

Injuries Among Construction Workers: An Exploratory Study

Carla Lopez del Puerto, PhD and David Gilkey, PhD
Colorado State University
Fort Collins, CO

The typical construction work environment is generally more hazardous than most other work environments due to the use of heavy equipment, dangerous tools, hazardous materials, and rapidly changing work conditions. This leads to consistently high rates of work related injuries and fatalities among construction workers. This paper examined the demographic profiles of injured construction workers in Northern Colorado. Variables of interest included sector, age, years in construction, education attainment, and hours of safety training. Injury profiles revealed that 60% of all reported injuries could be classified as work related musculoskeletal disorders (WMSDs) and that back injuries were the most common (30% of all injuries). The researchers used analytic techniques to assess relationships of variables to injury. The results suggest that there is an increased risk to sustain work related injuries associated with a number of variables including working in the commercial sector, having no safety training and being younger than 30 years old. The contribution of these findings is to increase understanding of the injury patters that exist among construction workers and that certain demographic and work characteristics may increase risk for injury.

Key Words: construction accidents, back injuries, safety management

Introduction

The construction industry has ranked as one of our nation's largest employment sectors with an estimated 7.2 million workers in 2008 (Bureau of Labor and Statistics (BLS), 2011). This industry consistently maintains high rates of injuries and fatalities compared to other industries. Exceeded only by the mining and agriculture industries, construction is the third most dangerous industry in the United States (Abudayyeh, Fredericks, Butt, & Shaar, 2006). In 2011, the construction industry employed 5,576,700 workers and experienced 184,700 illnesses and injuries with 103,300 suffering days away from work (BLS, 2012).

Mahboob et. al. (2003) examined 35,267 claims filed with the State Fund in Washington State between years 1993-1999 and found that wood frame homebuilders had higher injury and illness rates than all other construction classes and industries. The investigation team identified that carpenters, apprentices and laborers were the most frequently injured; these three groups comprised 74% of all claims filed. Among the claims filed, overexertion was the second most common mechanism or type of injury and accounted for 20.8% of all cases. Sprains and strains made up 27% of reported cases and were second most frequently reported nature of injury effecting chest, abdomen, and back (71.7%), lower limb (29.2%) and upper limb (8.7%). Approximately 15% of strain and sprain cases effected multiple body parts. The most common cause of non-fatal injuries in construction is over-exertion such as in lifting, pushing, pull and straining. The most common body parts injured are the back, hand and finger, knee, shoulders, feet and eyes (CPWR), 2007). Back injuries continue to be a major problem in construction. Lipscomb et. al. (2008) reported high rates of back injuries among Washington State union carpenters employed in the residential building industry and installing drywall. The research team investigated 4,138 workers' compensation claims and found that 64.1% of the back injury cases were caused by overexertion resulting in 65.5% of the reported strain and sprain type injuries. Simonton (2007) reported that work-related musculoskeletal disorders (WMSDs) comprised 29% of 218,026 construction injury claims from 2001-2004 evaluated in Colorado and that lifting strain events were the number one cause of injury. He concluded that residential carpentry earned #1 premium rank due to their frequency and severity of WMSDs and that 46% of injuries were due to lifting, carrying or holding materials. The lower back comprised the most frequent area of injury at 40% compared to the shoulder at 10%, wrist at 5% and the elbow at 3%. It is important to note that WMSDs are broadly believed to be underreported (NORA, 2008).

Hand and power tools make construction work easier and improve productivity but have the potential to also cause serious accidents and injuries. Power-tools are often classified based on the power source and capacity. Power tools can be electric, pneumatic, liquid fuel, hydraulic, or powder-actuated (OSHA, 1996). Construction workers often remove safeguards from power tools to expedite the process and use the power tools in ways that they were not designed. Safe guards are physical barriers that prevent the worker from making contact with dangerous machine parts or work product during use. Amputations can result from a worker removing a safeguard as well as other injuries or even death. The most common form of amputation is finger amputations (OSHA, 1996). Another hazard resulting from the use of power tools are foreign particles entering in the eyes. This hazard can be reduced with the proper use of safety glasses or safety goggles (OSHA, 1996). Over the past 10 years, the construction industry has maintained high levels of fatal and non-fatal injuries and illness despite focusing attention on safety procedures and programs (Abudayyeh, Fredericks, Butt, & Shaar, 2006). This trend has been attributed to a combination of factors that is unique to the construction industry.

