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Fatal injuries among Hispanic workers in the U.S. construction industry: Findings from FACE investigation reports

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ABSTRACT

Introduction: Identifying and understanding the characteristics of workplace accidents can provide vital information required to clarify their causes and prevent similar accidents from happening in the future. The Hispanic workforce represents a significant segment of the U.S. construction labor force that is projected to continue increasing in population. The government statistical data show higher rates of fatalities among Hispanic workers when compared to other ethnic groups. *Method:* This study aims to provide details about the trends of fatal injuries among Hispanic workers. The study examined 92 government investigation reports to reveal the general trends, then an examination of fatal fall injuries within the study sample was conducted since falling is the predominant cause of fatal injuries. *Results:* The findings suggest differences in accident characteristics between Hispanic workers and all workers, which could indicate a need for different interventions to improve the overall site safety. The study also revealed the dire need to propose revised investigation procedures that would help identify the root causes of accidents, which in turn leads to better recommendations and interventions.

1. Introduction

The Hispanic workforce continues to increase in the U.S. construction industry, filling the demand for construction workers with an average representation of 30% in 2015 (Dong, Wang, & Goldenhar, 2016). At the same time, the data indicate that Hispanic workers face higher rates of fatal injuries when compared to other ethnic groups in the construction industry (Al-Bayati, Abudayyeh, Fredericks, & Butt, 2017a; CPWR, 2013; Flynn, 2014; Morrison, 2015). Many factors are contributing to the increased likelihood of Hispanic workers sustaining injuries in comparison to other ethnic groups. This may include young age, experience and education, immigration status, language and cultural barriers, and work type (Al-Bayati, Abudayyeh, Fredericks, & Butt, 2017b; Anderson, Hunting, & Welch, 2000; Flynn, 2014; Hurley & Lebbon, 2012; Jaselskis, Strong, Aveiga, Canales, & Jahren, 2008; Kouyoumdjian, Zamboanga, & Hansen, 2003; McGlothlin, Hubbard, Aghazadeh, & Hubbard, 2009; Morrison, 2015; Nash, 2004; Smith, Perry, & Moyer, 2006). On the other hand, current data suggest that nonfatal injuries are lower among Hispanic workers (CPWR, 2013). This suggestion may not be reliable since there is a potential of significant underreporting due to financial and legal concerns (Al-Bayati et al., 2017a). For example, in 2004, a 16-year-old Hispanic worker went home, instead of going to a hospital or emergency room, after falling approximately 10 ft from a scaffold and injuring his head. He died shortly thereafter (FACE, 2017a). As of today, few, if any, studies have investigated the characteristics of fatal injuries among Hispanic workers in the U.S. construction industry. Therefore, an investigation of fatal injuries among Hispanic construction workers is crucial to understanding the trends of injuries among this important segment of the U.S. workforce. Accordingly, this study will aid construction safety professionals, as well as government agencies, by suggesting better tools to improve overall site safety of the Hispanic workforce.

Knowing the characteristics of fatal injuries is crucial for preventing future accidents (Bunn, Costich, & Slavova, 2006). As a result, the National Institution of Occupational Safety and Health (NIOSH) established the Fatality Assessment and Control Evaluation (FACE) program to investigate work-related fatal injuries (Dong et al., 2017). The goal of the program is to prevent fatal injuries by examining work environment, victim characteristics, the task the victim was performing, and the tool the victim was using when assessing accidents, as well as providing strategies to aid employers in correcting similar situations, thereby reducing fatalities. Currently, seven states have an agreement with NIOSH to conduct FACE investigations, including New York, California, Kentucky, Massachusetts, Michigan, Washington, and Oregon (FACE, 2017b). NIOSH also directly performs investigations in other states. Given its nature, this voluntary program does not enforce

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compliance or determine fault. In general, the investigation is focused on the following four areas:

- Employer information, including the number of employees working for the employer, as well as how many employees were on site at the time of the incident.
- Victim information, including the victim's primary language, job title, and age.
- Employer safety program, including the existence of the program and whether the employer hires someone within the company to implement it or not.
- Employer safety training records, including training measures and whether or not the victim received the proper training.

Once this information is collected, FACE reports provide recommendations to improve overall site safety based on the investigation findings. The fatality investigation reports of Hispanic workers can provide valuable insight information into injuries causation and circumstances. Therefore, analyzing the available reports is a vital step to provide safer working conditions for construction Hispanic workers.

