

A Survey Study of Ergonomic Perceptions among Construction Employees at an Industrial Construction Project in Eastern Nebraska, USA

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Abstract: Work-related musculoskeletal injuries and disorders (WMSDs) are among the most frequently reported causes of lost or restricted work time in the construction industry. Understanding of the workers' and managers' knowledge and perception of ergonomic issues in construction could play an important role to develop and implement effective ergonomic programs and policies. The objective of this pilot study is to categorize the similarities and differences of the awareness and perceptions of ergonomic-related concerns between workers and managers in the Midwestern construction industry. A survey questionnaire was developed and distributed to construction workers and managers employed at an industrial construction project located in eastern Nebraska. The questionnaire comprised of a total of forty questions and consisted of four major sections: background, safety and ergonomic programs, injuries and illnesses, and work conditions. A total of 193 participants completed the survey questionnaire. Ninety percent of their employer had a written safety program, while only 40% of them had an ergonomics program. Ergonomics was perceived as relatively less important compared to the safety issues. Managers were more likely to know that their companies have a written safety program, an ergonomics program, a manual lifting program, and safety teams/committees than workers. Managers were more likely to think that management encourages feedback from site employees than were workers. Workers were more likely to be unsure if their companies or unions provide ergonomic training or not if they have received ergonomic training specific to the task they perform or not, and if they know how to perform an ergonomic assessment or not than managers. Workers and managers alike reported having slight regard for the potential occurrence of a work-related musculoskeletal disorder. And they were more likely to get back injuries, carpal tunnel syndrome, injuries due to overexertion, injuries due to tools/machinery, and injuries due to chemicals in the participant's specific line of work than managers. While the construction industry has done an admirable job developing safety programs, it has done far less to develop comprehensive ergonomic programs and policies that would help provide education and guidance to its workers and managers in the industry.

Keywords: WMSD, Ergonomics, Perception, Management, Worker, Construction

1. Introduction

Work-related musculoskeletal injuries and disorders (WMSDs) are among the most frequently reported causes of lost or restricted work time in the construction industry. Overexertion, sprains, strains, pulls, and/or tears are all an unfortunate regular occurrence on many construction job sites. Incident investigations for soft-tissue injuries commonly point to programs, policies, and procedural changes to reflect a reactive change to one particular case or a series of cases. Though work-related musculoskeletal disorders have become far more common to construction trades including laborers, carpenters, and ironworkers in the past 20 years, construction workers are less likely to return to work after one of these injuries than other occupations (Boatman et al., 2015). WMSDs still receive much less attention than acute injuries (Albers et al., 1997). Traditionally, more focus is on physical, acute injury causing hazard reduction because they are more out in the open and apparent. Commercial and industrial contractors strive on pushing production and getting buildings turned over to clients within a schedule set by executive staff prior to the project starting. This eventually can put pressure the workers to increase their production that opens the opportunity for shortcuts to be taken instead of following the safe work methods that are also developed prior to the commencement of work. The National Institute for Occupational Safety and Health states that employees should be aware of employer's role in addressing and controlling risk factors (NIOSH, 2019). For the example used in this study, a site-specific safety plan is drawn up for self-perform carpenters for the crews with initial training being done in an office setting. The production-based nature that workers find themselves is based on a critical path that follows the next step in the building process, such as needing to install the studs before the drywall, drywall before tape and compound, finishes before paint, etc. Furthermore, the high-rise building format of typical floors being constructed the same way for months or years at a time breed receptiveness in the work. Though initial training is done with the field staff and supervisors, it is far more difficult to take the time to re-train or train field staff on a new task in the field due to time constraints and schedule impacts (Hecker et al., 2000).