The typical construction work environment is generally more hazardous than most other work environments due to the use of heavy equipment, dangerous tools, hazardous materials, and rapidly changing work to be done; all of which increase the potential for unsafe acts, errors, serious accidents and injuries (Abudayyeh, Fredericks, Butt, & Shaar, 2006). The study investigated injury profiles reported among construction workers employed in Colorado. The specific aim of this paper was to evaluate demographic characteristics, hours of safety training, and categorize self-reported injuries among construction workers. The goal of this paper is to highlight the frequency, type and severity of work-related injuries among construction workers.

Study Methods

This study recruited subjects using convenience sampling through companies in the Denver metro and Northern Colorado area who had developed existing working relationships with the construction management program at Colorado State University. The field investigator contacted the company's project manager to schedule a time to administer the survey. Upon entering the worksite, the field investigator explained to workers that participation on the survey was voluntarily and invited workers to participate by completing the survey. No personal identifiers were obtained; respondents were told that their answers would remain anonymous and would not be shared with the employer. Upon completing and submitting the survey, respondents were given ten dollars cash for compensation.

The survey instrument used in the study included both English and Spanish side-by-side text boxes designed for ease of use by either Spanish-speaking or English-speaking construction workers. Respondents were also asked to identify their construction sector: Residential, commercial and heavy civil. The study protocol was submitted and approved by the university Human Research Board (IRB/HRB). The instrument used in this study included both English and Spanish side-by-side text boxes designed for ease of use by either Spanish-speaking or English-speaking construction workers. Respondents were asked about the construction sector where they work, age, years in construction and highest educational level. Construction sectors were classified into three categories where 1 = residential, 2 = commercial and 3 = heavy civil. Age was classified into four categories where 1 = < 30 years, 2 = 30 – 40 years, 3 = 41 – 50 years and 4 = > 51 years. Year worked in construction were classified into four categories where 1 = < 5 years, 2 = 6 – 10 years, 3 = 11 – 15 years and 4 = > 15 years. Highest educational level was classified into six categories where 1 = < 6 years of school, 2 = some high school or less, 3 = high school graduate, 4 = some college, 5 = college graduate and 6 = technical or trade school.

Respondents were also asked about the amount of health and safety training that they had received in the past year, and whether or not they had ever sustained a work related injury. Number of hours of health and safety training were classified into six categories where 1= 0 hours, 2 = 1 hour, 3= 2 hours, 4 = 3 hours, 5 = 4 hours and 6 = > 5 hours. The responses regarding workers having ever sustained a work related injury were classified into two categories where 1= yes, 2 = no. Respondents who stated that they had sustained a work related injury where asked to briefly describe the injury and number of work days missed due to the injury. Injury descriptions were grouped by injury type and coded. Number of work days were classified into five categories where 1= 0 days, 2 = 1-3 days, 3 = 3-6 days, 4 = 6-9 days and 5 = > 1- days. Completed surveys were returned to the university, coded and entered into a computer database for analysis using the Statistical Package for Social Sciences (SPSS™) version 17.0. Analytic methods included univariate, descriptive and frequency statistics and logistic regression to generate odds ratio risk estimates for of injury. "An odds ratio (OR) is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure" (Szumilas, 2010, p. 227). An OR greater than 1 means that the odds have increased, an OR less than 1 means that the odds have decreased.