2. Fatal injuries among Hispanic construction workers

For a better understanding of the disparity in fatalities between Hispanic construction workers and white, non-Hispanic workers, an odds ratio was calculated by the authors using the numbers of fatalities among Hispanic and white workers, along with their representation in the construction industry. Workers were defined according to the Bureau of Labor Statistics; individuals classified as white are those having origins in any of the original peoples of Europe, the Middle East, or North Africa. Formula 1, shown below, was used to calculate the odds ratio for the years between 2005 and 2016. The numbers of fatalities and workers were extracted from United States Department of Labor (USDOL) website (USDOL, 2005a, 2005b).

$$Odds\ Ratio = \frac{p/(1-\mathrm{p})}{q/(1-q)} \quad (1)$$

where:

p: Percentage of fatalities among Hispanic workers in a specific year (Fatality cases/Hispanic population)

q: Percentage of fatalities among white workers in a particular year (Fatality cases/white population)

Fig. 1, shown below, depicts the yearly odds ratio over the 2005 to 2016 period. The odds ratio is a valid measure of association between the determinant and outcome, irrespective of study type. The overall resulting odds ratio for the 2005 to 2016 period was 1.118 (95% CI, 1.072–1.166). This result indicates that Hispanic workers, on average, are 1.118 times more likely to be killed on U.S. construction sites when compared to white, non-Hispanic workers. The 95% confidence interval of 1.072 to 1.166 means that one can be 95% confident that the true odds ratio lies somewhere between 1.079 and 1.179. The 95% confidence intervals that fall below 1.00 are commonly interpreted as statistically significant.

3. Research methodology

This study examined fatality investigation reports that have been produced by the FACE program to provide an overview of fatal injury characteristics among Hispanic construction workers. Also, this study focused on fatal fall injuries, due to the fact that falls are a leading cause of fatalities on U.S. construction sites, as suggested by several studies, including Kang, Siddiqui, Suk, Chi, and Kim (2017) and Hu, Rahmandad, Smith-Jackson, and Winchester (2011). The authors have followed the methods utilized in previous studies such as Huang and Hinze (2003), Kang et al. (2017), and Dong, Largay, Wang, Cain, and Romano (2017) which investigated fatal trends among all workers. Accordingly, this study compares trends of fatalities between Hispanic workers and all other construction workers. The comparison aims to assists industry professionals in identifying the areas where Hispanic workers face higher rates of fatalities, which could be further evaluated to help identify the root causes of accidents. At the time of this study, the research team found 101 reports that took place at construction worksites out of approximately 250 FACE reports involving Hispanic workers. Coded datum was cross-checked during meetings between the research team, and questionable data were removed from the final dataset. As a result, data were extracted from 92 investigation reports by predetermining the required information and the associated parameters. Each report was then manually reviewed and coded into a Microsoft Excel file. If an investigation report involved more than one decedent, then datum was coded individually for each fatality. Only one report within the data set included two fatalities. Accordingly, 93 cases have been analyzed in this study.

