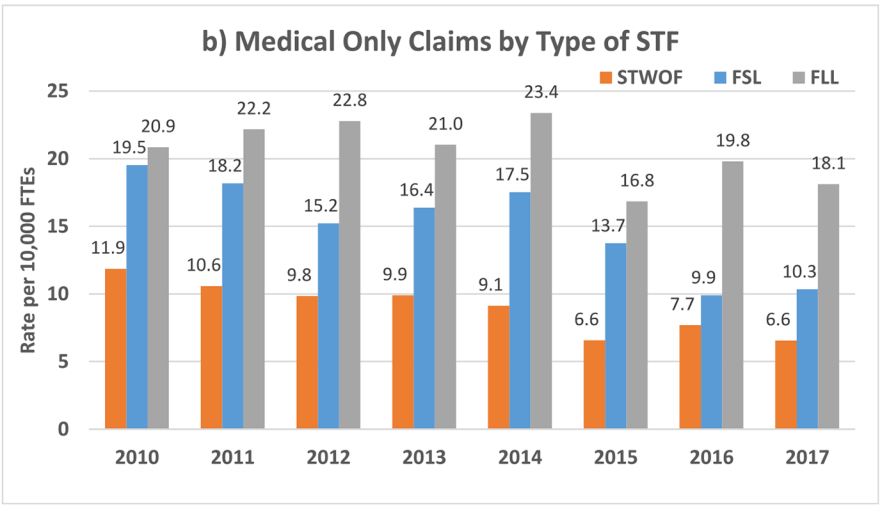


Fig. 3.

Rates of construction industry workers' compensation injury claims by type of slip, trip, or fall (STF) for lost-time claims (a) and medical-only claims (b), Ohio—2010–2017.

Table 1

Number and percentage of construction industry workers' compensation claims involving a slip or trip without a fall (STWOF) by claim type, sex, age group, contributing factors, and occupation, Ohio—2010-2017.

	Lost-time injury claims		Medical-only injury claims		Total injury claims	
	N	%	N	%	N	%
Sex						
Male	493	96.7	1061	93.8	**1554**	**94.7**
Female	15	2.9	61	5.4	**76**	**4.6**
Unknown	2	0.4	9	0.8	**11**	**0.7**
Age group (in years)						
≤19	5	1.0	17	1.5	**22**	**1.3**
20–24	18	3.5	92	8.1	**110**	**6.7**
25–34	82	16.1	277	24.5	**359**	**21.9**
35–44	141	27.6	273	24.1	**414**	**25.2**
45–54	154	30.2	266	23.5	**420**	**25.6**
55–64	102	20.0	189	16.7	**291**	**17.7**
65 and over	8	1.6	17	1.5	**25**	**1.5**
Contributing factors[a,b]						
Tripping or slipping hazards	101	19.8	241	21.3	**342**	**20.8**
Floor irregularities	86	16.9	206	18.2	**292**	**17.8**
Ice or snow	90	17.6	193	17.1	**283**	**17.2**
Unknown	68	13.3	125	11.1	**193**	**11.8**
Solid contaminants	41	8.0	65	5.7	**106**	**6.5**
Stairs or steps	24	4.7	56	5.0	**80**	**4.9**
Liquid contaminants	15	2.9	55	4.9	**70**	**4.3**
Ladder	23	4.5	38	3.4	**61**	**3.7**
Machinery	20	3.9	34	3.0	**54**	**3.3**
Vehicle	15	2.9	39	3.4	**54**	**3.3**
Roof	12	2.4	36	3.2	**48**	**2.9**
All other	9	1.8	19	1.7	**28**	**1.7**
Injured worker	3	0.6	10	0.9	**13**	**0.8**