The receptiveness and push for production and speed throughout an entire carpenter's career pose a large impact on the frequency and severity of WMSDs. Repetition and excessive force being a primary cause of WMSDs, the aging workforce poses a great risk to companies who employ them, with repeated trauma having affected workers for years, it often becomes a matter of time before a pre-existing condition becomes a worker's compensation claim, though that may never be the workers' intent or any fault of what they are currently doing, but more the human body having taken too much of a beating. Furthermore, that aging workforce is less likely to adapt new methods or technologies because of the traditional methods that they have used for years that have proved effective (Hecker et al., 2000). Ergonomics – fitting the task to the worker - is still a relatively new theme for the construction industry. However, understanding of the workers' and managers' knowledge and perception of ergonomic issues in construction could play an important role to develop and implement effective ergonomic programs and policies (Sneller, Choi, & Ahn, 2018).

The purpose of this survey study is to categorize the similarities and differences of the awareness and perceptions of ergonomic-related concerns between workers and managers in the Midwestern construction industry.

2. Methods and Procedures

2.1 Survey Instrument

The survey for this study was identical to the survey developed for the research paper, "Awareness and Perceptions of Ergonomic Programs between Workers and Managers Surveyed in the Construction Industry" (Sneller, Choi, & Ahn, 2018). This study utilized the same survey so that it would be possible to compare the survey results of both studies for future research. The survey (Sneller, Choi, & Ahn, 2018) was developed by reviewing peer-reviewed articles and journals as well as existing ergonomic surveys used to study the construction industry to enhance the authors' understanding of the construction industry's ergonomic issues. The research resulted in the authors electing to base the survey questions, in part, to previous surveys found in Choi (2012) and Choi et al. (2007). The survey consisted of four main sections: (1) background information about participants; (2) safety and ergonomic programs; (3) work-related injuries; and (4) work conditions. The first section, "Background" consisted of questions pertaining to survey participant's work title, job function, and length of employment, race, gender and union affiliation. The section also contained questions concerning the participant's employer, including their employer's total number of employees, length of time in business, union or non-union affiliation, and the type of safety training that had been offered to them by their employer or union. Section two, "Safety and Ergonomic Programs," focused on their employer's safety and ergonomic programs. Did their employer have written ergonomic and safety policies and if so, how long had they been in place? The section also contained various questions concerning the content of employer's ergonomic program, management's level of concern for non-compliance with the company's safety program, as well as the perceived importance of their employer's ergonomic and safety programs. Section three, "Injury and Illness," asked the

participants to choose from a list of injury types or illness in which they felt most commonly occurred in their line of work, and what was cause for those injuries or illnesses. The section also asked the participants to rank a list of seven commonly injured body parts from 1 to 7 with (1) one being the “most frequent” and (7) the “least frequent.” The final section titled, “Workplace Conditions,” focused on the working conditions found at their current employer’s job sites. Questions included the type of work surfaces the participants were exposed to, the type of tools that they used to complete their tasks, the types of workplace ergonomic hazards they were exposed to, as well as a matrix of questions concerning manual lifting including the amount of time spent during the workday tasked with manually lifting, the required distance an object was required to be carried for a typical manual lift, as well as the average weight of a manual lift.

2.2 Procedures for Gathering Data

In September 2018, the study survey was presented during an all-hands weekly safety meeting to the construction workers and managers employed at an industrial construction project located in eastern Nebraska. Prior to distributing the survey, a brief review of construction ergonomics was presented to the attendees. Following the presentation, the survey was distributed to the group, the purpose of the survey was discussed, and the willing participants completed the questionnaire. The \$200 million-dollar construction project was located within an existing biotechnology facility that housed several bioprocessing plants. The project’s scope included modifying an existing fermentation production plant and tying into its electrical and mechanical systems to service a new processing plant, tank farm, warehouse, and laboratory. When complete, the facility will produce omega-3 fatty acids EPA and DHA that will be used as a food additive for salmon aquaculture and for the first time, without reliance on fish oil obtained from wild fish stocks.