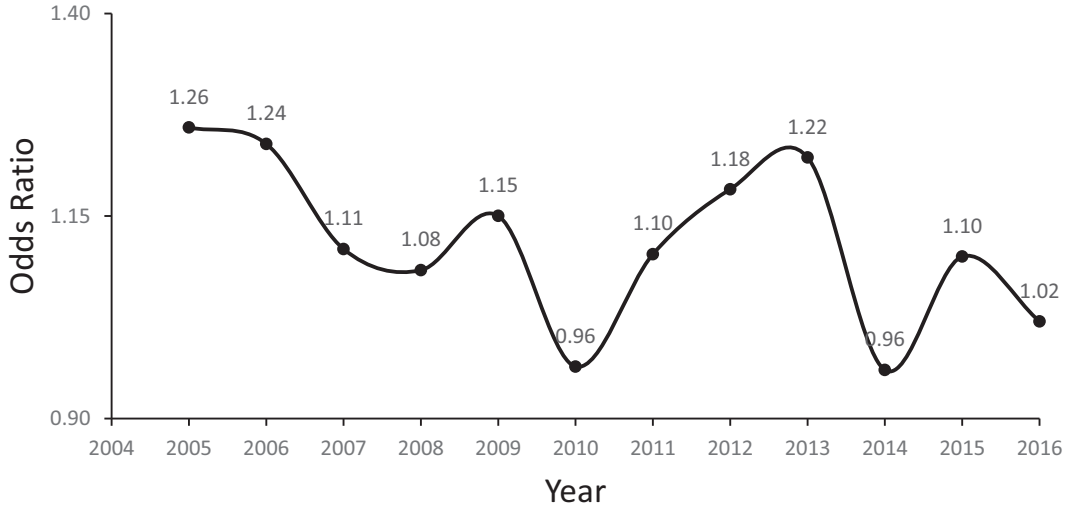

Fig. 1. The odds ratio of Hispanic workers in comparison with White workers.

4. Findings

The 93 cases explored in this study were conducted between 1992 and 2014. The study examines victims' characteristics (e.g., age and years of experience), employer characteristics (e.g., employer size and expertise), and accident causes and conditions. In addition, the study focused on the characteristics of fall accidents. The findings were then compared to previous studies that have investigated the trends of fatal injuries in the construction industry. The comparison is necessary to reveal possible differences in trends between the Hispanic workforce and the construction workforce in general.

4.1. General trends of fatal injuries among Hispanic eorkers

4.1.1. Accident causes and conditions

The direct causes of accidents within the study sample, as well as their frequencies, are illustrated in Table 1. The overall results suggest that falling is the primary cause of fatal injuries and accounts for 40 (43.0%) of the study sample. Other major causes include fatal struck by injuries 37 (39.8%), caught in or between 7 (7.5%), electrocution 5 (5.4%), and other 4 (4.3%). These findings are in agreement with the four leading causes of fatal injuries that have been identified by the Occupational Safety and Health Administration (OSHA), which are fall, struck by, caught in or between, and electrocution (OSHA, 2011). Furthermore, the comparison of this finding with two previous studies that investigated trends in fatal accidents in the construction industry, namely, Huang and Hinze (2003) and Kang et al. (2017), indicates that struck by is significantly higher among Hispanic workers (see Table 1).

According to the Standard Industrial Classification (SIC), construction companies can be classified, based on a company's primary business activity, into the following categories: general contractors and operative builders, heavy construction, and specialty trade contractors. Most of the fatalities in this study sample, 58 (62.4%), occurred on general contractor construction sites, while 25 (26.9%) occurred on specialty trade contractors' construction sites, and 10 (10.8%) occurred on heavy construction sites (see Table 2). Most of the examined reports provide information about written safety programs and safety training documentation. However, there was no information regarding safety programs in 9 (9.7%) of the reports. There were 50 reports (53.8%) that indicated the availability of a written safety program, while 34 reports (36.6%) showed that a written safety program was not available. Only 41 of the reports (44.1%) confirmed the availability of safety training documentation, and 46.5 of the reports (49.5%) indicated that training documentation was not available. Training in victims' native language (i.e., Spanish), which is crucial for their safety, was not investigated in 55 (59.1%) of the reports. Accordingly, only 15 (16.1%) reports indicated that safety training in Spanish was provided, while 23 reports (24.7%) indicated that no training in Spanish was provided. Finally, the data regarding the accident locations showed that 37 (39.8%) of the accidents happened on the same work level, followed by 25 (26.9%) accidents on roofs, 9 (9.7%) on scaffoldings, and 7 (7.5%) on trenching and excavations. For more information about accident location, see Table 2.

Table 1
The frequency of fatal injuries' direct cause.

Direct cause	This study (Hispanic) (%)	Kang et al. (2017) (All) (%)	Huang and Hinze (2003) (All) (%)
Fall	43.0	44.6	36.3
Struck by	39.8	22.8	24.3
Caught in or between	7.5	11.1	11.6
Electrocution	5.4	6.8	13.4
Others	3.4	14.6	14.5

Table 2
Fatal injuries' characteristics according to the study Ssmple.