	Lost-time injury claims		Medical-only injury claims		Total injury claims	
	N	**%**	**N**	**%**	**N**	**%**
Scaffold	3	0.6	10	0.9	**13**	**0.8**
Ceilings and walls	0	-	4	0.4	**4**	**0.2**
Leading occupations (Top 10)[a,c]						
47-2060-Construction Laborers	79	15.5	161	14.2	**240**	**14.6**
47-2030-Carpenters	41	8.0	68	6.0	**109**	**6.6**
47-2150-Pipelayers, Plumbers, Pipefitters, and Steamfitters	39	7.6	70	6.2	**109**	**6.6**
47-1010-First-Line Supervisors of Construction Trades and Extraction Workers	37	7.3	65	5.7	**102**	**6.2**
47-2110-Electricians	35	6.9	65	5.7	**100**	**6.1**
53-7060-Laborers and Material Movers, Handlers	21	4.1	73	6.5	**94**	**5.7**
49-9020-Heating, Air Conditioning, and Refrigeration Mechanics and Installers	24	4.7	59	5.2	**83**	**5.1**
11-9020-Construction Managers	10	2.0	43	3.8	**53**	**3.2**
49-9070-Maintenance and Repair Workers, General	22	4.3	31	2.7	**53**	**3.2**
47-2070-Construction Equipment Operators	18	3.5	28	2.5	**46**	**2.8**
Total	**510**	**100**	**1131**	**100**	**1641**	**100**

Abbreviation, NEC = Not elsewhere classified.

[a]Contributing factors and occupations were identified based on the number of total injury claims only.

[b]Injured worker = Includes bodily conditions and self-induced bodily motion injuries; Tripping hazards = Includes plank, plywood, wire, hose, tools, carpet, rock, concrete, and other objects; Floor or ground irregularities = uneven ground, hole, cracks, trench, and other irregularities; Weather conditions = Ice, snow, wind, and rain; Contaminants = Mud, grease, wet surface, oil, gravel, dirt, and other contaminants.

[c]The 2010 Standard Occupational Classification system was used to assign codes to text entry occupations at a broad level (5-digit) from a combination of NIOCCS and manual review from a trained coder.

Table 2

Number and percentage of construction industry workers' compensation claims involving a fall on the same level (FSL) by claim type, sex, age group, contributing factors, and occupation, Ohio—2010-2017.

	Lost-time injury claims		Medical-only injury claims		Total injury claims	
	N	%	N	%	N	%
Sex						
Male	797	93.3	1711	90.6	**2508**	**91.5**
Female	54	6.3	158	8.4	**212**	**7.7**
Unknown	3	0.4	19	1.0	**22**	**0.8**
Age group (in years)						
≤19	7	0.8	34	1.8	**41**	**1.5**
20–24	41	4.8	149	7.9	**190**	**6.9**
25–34	113	13.2	384	20.3	**497**	**18.1**
35–44	207	24.2	405	21.5	**612**	**22.3**
45–54	274	32.1	483	25.6	**757**	**27.6**
55–64	185	21.7	372	19.7	**557**	**20.3**
65 and over	27	3.2	60	3.2	**87**	**3.2**
Unknown	0	-	1	0.1	**1**	**<0.1**
Contributing factors[a,b]						
Floor irregularities	249	29.2	758	40.1	**1007**	**36.7**
Tripping or slipping hazards	187	21.9	390	20.7	**577**	**21.0**
Ice or snow	135	15.8	209	11.1	**344**	**12.5**
Unknown	112	13.1	227	12.0	**339**	**12.4**
Roof	25	2.9	64	3.4	**89**	**3.2**
All other	27	3.2	34	1.8	**61**	**2.2**
Solid contaminants	28	3.3	30	1.6	**58**	**2.1**
Machinery	18	2.1	38	2.0	**56**	**2.0**
Stairs or steps	17	2.0	36	1.9	**53**	**1.9**
Vehicle	18	2.1	33	1.7	**51**	**1.9**
Liquid contaminants	19	2.2	26	1.4	**45**	**1.6**
Scaffold	6	0.7	21	1.1	**27**	**1.0**