Results

The survey was administered to 341 respondents in Northern Colorado and the Denver metropolitan area. As shown in Table 1, respondents represented the three major construction sectors with approximately 1/3 of respondents in each sector (36% residential, 31% commercial and 32% heavy civil). Respondents were asked to mark in a multiple choice question their age. The possible answers were younger than 30 years old, between 31 and 40 years old, between 41 and 50 years old, and over 50 years old. The results show that 65% of respondents are younger than 40 years old. Respondents were also asked how many years they have worked in construction. The possible answers were 5 years or less, between 6 and 10 years, between 11 and 15 years and more than 16 years, as shown in Table 1. When asked about their highest educational grade level, they were asked to select among the six possible choices: 6th grade or less, some high school or less, high school graduate, some college, college graduate and technical school or trade school. As it can be seen in Table 1, 40% of respondents reported that they had not graduated high school. Of the 341 respondents, 58 (17%) reported that they had only completed sixth grade or less while 76 (22%) reported that they had formal education beyond high school.

Table 1: Respondent demographic characteristics

Variable	Number of Workers	Percentage
Construction Sector		
Residential	124	36%
Commercial	105	31%
Heavy Civil	110	32%
No Response	2	1%
Total	**341**	**100%**
Age		
Younger than 30 years old	92	27%
Between 31 and 40 years old	128	38%
Between 41 and 50 years old	44	13%
Older than 51 years old	30	9%
No Response	47	14%
Total	**341**	**100%**
Years in Construction		
5 years or less	63	18%
Between 6 and 10 years	93	27%
Between 11 and 15 years	65	19%
More than 16 years	71	21%
No Response	49	14%
Total	**341**	**100%**
Highest Educational Grade Level		
6th grade or less	58	17%
Some high school or less	79	23%
High school graduate	76	22%
Some college	42	12%
College graduate	21	6%

Technical school/ Trade school	13	4%
No Response	52	15%
Total	**341**	**100%**

Respondents were also asked about the number of hours of health and safety training in the past 12 months. They were asked to select among the following six choices: zero hours (no training), one hour, two hours, three hours, four hours, and five or more hours, see Table 2. Twenty percent of participant reported that they had not received training over the last year, 30% of respondents reported that they had between one and four hours of training, and 50% of respondents reported that they had 5 or more hours of training. When asked about whether or not respondents had ever sustained a work related injury, 57 (17%) respondents reported that they have been injured on the worksite and 83% reported that they had not been injured on the worksite. Respondents who reported that they were injured on the worksite were asked the amount of work days that they missed due to the reported injury. Of the 57 workers that reported having been injured on the worksite, 46% reported that they did not miss work days due to the injury, 23% reported that they had to miss between one and three days, and 30% reported that they had to miss four or more days.

Table 2: Health and safety training and reported work-related injuries

Variable	Number of Workers	Percentage
Hours of Health and Safety Training in the Past Year		
0	69	20%
1 hour	12	4%
2 hours	28	8%
3 hours	29	9%
4 hours	33	10%
5+ hours	170	50%
Total	**341**	**100%**
Sustained a Work Related Injury		
Yes	57	17%
No	284	83%
Total	**341**	**100%**
If Injured, Number of Work Days Missed		
0	26	46%
1-3 days	13	23%
4-6 days	3	5%
7-9 days	5	9%
10+ days	9	16%
No Response	1	2%
Total	**57**	**100%**

Respondents were also asked an open ended question about the type of injury that they had sustained at the worksite. Responses were classified into the following four categories: finger/ hand injuries (mainly finger amputations), back injuries, WMSD excluding back injuries and other. The other category included injuries that were not classified in one of the previous three categories. As shown in Figure 1, 60% of work-related accidents reported by construction workers were musculoskeletal disorders. The work-related musculoskeletal disorders (WMSDs) resulted from lifting or slips and falls.