Characteristic	Number (%)
Standard Industrial Classification (SIC)	
General contractors & operative builders	58 (62.4)
Specialty trade contractors	25 (26.9)
Heavy construction	10 (10.8)
Written safety program	
Yes	50 (53.8)
No	34 (36.6)
Not reported	9 (9.7)
Safety training documentation	
Yes	41 (44.1)
No	46 (49.5)
Not reported	6 (6.5)
Training in Spanish	
Yes	15 (16.1)
No	23 (24.7)
Not reported	55 (59.1)
Accidents' location	
Same work level	37 (39.8)
Roof	25 (26.9)
Scaffolding	9 (9.7)
Ladder	6 (6.5)
Trenching and excavations	7 (7.5)
Equipment	5 (5.4)
Aerial lift	3 (3.2)
Road	1(1.1)

4.1.2. Victims' and employers' characteristics

The information regarding victims' education was limited to few reports, while most reports (76; 81.7%) had no information about victims' education. Similarly, the country of origin was not reported in 58 (62.4%) out of the 93 cases. Mexico was the country of origin for 20 cases (21.5%), followed by Guatemala 7 (7.5%), United States 3 (3.2%), Honduras 2 (2.2%), and others 3 (3.3%) (see Table 3). This finding confirms the literature, which suggests that a high percentage of Hispanic construction workers come from Mexico. The victims' years of experience was stated in 55 (59.1%) reports. The data regarding victims'

Table 3
Victims' and employers' characteristics according to the study sample.

Characteristics	Number (%)
Victims' education	
High school	9 (9.7)
Middle school	4 (4.3)
Elementary school	2 (2.2)
No education	2 (2.2)
Not reported	76 (81.7)
Country of origin	
Mexico	20 (21.5)
Guatemala	7 (7.5)
USA	3 (3.2)
Honduras	2 (2.2)
Costa Rica, Cuba, and Ecuador	3 (3.3)
Not reported	58 (62.4)
Years of experience – victims	
Less than 5 years	23 (24.7)
5–10 years	20 (21.5)
More than 10 years	12 (12.9)
Not reported	38 (40.9)
Years of experience – employers	
Less than 5 years	10 (10.8)
5–10 years	16 (17.2)
More than 10 years	48 (51.6)
Not reported	19 (20.4)

years of experience indicate that 23 (24.7%) victims had less than five years of experience in the U.S. construction industry, followed by 20 (21.5%) with experience between five and 10 years, and 12 (12.9%) victims with experience of more than 10 years. The reported years of experience show that a high percentage of victims had less than five years of experience (see Table 3). Within this study sample, the victims' reported ages indicate that the majority of cases (54; 58.1%), involved victims aged between 25 and 44 years, followed by 20 (21.5%) cases where the victim's age was less than 25 years, 15 (16.1%) cases where the age was between 45 and 64 years, and 4 (4.3%) cases where the age was more than 65 years. Comparing the age ranges in this study with and Dong, Largay, Choi, et al. (2017), who investigated FACE reports in general, indicates that the numbers of fatalities among Hispanic workers who are aged 44 years or younger are higher than the industry average (see Table 4). The victims' reported occupations show that the majority (48; 52.6%), were general construction labors, followed by carpenters 12 (12.9%), equipment operators 11(11.8%), roofers 10 (10.8%), and others (13%). A comparison of the occupation of victims between this study and Dong, Largay, Choi, et al. (2017), indicates that most of the Hispanic victims were filling blue-collar positions and very few, if any, working as a supervisor (see Table 4). Accordingly, Hispanic workers are filling blue-collar positions and, as a result, they are facing the significant four hazards in workplaces (i.e., fall, electrocution, struck by, and caught in or between) more than other ethnic groups.

Employers' years of experience were reported in 74 (79.5%) reports. The findings indicate that 48 (51.6%) of employers had more than 10 years of experience, followed by 16 (17.2%) who had between 5 and 10 years of experience, and 10 (10.8%) who had less than five years of experience. According to the study sample, employer size indicated that 26 (28.0%) of the cases occurred within construction firms that hire up to 20 employees, while 32 (34.4%) of the cases occurred within construction firms that hire between 21 and 200 employees. The study also revealed 20 (21.5%) of the cases occurred within construction firms that employ more than 200 employees, and 15 (16.1%) reports did not include employer size information. A comparison between employer sizes in this study and Dong, Largay, Choi, et al. (2017) revealed that there is a higher number of fatalities among Hispanic construction workers in firms that hire between 21 and 200 employees, but there is a lower number of fatalities in smaller size firms that hire less 21 employees, see Table 4.

Table 4
Victims' and employers' characteristics – a comparison.