	Lost-time injury claims		Medical-only injury claims		Total injury claims	
	N	%	N	%	N	%
Ladder	8	0.9	8	0.4	**16**	**0.6**
Ceilings and walls	3	0.4	10	0.5	**13**	**0.5**
Injured worker	2	0.2	4	0.2	**6**	**0.2**
Leading occupations (Top 10)[a,c]						
47-2060-Construction Laborers	130	15.2	256	13.6	**386**	**14.1**
47-2150-Pipelayers, Plumbers, Pipefitters, and Steamfitters	78	9.1	117	6.2	**195**	**7.1**
47-2110-Electricians	59	6.9	130	6.9	**189**	**6.9**
53-7060-Laborers and Material Movers, Handlers	52	6.1	126	6.7	**178**	**6.5**
47-1010-First-Line Supervisors of Construction Trades and Extraction Workers	55	6.4	108	5.7	**163**	**5.9**
47-2030-Carpenters	58	6.8	103	5.5	**161**	**5.9**
11-9020-Construction Managers	19	2.2	82	4.3	**101**	**3.7**
49-9020-Heating, Air Conditioning, and Refrigeration Mechanics and Installers	34	4.0	65	3.4	**99**	**3.6**
53-3030-Driver/Sales Workers and Truck Drivers	26	3.0	46	2.4	**72**	**2.6**
47-2070-Construction Equipment Operators	29	3.4	36	1.9	**65**	**2.4**
Total	**854**	**100**	**1888**	**100**	2742	**100**

Abbreviation, NEC = Not elsewhere classified.

[a]Contributing factors, and occupations were identified based on the number of total injury claims only.

[b]Injured worker = Floor or ground irregularities = uneven ground, hole, cracks, trench, and other irregularities; Tripping hazards = Includes plank, plywood, wire, hose, tools, carpet, rock, concrete, and other objects; Weather conditions = Ice, snow, wind, and rain; Contaminants = Mud, grease, wet surface, oil, gravel, dirt, and other contaminants.

[c]The 2010 Standard Occupational Classification system was used to assign codes to text entry occupations at a broad level (5-digit) from a combination of NIOCCS and manual review from a trained coder.

Table 3

Number and percentage of construction industry workers' compensation claims involving a fall to a lower level (FLL) by claim type, sex, age group, contributing factors, and occupation, Ohio—2010-2017.

	Lost-time injury claims		Medical-only injury claims		Total injury claims	
	N	%	N	%	N	%
Sex						
Male	2205	96.8	2505	95.9	**4710**	**96.4**
Female	53	2.3	78	3.0	**131**	**2.7**
Unknown	19	0.8	28	1.1	**47**	**1.0**
Age group (in years)						
<19	42	1.8	65	2.5	**107**	**2.2**
20–24	156	6.9	249	9.5	**405**	**8.3**
25–34	429	18.8	626	24.0	**1055**	**21.6**
35–44	584	25.6	614	23.5	**1198**	**24.5**
45–54	631	27.7	645	24.7	**1276**	**26.1**
55–64	382	16.8	367	14.1	**749**	**15.3**
65 and over	52	2.3	42	1.6	**94**	**1.9**
Unknown	1	<0.1	3	0.1	**4**	**0.1**
Contributing factors[a,b]						
Ladder	903	39.7	944	36.2	**1847**	**37.8**
Vehicle	207	9.1	344	13.2	**551**	**11.3**
Stairs or steps	139	6.1	254	9.7	**393**	**8.0**
Floor irregularities	152	6.7	222	8.5	**374**	**7.7**
Tripping or slipping hazards	162	7.1	187	7.2	**349**	**7.1**
Scaffold	181	7.9	158	6.1	**339**	**6.9**
Roof	214	9.4	98	3.8	**312**	**6.4**
Machinery	104	4.6	145	5.6	**249**	**5.1**
Ceilings and walls	51	2.2	92	3.5	**143**	**2.9**
All other	63	2.8	64	2.5	**127**	**2.6**
Unknown	61	2.7	47	1.8	**108**	**2.2**
Stilts	16	0.7	26	1.0	**42**	**0.9**