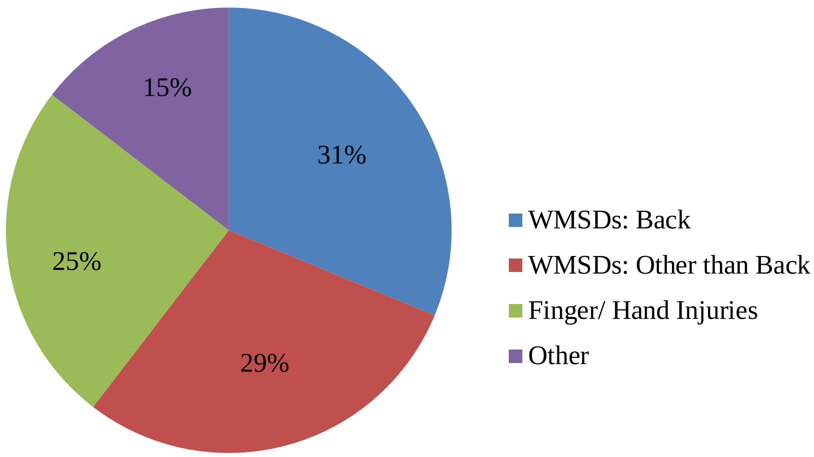

Figure 1: Self-reported Work-related Injuries by Type

As seen in the odds ratios risk estimates in Table 3, the commercial construction workers were at greatest risk of injury with OR 2.16 (CI 1.02-2.63). Age groups less than 30 and between 31 – 40 years were at greatest risk for injury, OR 3.52 (CI 1.37-9.06) and OR 2.95 (CI 1.23-7.09) respectively. The lack of safety training increased risk of injury OR 3.56 (CI 1.34-9.49). Hours of safety training did not yield significant ORs but did identify an inverse relationship of increasing risk with decreasing hours of training.

Table 3 – Risk estimates for injury associated with worker demographic characteristic

Variable	Odds Ratio (95%)	L-CI	U-CI	P-Value
Residential Sector	1.37	0.713	2.63	0.35
Commercial Sector	2.16*	1.02	4.59	0.04*
Age < 30 years	3.52*	1.37	9.06	0.01*
Age 31-40 years	2.95*	1.23	7.09	0.02*
Age 41-50 years	1.54	0.57	4.18	0.40
< 5 yrs in Const	2.54*	1.10	5.88	0.03*
6-10 yrs in Const	2.70*	1.27	5.75	0.01*
11-15 yrs in Const	3.41*	1.40	8.33	0.01*
6th Grade Ed	3.91*	1.02	14.97	0.04*
Some High School	3.86*	1.07	13.98	0.04*
High School Grad	4.65*	1.24	17.35	0.02*
Some College	0.83	0.02	2.88	0.78
College Grad	2.00	0.45	8.98	0.37
No Safety Training	3.56*	1.34	9.49	0.01*
1 Hr Safety Training	3.06	0.38	24.48	0.29
2 Hr Safety Training	2.32	0.66	8.11	0.19
3 Hr Safety Training	1.07	0.40	2.81	0.89
4 Hr Safety Training	1.56	0.56	4.32	0.39

Non-Adjusted Odds Ratios 95% Confidence / Lower Confidence Limit (L-CI) / Upper Confidence Limit (U-CI) / P-Value, *Significant Odds ratios and P-values

The first three categories for years in construction yielded increased risk estimates with the highest seen in those with 11-15 years, OR3.43 (CI 1.40-8.33). Less education was associated with increased risk, college educated and college graduate did not have increased risk estimates. The highest risk estimates was seen in the high school graduate group, OR 4.65 (CI 1.24-17.35). The lack of safety training was an estimate for increased risk with an OR 3.56 (CI1.34-9.49). While risk estimate were associated with additional levels of safety training, the confidence intervals included zero and p-values were not significant.

Discussion

The exploratory study did find interesting patterns and results worth comparing to the published literature. In this study, the commercial sector had the highest risk for non-fatal injury, OR 2.16 (CI 1.02-4.59). However, when seeking comparisons the researchers found that the classifications did not align with the three groups but revealed that specialty trades are the highest risk group with 69% of all injury claims followed by construction of buildings at 18% of and heavy civil at 13%. Evaluation of demographic characteristics revealed that 65% of the study respondents were 40 years of age or younger and that they were at increased risk for injury. Those < 30 years of age were at highest risk, OR 3.52 (CI 1.37-9.06), is somewhat differing from recently published results by the Center for Construction Research and Training (CPWR, 2013). The CPWR found that the age group 45-54 years at the greatest risk of injury followed by the 25-34 year age group, this is somewhat consistent with these findings. The CPWR also identified that older workers, ages 55-64 years, lost the greatest time away from work following an injury.