Characteristics	This study (Hispanic) (%)	Dong, Largay, Wang, et al. (2017) (All) (%)
Age		
Less than 25 years	21.5	16.4
25–44 years	58.1	48.8
45–64 years	16.1	24.6
65 + years	4.3	3.3
Not reported	0	6.9
Occupation		
General labor	52.6	24.2
Structural metal workers	0	7.9
Supervisor	0	12.7
Carpenters	12.9	7.1
Roofers	10.8	5.3
Equipment operator	11.8	0
Others	24.7	42.8
Employers' size		
Up to 20	28	46.2
21 to 200 employees	34.4	28.9
More than 200 employees	21.5	12.1
Unknown/not reported	16.1	12.8

4.2. General trends of fall fatal injuries

In this section, several characteristics regarding the fall accidents included within the study sample will be explored. In addition, a comparison between fall accidents among Hispanic construction workers and all construction workers will be conducted. Falling is the leading cause of fatalities in the construction industry. The findings of this study support the claim that falls are a leading cause of fatal injuries, with more than 40% of the study sample being the result of a fall. To address the high probability of fall injuries OSHA requires fall protection systems, such as personal fall arrest system and guardrail system where an unprotected side or edge is higher than six feet or more above the lower level. Accordingly, fall protection systems are often required when workers operate from elevated platforms.

Fall accidents, classified according to SIC code, are presented in Table 5. Most of the fall fatalities, 27 (67.5%), have occurred on general contractor construction sites, and 13 (32.5%) occurred on specialty trade contractor construction sites. None of the fall fatalities investigated during this study occurred on heavy construction sites. A comparison of this finding with the two previous studies (i.e., Huang & Hinze, 2003; Kang et al., 2017) indicate that fall fatalities among Hispanic workers are significantly higher in general contractors' sites; these findings are inconsistent with all construction workers' trends (see Table 5). The data analyzed during this study also suggest that fall fatalities involving Hispanic workers occur infrequently on heavy construction projects. The data concerning the heights from which fatal fall accidents occurred reveal that 14 (35%) of fall accidents occurred from a height between 20 and 30 ft, followed by 12 (30%) from between 10 and 20 ft, 5 (12.5%)

Table 5
Characteristics of fall fatal injuries among Hispanic workers.

Characteristic	This study (Hispanic) (%)	Kang et al. (2017) (All) (%)	Huang and Hinze (2003) (All) (%)
SIC code			
General contractors	67.5	19	N/A
specialty trade contractors	32.5	75.4	Roughly 80
Heavy construction	0	5.5	N/A
Fall height (ft)			
Less than 10 ft	12.5	22.1	23
10–20	30	42.5	28
20–30	35	19.9	22
30–40	7.5	6.8	9
40–50	7.5	2.3	5
50–60	5	1.3	2.5
More than 60	2.5	4.9	10.5
Project type			
New project or addition	22.5	59	59
Alteration or rehabilitation	25	18.2	18
Maintenance or repair	25	16.2	15.6
Demolition	10	2.5	3.4
Others	12.5	3.6	3.4
Not reported	5	0.5	0.3
Construction end use			
Commercial building	32.5	31.4	33.3
Single family/duplex dwelling	27.5	28.3	17.4
Multifamily dwelling	12.5	10.1	9.3
Manufacturing/Industrial	15	3.3	6.5
Other buildings	5	26.9	34.4
Not reported	7.5	0	0
Accident location			
Roof	62.5	24.7	28.4
Scaffold	20	14.3	13
Ladder	12.5	16	11.3
Fall with structure	2.5	16.4	19.3
Aerial left	2.5	5.3	3.2
Others	0	23.3	24.8

from less than 10 ft, and 9 (22.5%) from more than 30 ft. These findings indicate that fall fatalities from less than 10 ft are less frequent among Hispanic workers than among all workers (see Table 5). This study also found that fatalities between 20 and 30 ft are higher among Hispanic workers.