	Lost-time injury claims		Medical-only injury claims		Total injury claims	
	N	**%**	**N**	**%**	**N**	**%**
Ice or snow	17	0.7	10	0.4	**27**	**0.6**
Solid contaminants	3	0.1	12	0.5	**15**	**0.3**
Liquid contaminants	3	0.1	8	0.3	**11**	**0.2**
Injured worker	1	-	0	-	**1**	**0.0**
Leading occupations (Top 10)[a,c]						
47-2060-Construction Laborers	285	12.5	333	12.8	**618**	**12.6**
47-2110-Electricians	191	8.4	241	9.2	**432**	**8.8**
47-2030-Carpenters	230	10.1	179	6.9	**409**	**8.4**
53-7060-Laborers and Material Movers, Handlers	149	6.5	160	6.1	**309**	**6.3**
47-2150-Pipelayers, Plumbers, Pipefitters, and Steamfitters	116	5.1	143	5.5	**259**	**5.3**
47-1010-First-Line Supervisors of Construction Trades and Extraction Workers	98	4.3	136	5.2	**234**	**4.8**
49-9020-Heating, Air Conditioning, and Refrigeration Mechanics and Installers	101	4.4	110	4.2	**211**	**4.3**
47-2180-Roofers	120	5.3	75	2.9	**195**	**4.0**
49-9070-Maintenance and Repair Workers, General	67	2.9	85	3.3	**152**	**3.1**
53-3030-Driver/Sales Workers and Truck Drivers	73	3.2	74	2.8	**147**	**3.0**
Total	**2277**	**100**	**2611**	**100**	**4888**	**100**

Abbreviation, NEC = Not elsewhere classified.

[a]Contributing factors, and occupations were identified based on the number of total injury claims only.

[b]Injured worker = Tripping hazards = Includes plank, plywood, wire, hose, tools, carpet, rock, concrete, and other objects; Floor or ground irregularities = uneven ground, hole, cracks, trench, and other irregularities.

[c]The 2010 Standard Occupational Classification system was used to assign codes to text entry occupations at a broad level (5-digit) from a combination of NIOCCS and manual review from a trained coder.

Table 4

Number and rate[a] of construction industry workers' compensation claims involving a fall, by type of STF, Ohio—2010–2017.

	Slips or trips without a fall				Falls on the same level				Falls to a lower level			
	Lost-time injury claims		Total injury claims		Lost-time injury claims		Total injury claims		Lost-time injury claims		Total injury claims	
	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs
Establishment size (estimated)												
>0 to 10 FTEs	**111 (21.8)**	3.2	312 (19.0)	8.9	203 (23.8)	5.7	579 (21.1)	16.1	872 (38.3)	24.4	1547 (31.6)	43.4
>10 to <50 FTEs	219 (42.9)	4.2	671 (40.9)	12.7	357 (41.8)	6.8	1,108 (40.4)	21.0	874 (38.4)	16.6	1935 (39.6)	36.6
>=50 to <100 FTEs	88 (17.3)	4.7	325 (19.8)	17.6	143 (16.7)	7.8	486 (17.7)	26.3	283 (12.4)	15.4	696 (14.2)	37.8
>=100 to <250 FTEs	59 (11.6)	4.0	241 (14.7)	15.8	107 (12.5)	6.8	435 (15.9)	28.7	186 (8.2)	12.5	526 (10.8)	35.1
>=250 to <1000 FTEs	30 (5.9)	7.1	79 (4.8)	18.6	40 (4.7)	9.4	118 (4.3)	27.8	46 (2.0)	10.8	144 (2.9)	33.9
Unknown	3 (0.6)	–	13 (0.8)	–	4 (0.5)	–	16 (0.6)	–	16 (0.7)	–	40 (0.8)	–
Industry group (four-digit NAICS)												
2361 - Residential Building	41 (8.0)	3.4	146 (8.9)	12.4	75 (8.8)	6.5	234 (8.5)	20.0	272 (11.9)	23.4	523 (10.7)	**44.8**
2362 - Nonresidential Building	**61 (12.0)**	4.2	199 (12.1)	**13.2**	105 (12.3)	6.8	344 (12.5)	**22.4**	196 (8.6)	13.3	440 (9.0)	29.6
2371 - Utility System	56 (11.0)	5.7	153 (9.3)	**15.5**	77 (9.0)	7.8	204 (7.4)	20.8	113 (5.0)	11.4	255 (5.2)	25.6
2372 - Land Subdivision	1 (0.2)	2.4	2 (0.1)	4.7	0 (-)	–	2 (0.1)	4.7	2 (0.1)	4.7	5 (0.1)	11.9
2373 - Highway, Street, and Bridge	17 (3.3)	3.6	80 (4.9)	**16.5**	37 (4.3)	7.1	135 (4.9)	**27.2**	65 (2.9)	12.7	177 (3.6)	35.5
2379 - Other Heavy and Civil Engineering	5 (1.0)	3.8	12 (0.7)	9.2	5 (0.6)	3.8	23 (0.8)	17.7	13 (0.6)	10.0	35 (0.7)	26.9
2381 - Foundation, Structure, and Building Exterior Contractors	64 (12.5)	4.0	220 (13.4)	**13.7**	136 (15.9)	8.5	391 (14.3)	**24.4**	452 (19.9)	28.0	839 (17.2)	**52.2**
2382 - Building Equipment Contractors	161 (31.6)	3.8	565 (34.4)	**13.3**	266 (31.1)	6.3	945 (34.5)	**22.4**	702 (30.8)	16.7	1701 (34.8)	**40.2**
2383 - Building Finishing Contractors	41 (8.0)	3.2	115 (7.0)	9.2	87 (10.2)	6.9	237 (8.6)	18.8	289 (12.7)	22.7	569 (11.6)	**44.9**