Twenty-six different union and non-union contracting firms were hired to work at the project. These contractors were tasked to complete a wide range of work. The contractors installed steel pilings, excavated and graded the site, placed rebar, and poured concrete footings, foundations, driveways, sidewalks, and roads. They erected structural steel, placed floor grating, and installed siding panels. They also built stainless steel tanks, installed the fire protection, electrical and mechanical systems. The 23-month construction project had a peak employment of 435 personnel. These individuals were skilled and unskilled craftsmen, supervisors, foremen, construction and project managers, safety professionals, as well as engineers, quality control technicians and managers, schedulers, procurement professionals, and project control personnel.

2.3 Statistical Analysis

Statistical analysis for descriptive statistics and Pearson’s chi-square tests of the data were conducted using SAS® (Statistical Analysis Software) 9.3 Software. SAS® is an analytics software suite developed by SAS Institute Inc., Cary, NC, USA.

3. Results and Discussion

A construction worker’s perception of their management’s concern for their workplace safety is vital to the success of an organization’s ergonomic programs and safety programs. A total of 193 participants completed the survey. The results of the survey were broken down per the survey format of Background, Safety and Ergonomic Program, Injury and Illness, and Work Conditions. The results of the survey are as follows.

3.1 Background

Table 1 lists the surveyed characteristics of the participants’ reported background. Most of the respondents were male (88%). Fifty-four percent of the workers were white, followed by Latinos (34%), and African Americans (5%). Their average age was 36, and the age range was from 19 to 70. The range of the participants’ current company employment length was 0 to 30 years, with an average of 3.2 years. Eighteen percent of the participants reported that they were union members while 81% were not. Seventy-seven percent of the participants were workers while twenty-three percent were managers. The managers were significantly older (average age of 43) than the workers (average age of 34). The managers also had significantly longer employment length (average 8.2 years) than the workers (average 1.6 years). Fifty-eight percent of the participants reported that they had some types of safety training offered by the company or union. The most frequent type of safety training was OSHA training (93), followed by fall protection (32), confined space (20), and manual lifting/ergonomics (7).

Table 1. Background characteristics

Variable		Frequency (%)
Gender	Female	22 (11.6%)
	Male	168 (88.4%)
Race	African American	9 (4.9%)
	Latino	62 (33.9%)
	White	98 (53.6%)
	Others	14 (7.7%)
Union	Member	25 (18.0%)
	Non-member	113 (81.3%)
	Both	1 (0.7%)
Job Position	Manager	41 (23.2)
	Worker	136 (76.8%)
Age (years, mean \pm SD)		36.3 \pm 12.0
Employment Length (years, mean \pm SD)		3.2 \pm 6.0

3.2 Safety and Ergonomics Programs

The participants were asked if they knew if their employer had a written safety program; 90% responded yes, while only 40% stated that their employer had an ergonomics program. Of the respondents stating that their company did not have an ergonomics program only seven participants mentioned that they formulated an action plan to develop self-precaution or warm up stretches plan. Only 37% of the participants reported that their company or union-provided ergonomic training, and 41% of the participants reported that they had received ergonomic training specific to the task they perform. The participants were asked if they knew how to perform an ergonomic assessment and only 33% reported that they did. And about 27% of respondents stated that an ergonomic evaluation had been completed on the task they perform. These results show that ergonomics is not well perceived and practiced.

About 42% of the participants stated that there was a stretching or flex exercise policy at work and they stretched before work. Fifty-four percent considered purchasing/selecting ergonomic handle of power tools. Half of the participants stated that they had a manual lifting training program and that 72% reported that they had a weight limit on single person manual lifting. Most of the limits were 36-50 pounds (88%), but 9% reported above 50 pounds. Only 21% stated that they have work practices or personal protective equipment (PPE) for vibrations. While 56% responded that the company had a safety team/committee whereas only 6% stated that their employer had an ergonomic team/committee.