This study also evaluated the occurrence of fall fatalities by project type. Within the study sample, 10 (25%) of the fatalities occurred on alteration or rehabilitation projects, 10 (25%) occurred on maintenance or repair projects, 9 (22.5%) on new projects or additions, 4 (10%) on demolition projects, 5 (12.5%) on other projects, and 2 (5%) were not reported. A comparison between the findings of this study and the two previous studies revealed that fatalities among Hispanic workers were well distributed among different project types (see Table 5). When evaluated, based on construction end use, the data indicate that 13 (32.5%) cases occurred in commercial projects, 11 (27.5%) occurred in single family/duplex dwelling projects, 5 (12.5%) cases in multifamily dwelling, 6 (15%) in manufacturing and industrial projects, 2 (5%) in other projects, and there were 3 (7.5%) cases with no information about project end use. These findings are in agreement with those of both Kang et al. (2017) and Huang and Hinze (2003), except the number of cases in manufacturing/industrial projects, which is higher among Hispanic workers (see Table 5). Within the study sample, a majority of the fall fatalities within the study sample occurred from roofs 25 (62.5%), followed by scaffolding 8 (20%), and ladders 5 (12.5). The comparison revealed that the likelihood of falling from roofs is much higher among Hispanic workers than among all construction workers. On the other hand, falls from roofs, scaffolds, and ladders account for 95% of fall fatalities among Hispanic workers while falls from these platforms account for up to 55% among all workers. This finding may be a result of the type of occupations that are filled by Hispanic workers (see Table 5). Within the available data, the fall fatality reports suggest that 34 (85%) of victims did not have their required personal protective (PPE) systems on, despite the fact that a written safety program was available in 19 (47.5%) cases and a documented safety training was available in 14 (35%) of the cases.

5. Discussion

This study investigated the characteristics of fatal injuries among Hispanic workers. The purpose is to compare the characteristics of fatal injuries among Hispanic workers with the characteristics among all workers that have been reported in previous studies. Accordingly, the study highlights the areas where Hispanic workers face higher rates of fatalities in order to assist industry professionals in identifying the root causes of accidents, and in determining corrective actions. The findings suggest several differences when comparing them to the trends among all construction workers that have been reported in previous studies. Table 6 illustrates the main differences in trends between Hispanic workers and all workers. Dong, Largay, Choi, et al. (2017) suggested not to investigate FACE reports of Hispanic or foreign-born workers due to the fact that demographic data are missing. However, the authors believe the study sample that produced from investigation FACE reports is reliable. Accordingly, the patterns identified in this study are important and must be published. In addition, the study verifies that many reports have missing data as reported by Dong.

The study confirms that fall accidents are the leading cause of fatal injuries among Hispanic workers. In addition, struck by accidents have been identified as the second leading cause of fatalities among Hispanic workers. The percentage of struck by fatalities among Hispanic workers is significantly higher than the percentage among all workers that have been reported in two previous studies (i.e., Huang & Hinze, 2003; Kang et al., 2017; 39.8 vs. 22.8% & 24.3%). Further investigation is required to reveal the cause of this finding. The findings also show that there are slightly more fatal injuries among younger Hispanic workers (see Table 6). This finding supports the suggestion that Hispanic construction workers are younger than other ethnic groups (CPWR, 2013). In general, young workers suffer disproportionately from fatal and nonfatal work-related injuries (NIOSH and ASSE, 2015). Thus, the younger age of workers is considered as one of the leading causes of higher fatality rates among Hispanic workers. Hispanic workers would be less likely to receive adequate training because of their youth (O'Connor, Loomis, Runyan, Janet, & Schulman, 2005). In addition, their younger age means less experience in recognizing work-related hazards and overall safety regulations (Al-Bayati et al., 2017a). The data indicate that a majority of the Hispanic victims were general laborers with a percentage of 52.6%, which is more than double the percentage among all workers (i.e., 24.2%). This finding is in agreement with the CPWR (2013) finding regarding the occupations of Hispanic workers, which suggest that occupation type is one of the root causes of higher rates of fatalities among Hispanic workers as been suggested by Al-Bayati et al. (2017b). Most Hispanic workers (96%) are filling worker-type positions that are more susceptible to OSHA's big four construction hazards: falls, electrocution, caught in, and struck by.