	Slips or trips without a fall				Falls on the same level				Falls to a lower level			
	Lost-time injury claims		Total injury claims		Lost-time injury claims		Total injury claims		Lost-time injury claims		Total injury claims	
	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs	N (%)	Rate per 10,000 FTEs
2389 - Other Specialty Trade Contractors	63 (12.4)	4.9	149 (9.1)	11.6	66 (7.7)	5.1	227 (8.3)	17.5	173 (7.6)	13.5	344 (7.0)	26.7
Total	**510 (100)**	**4.0**	**1641 (100)**	**12.9**	**854 (100)**	**6.7**	**2,742 (100)**	**21.5**	**2,277 (100)**	**17.9**	**4,888 (100)**	**38.4**

[a]Rates are calculated for the majority of allowed claims that had reliable employee counts for the corresponding policy-year (158 of 9,517 claims were not included in the rate calculation). Abbreviations: FTE = Full-time equivalent worker, defined as 2,000 hours worked annually, NAICS = North American Industry Classification System.

Table 5

Number and percentage of injured worker clinical diagnosis groups for the construction industry by claim type and STF type, Ohio — 2010–2017.

	Distinct clinical diagnosis groups (N = 18,674)[a]				Distribution of lost-time clinical diagnosis groups (N = 9,842) by STF type							
	Lost time (52.7%)		Medical-only (47.3%)		Slip or trip without a fall (10.0%)		Falls on the same level (20.0%)		Falls to a lower level (67.1%)		All other (2.8%)	
Clinical Diagnosis Groups[b]	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Sprain	3,193	32.4	3,627	41.1	547	55.5	762	38.6	1,790	27.1	94	33.9
Sprains - lower extremity except knee	*922*	9.4	*1,533*	17.4	*220*	22.3	*184*	9.3	*471*	7.1	*47*	17.0
Sprains - upper extremity	*884*	9.0	*974*	11.0	*107*	10.9	*279*	14.1	*483*	7.3	*15*	5.4
Sprains - back	*559*	5.7	*732*	8.3	*60*	6.1	*131*	6.6	*360*	5.4	*8*	2.9
Knee sprain or tear	*447*	4.5	*271*	3.1	*138*	14.0	*85*	4.3	*204*	3.1	*20*	7.2
Sprains - neck	*300*	3.0	*286*	3.2	*18*	1.8	*66*	3.3	*214*	3.2	*2*	0.7
Sprains - NEC	*81*	0.8	*102*	1.2	*4*	0.4	*17*	0.9	*58*	0.9	*2*	0.7
Fracture	2,003	20.4	679	7.7	92	9.3	253	12.8	1,598	24.2	60	21.7
Fracture - lower extremity	*776*	7.9	*152*	1.7	*74*	7.5	*112*	5.7	*551*	8.3	*39*	14.1
Fracture - upper extremity	*548*	5.6	*314*	3.6	*14*	1.4	*90*	4.6	*435*	6.6	*9*	3.2
Fracture - neck and trunk	*499*	5.1	*161*	1.8	*2*	0.2	*38*	1.9	*450*	6.8	*9*	3.2
Fracture - head	*107*	1.1	*35*	0.4	-	-	*7*	0.4	*98*	1.5	*2*	0.7
Fracture - NEC	*73*	0.7	*17*	0.2	*2*	0.2	*6*	0.3	*64*	1.0	*1*	0.4
Diseases of musculoskeletal and connective tissue	1,364	13.9	281	3.2	178	18.1	349	17.7	800	12.1	37	13.4
Soft tissue/enthesopathy	*541*	5.5	*158*	1.8	*72*	7.3	*162*	8.2	*291*	4.4	*16*	5.8
Diseases of musculoskeletal and connective tissue, NEC	*369*	3.7	*32*	0.4	*48*	4.9	*82*	4.2	*227*	3.4	*12*	4.3
Disc disorders and spinal stenosis	*232*	2.4	*33*	0.4	*26*	2.6	*52*	2.6	*151*	2.3	*3*	1.1
Joint disorders, NEC	*138*	1.4	*38*	0.4	*16*	1.6	*34*	1.7	*85*	1.3	*3*	1.1
Knee derangement	*59*	0.6	*18*	0.2	*16*	1.6	*13*	0.7	*27*	0.4	*3*	1.1
Spinal osteoarthritis	*23*	0.2	*2*	0.0	-	-	*6*	0.3	*17*	0.3	-	-
Congenital abnormalities, NEC and perinatal conditions	*2*	0.0	-	-	-	-	-	-	*2*	0.0	-	-
Contusion with intact skin surface	1,071	10.9	2,345	26.6	70	7.1	268	13.6	715	10.8	18	6.5
Superficial injury	328	3.3	469	5.3	7	0.7	34	1.7	286	4.3	1	0.4