The survey asked the participants to rank their perception of their company's safety and ergonomics issues on a scale of 1-5 with "1" labeled as "not important" and "5" labeled as "extremely important." Figure 1 shows the participants' responses. The average scores and their standard deviations (SD) for those questions were 4.17 (SD=1.11), 4.04 (SD=1.11), 4.18 (SD=1.10), and 3.59 (SD=1.31), respectively. The respondents perceived that their employer was concerned about their workplace safety. However, the participants' perception of the company's ergonomic well-being was ranked much lower than their perception ranking of the company's safety concerns. Only 35% thought it was extremely important ("5") to their employer. It clearly shows that ergonomics is perceived relatively less important compared to the safety issues (management express concern; management encourage feedback; "Safety" perception). Also, the average score for management encourages feedback was significantly lower than the average scores for management express concern and "Safety" perception.

When the study's survey responses were separated into management and worker categories the comparisons suggested interesting findings as follows:

- Managers were more likely to know that their companies have a written safety program, an ergonomics program, a manual lifting program (e.g., NIOSH Lifting Guidelines), and safety teams/committees ($p = 0.0125$, $p = 0.0078$, $p = 0.0391$, $p = 0.0329$, respectively)
- Managers were more likely to think that “Safety” is perceived important in their companies ($p = 0.0483$)
- Workers were more likely to be unsure if their companies or unions provide ergonomic training or not if they have received ergonomic training specific to the task they perform or not, and if they know how to perform an ergonomic assessment or not ($p = 0.0386$, $p = 0.0294$, $p = 0.0151$, respectively)

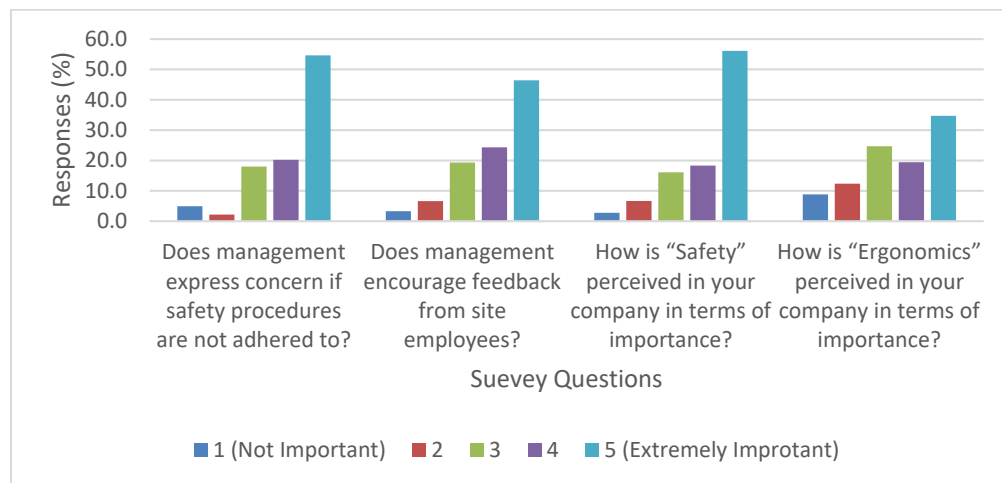


Figure 1. Participants’ perception of safety and ergonomics programs

3.3 Injury and Illness

The participants were asked if they knew how many non-fatal injuries and illnesses had occurred at their respective employer in the past year. They were also asked how many recordable injuries and illnesses had occurred during the same timeframe. Just 32% reported that they were aware of how many non-fatal injuries had occurred and only 24% stated that they knew the total number of recordable injuries.

The participants were asked to choose from a list of commonly occurring injuries in the construction industry that most frequently afflicted workers in the participant’s specific line of work. As shown in Figure 2, the choices included “sprain/strain,” “back injury,” “fractures,” “burns,” “cuts,” “carpal tunnel syndrome,” or “other(s).” The participants were allowed to choose more than one injury category from the list. Sprain/strain was chosen by 55% of the participants, back injuries 50%, cuts 49%, burns 33%, carpal tunnel syndrome 21%, fractures 15%, and others 8%. Written into other(s) included hand injuries, eye injuries, falls, etc.