The patterns of injury seen in the study population were consistent with the published literature (CPWR, 2013). Construction workers are exposed to strenuous activities such as lifting and carrying heavy loads, pushing, pulling, reaching, twisting, kneeling, climbing, repeated and forceful movements that have been associated with WMSDs (NIOSH,1997). WMSDs include muscle, tendon and/or ligament injury to various areas of the body such as back, neck, shoulders, lower and/or upper extremities. The researchers found that WMSDs represented 60% of reported injuries with the back being the single largest group at 31% of all injuries. These findings were consistent with results published by others (Lipscomb et. al., 2008; Simonton, 2007). CPWR (2013) identified WMSDs to be 16% higher than all other industries and that causation was associated with bodily reaction 34% and contact with objects at 33%. Over-exertion was the most common cause of back injury 38% and has the highest rate among concrete workers at 49 / 10,000 FTEs. These are significant finds in that 34% may become chronic in nature (CPWR, 2013).

When evaluating years worked in construction, the researchers found that 82% of respondents reported being in the field for more than 5 years. Comparing the number of years in construction to the reported age, the researchers concluded that the majority of respondents began working in construction at a fairly young age. They also found that the risk was associated with all categories up to 15 years with 11-15 years with the highest risk, OR 3.41 (CI1.40-8.33). This is in contrast to the findings reported by CPWR that rates fell by 30% among this group and tripled among the older workers (CPWR, 2013). When evaluating the relationship of education attainment to risk for injury the researchers found that 62% reported high school graduation or less and were at higher risk compared to those with college or college degrees. The CPWR (2013) reported that 58% of non-union construction workers and 74% of union workers were directly comparable having high school diploma or less education. The risk estimates reveals that high school graduates had the highest risk with OR 4.65 (CI 1.24-17.35). The evaluation of hours of safety training reveals that those who had no training were at risk with OR 3.56 (CI1.34-9.49) and that all levels of training yielded no statistically significant risk but did identify an inverse relationship of increasing risk with decreasing hours of training. Safety and health training effectiveness is a function of intensity, frequency and duration (Goldenhar and Schulte, 1994).

The exploratory study and results have a number of limitations worth stating. The sample was small and not random and therefor may not represent the average company in the Northern Colorado area. Respondents were employed at companies with established relationships with the university and may represent better than average companies. The number of injured workers was reported at 17% and should be cautiously externalized to larger construction groups. Underreporting injuries and injuries common among construction workers (GAO, 2009), therefore the number of injured workers among the sample population may be greater than those self-reported by respondents. The use of a self-report survey that may have yielded biased results due to failed recall or intentional misinformation. Self-reported data may yield differences in incidence rates compared to non-self-reported data. This is a limitation common to all self-report instruments.

Conclusion

The researchers executed this exploratory study among a cohort of 341 construction workers from three sectors. Results revealed that patterns did exist among workers and that associations were identified between variables and increased risk for injury. The results suggest that there is an increased risk to sustain work related injuries associated with a number of variables including working in the commercial sector, having no safety training and being younger than 30 years old.

When comparing the findings of the study to the published literature, the researchers conclude that the findings were consistent with others who identified that WMSDs have been a major problem in construction (Lipscomb, et al., 2008; Maboob, et al., 2003). The subset of injured workers in this study represented 17% of the total group and was thought to be low compared to previous findings (Gilkey, et al., 2007).

While the study was exploratory in nature and included a small sample size of injured workers, the researchers believe that it represents a larger pattern of exposure and injuries common to the industry. Future work will seek to evaluate organizational and safety culture factors and their role to explain injury among construction workers. The researchers believe that organizational factors are the major drivers for human behavior and safe work practices on construction sites. Future research will include larger samples sizes and greater details about worker characteristics, perceptions and behaviors. The long-term goal is to develop effective interventions to reduce the incidence and severity of injury suffered by construction workers.

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