	Distinct clinical diagnosis groups (N = 18,674)[a]				Distribution of lost-time clinical diagnosis groups (N = 9,842) by STF type							
	Lost time (52.7%)		Medical-only (47.3%)		Slip or trip without a fall (10.0%)		Falls on the same level (20.0%)		Falls to a lower level (67.1%)		All other (2.8%)	
Clinical Diagnosis Groups[b]	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Open wounds NEC	325	3.3	642	7.3	14	1.4	55	2.8	253	3.8	3	1.1
Dislocation	229	2.3	90	1.0	13	1.3	51	2.6	159	2.4	6	2.2
Intracranial injury	200	2.0	126	1.4	2	0.2	26	1.3	170	2.6	2	0.7
Mental, behavioral and neurodevelopmental disorders NEC	189	1.9	-	-	15	1.5	33	1.7	131	2.0	10	3.6
Internal or blood vessel injuries NEC	158	1.6	14	0.2	2	0.2	9	0.5	145	2.2	2	0.7
Diseases of the nervous system and sense organs NEC	142	1.4	7	0.1	7	0.7	25	1.3	103	1.6	7	2.5
Other and unspecified effects of external cause NEC	112	1.1	138	1.6	3	0.3	18	0.9	88	1.3	3	1.1
All other injuries and illnesses[c]	499	5.1	127	1.4	34	3.4	77	3.9	356	5.4	32	11.6
Missing	29	0.3	16	0.2	2	0.2	13	0.7	12	0.2	2	0.7
Total	**9,842**	**100**	**8,832**	**100**	**986**	**100**	**1,973**	**100**	**6,606**	**100**	**277**	**100**

Abbreviation, NEC = Not elsewhere classified.

[a] Can include more than one clinical diagnosis group per claim.

[b] Clinical diagnosis groups with < 1% of all lost-time clinical diagnosis groups were combined into “all other injuries and illnesses” groups. Diagnosis groups were ordered based on the number of lost-time clinical diagnosis groups.

[c] “All other injuries and illnesses” include Diseases of the circulatory system NEC; Complications of surgical and medical care NEC; Injury to nerves and spinal cord; Cellulitis or abscess; Diseases of the respiratory system NEC; Carpal tunnel syndrome; Mental disorders from brain damage; Symptoms, signs, abnormal clinical or laboratory findings NEC; Diseases of the digestive systems NEC; Diseases of the genitourinary system; Diseases of the skin and subcutaneous tissue NEC; Infectious and parasitic diseases; Amputation; Hernia; Crushing injury; Burn;Diseases of the blood and blood-forming organs; Poisoning and toxic effects, medical or non-medical; Acute myocardial infarction/heart failure; Endocrine, nutritional, and metabolic diseases; Neoplasms; Contact dermatitis and other eczema; and Foreign body, eye.