Employers' years of experience do not seem to be a significant contributing factor since 51.6% of cases happened in workplaces where employers have more than 10 years of experience. Similarly, the results indicate that among Hispanic workers a higher percentage of fatalities occur where the employers' size is between 21 and 200 employees, while the trend among all workers suggests a higher percentage of fatalities with employers that have 20 or fewer employees. In general, these findings may suggest that the characteristics of Hispanic workers contributed to work-related accidents significantly more than employers' characteristics. Al-Bayati et al. (2017a) suggested several characteristics that lead to higher rates of fatalities among Hispanic workers such as immigration status, job security, cultural and language barriers, and years of experience. These characteristics increase the overload and emotional fatigue among Hispanic workers. According to Goetsch (2013), three factors may increase work-related accidents and human errors: overload, inappropriate responses, and inappropriate activities. Accordingly, Goetsch (2013) suggests that internal, environmental, and situational elements lead to workers' overload. The authors believe that internal elements, such as immigration status and young age, and environmental and situational elements, such as cultural and language barriers, have a higher contribution to work-related accidents among

Table 6
Summary of main differences in trends between Hispanic and all workers.

Dimension	Remark
Struck by fatalities – all fatal	The percentage of struck by fatalities among Hispanic workers is significantly higher than the percentage of all worker
Workers age – all fatal	The percentage of Hispanic victims with age less than 44 years old is 79.6%, while the percentage among all workers is 65.2%
Workers' occupation – all fatal	The study found that higher percentage of Hispanic victims were general labors (52.6%), while this percentage drop down to 24.2% among all workers.
Employers' size – all fatal	The percentage of Hispanic workers' fatalities was higher among employers who hire between 21 to 200 employees, while it was higher among employers who employ less than 21 employees for all workers
SIC code – fall fatal	Fatalities among Hispanic workers in general contractors' workplaces are significantly higher than all workers where their percentage is higher in specialty trade contractors' workplaces.
Fall height	Fall height range between 20 and 30 ft represents the highest frequency among Hispanic workers, while fall height range between 10 and 20 ft represented the highest frequency among all workers. On the other hand, the percentage of fewer than 10 ft range was significantly less among Hispanic workers.
Accident location – fall fatal	Most of the fall fatalities among Hispanic workers were from the roof. Roof fall fatalities represent 62.5% among Hispanic workers, while represents less than 30% among all workers.

Hispanic workers than employers' characteristics (Al-Bayati et al. 2017b). Each of these elements (i.e., characteristics) eventually impacts the safety performance of Hispanic workers. For example, immigration status significantly influences the ability of Hispanic workers to reach government agencies such as OSHA when an unsafe condition is noticed (Al-Bayati et al., 2017b). On the other hand, cultural barriers and language barriers significantly influence the communication between Hispanic workers and their supervisors (Al-Bayati et al., 2017a). Accordingly, it is the employers' and government agencies' (such as OSHA) responsibility to adopt novel strategies to reduce the influence of these elements on overall site safety. When safety management systems do not account for these elements, it becomes a system error, rather than a human error.

Fall fatalities among Hispanic workers are significantly higher on general contractors' sites which could be a result of the fact that Hispanic workers are filling general labor positions. It has also been found that fall accidents from heights between 10 and 30 ft are more frequent among Hispanic workers, and fall accidents occurring from heights less than 10 ft are less frequent among Hispanic workers. On the other hand, the data indicate that the majority of fatal fall accidents within the study sample, with a percentage of 62.5%, occurred when the victim was working from a roofing platform. Fatal falls from roofing platforms are also the predominant cause among all construction workers, but its percentage is significantly higher among Hispanic workers. Therefore, an intervention is required to improve the safety performance of Hispanic roofers.

The findings discussed in this section contributes to the industry's knowledge regarding the trends of fatal injuries among Hispanic workers. Additionally, the comparison between Hispanic workers and all workers helps industry professionals and government agencies identify areas where the Hispanic workforce is at higher risk and develop new strategies to improve the safety of the Hispanic workforce.

6. Recommendations

FACE investigation reports should go beyond examining the direct causes of accidents, such as fall or struck by, and identify their root causes. An investigation strategy that reveals root causes to improve the effectiveness of suggested remedies is needed; otherwise, the effectiveness of recommended remedies is questionable (Gibb, Lingard, Behm, & Cooke, 2014; Marin, Lipscomb, Cifuentes, & Punnett, 2017). In addition, fatal injuries involving Hispanic workers should be investigated using a particular investigation form that solicits information regarding identified root causes related to Hispanic workers to assess their weighted influence. Low education levels, inadequate experience, young age, language proficiency and literacy issues, immigration status, cultural differences, and lack of access to training have been identified as root causes that lead to higher fatality rates among Hispanic workers (Al-Bayati, Abudayyeh, & Albert, 2018; Cunningham et al., 2018; Flynn, 2014; Hurley & Lebbon, 2012; Jaselskis et al., 2008; McGlothlin et al., 2009; Morrison, 2015). Therefore, the FACE investigation strategy should be evaluated and updated to include research findings made over the last decade regarding causation of work-related accidents. Construction scholars have explored various accident factors such as hazard-recognition performance (Albert & Hallowell, 2017), the nature and influence of cultural differences (Al-Bayati et al., 2018), and the needs of high-risk groups (Cunningham et al., 2018). Therefore, revisiting program strategies, investigation processes, and investigators' ability is a vital step in delivering in-depth information that uncovers the root causes, not just the direct cause. This is important because the effectiveness of recommendations is highly dependent on the insights provided throughout the initial investigation processes (Dien, Dechy, & Guillaume, 2012). Consequently, the reports could be improved by going beyond the repetitive and general instructions. According to Dong, Largay, Wang, et al. (2017), safety training, personal protective equipment (PPE), job hazard analysis, and safety inspection were commonly recommended. The investigation reports must be more case specific and address the unique conditions of each case. This approach could provide a better understanding of accident causation.

Additionally, the findings of this study reveal the following recommendations to improve overall site safety:

- An intervention to improve the performance of Hispanic roofers is required. This intervention could be through new training modules and increased supervisory efforts.
- The influence of Hispanic workers' characteristics on work-related accidents requires special attention from government agencies and research centers to reduce undesirable effects. According to the findings of this study, these characteristics contributed more than employers' characteristics to work-related accidents. Therefore, employers must effectively manage their employees to ensure their safety and health. Accordingly, providing employers with the appropriate resources to effectively managing young non-native workers is necessary (Cunningham et al., 2018). This necessity requires a greater effort in creating tailored management techniques. Also, tailored training material is needed as has been suggested by Cunningham et al. (2018).
- Construction supervisors and government agencies should be aware of Hispanic workers' characteristics, such as young age, English language skills, and cultural barriers, and their influence on overall site safety. Thus, close supervision efforts, explicit instruction, bilingual training, and cultural awareness are required.

7. Limitation

The results reported in this paper should be interpreted in light of two main limitations. First, the study's sample size, which only represents a small proportion of fatalities among Hispanic workers. Second, the authors have noticed that the information provided in the FACE investigation reports lack consistency in both format and content. Moreover, the indirect wording used in the reports often makes it challenging to identify contributing factors and heightens the probability of misapprehensions. Examples of inconsistencies found in the provided information include a report that does not mention anything about the employers' safety and training programs, as well as another report that states two different ages for the same decedent (see FACE, 2017c, 2017d). According to a FACE project officer, this is because some investigators ask about these characteristics and some do not. As a result, investigators may collect information subjectively. Therefore, there are several characteristics that are not stated in all reports. It would be beneficial to have a unified investigation form that collects necessary information with a strategy to identify root causes. Hopefully, the recent improvements incorporated into FACE program as has been suggested by Dong, Largay, Wang, et al. (2017) will provide better information in the near future. However, these suggested improvements seem not to be noticeable in the reports that have been reviewed in this study. Therefore, the quality of FACE reports in this study represents the second main limitation.

8. Conclusion

A quantitative dataset of 93 cases has been extracted from the 92 fatality investigation reports generated by the FACE program where the victims were construction Hispanic workers. The data examination within the study sample indicates several differences in trends between Hispanic workers and all workers including the percentage of stuck by cases, age and occupation of victims, employers' size, fall height, and others. As a result, the study suggests interventions to address the trends related to the Hispanic workforce. In addition, the investigation found an inconsistency in information reported by the program investigators, which indicates a dire need to reevaluate the current

investigation procedures and strategies, especially for accidents that involved Hispanic workers due to their characteristics and accident trends. Therefore, this study contributes to the body of knowledge relating to construction workplace safety and is intended to aid industry professionals and government agencies in improving overall site safety in U.S. construction workplaces. Further investigation and studies are needed to validate and propose practical solutions to the issues that have been revealed and discussed in this manuscript.

Data availability statement

Data analyzed during the study were provided by a third party. Requests for data should be directed to the provider indicated in the Acknowledgments.

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