The participants were then asked their perception of the possible causes for the injury or illness in which they had chosen. They were given the choice of “overexertion,” “motion/position,” “slip/trip/fall,” “tools/machinery,” “chemicals,” or “other(s)” in which they could write the cause. “Slip/trip/fall” was chosen by 53% of the participants, “motion/position” 52%, “tools/machinery” 37%, “overexertion” 33%, “chemicals” 9%, and “others” 4%.

The participants were asked to rank which body part was most frequently injured from a list. They were instructed to rank the body parts from “1” to “7” with “1” being the most frequent and “7” the least. The results of the ranking were hand/fingers (median 1, mode 1), back (median 2, mode 1), eyes (median 3, mode 1), foot/ankle (median 4, mode 1), knees (median 4, mode 1), head/neck (median 4, mode 7), and shoulders (median 4, mode 7). Twenty-seven participants (14%) reported that they had lost time due to a work-related injury and 63 participants (33%) stated they had experienced body discomfort or pain in the last 12 months at work. The body parts that they had experienced bodily discomfort are, “back” (36 times), “knees” (21 times), “shoulder” (18 times), “feet” (10 times), “neck” (9 times), “hands” (8 times), “legs” (5 times), “all parts” (5 times), “eyes” (4 times), “wrists” (4 times), “arms” (4 times), “ankles” (3 times), “elbows” (3 times), “body” (2 times), “finger” (1 time), “hip” (1 time), “respiratory” (1 time), and every joint (1 time). Comparing to managers, workers were more likely to get back injuries, carpal tunnel syndrome, injuries due to overexertion, injuries due to tools/machinery,

and injuries due to chemicals in the participant's specific line of work than managers ($p = 0.0012$, $p = 0.0181$, $p = 0.0048$, $p = 0.0205$, $p = 0.0173$).

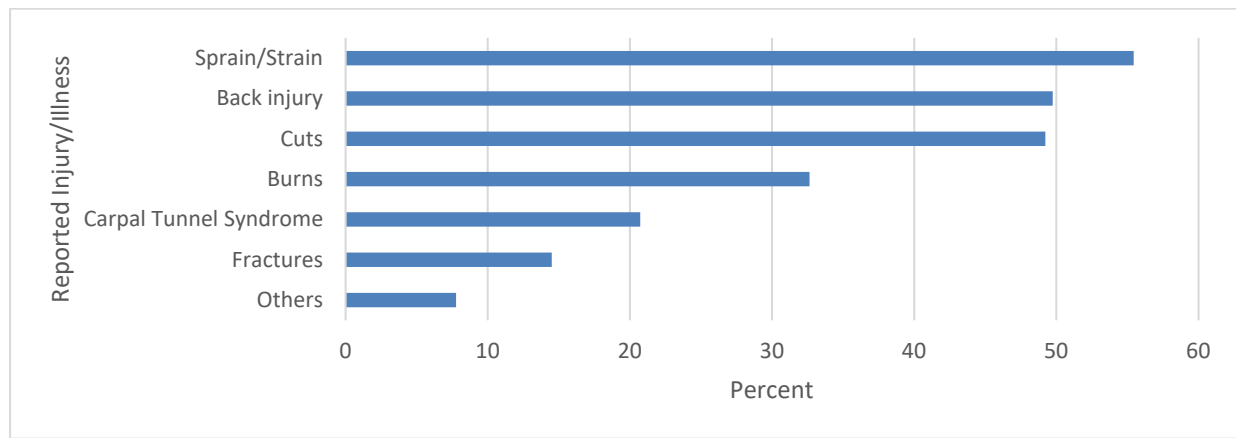


Figure 2. Most frequently occurring injuries/illnesses – survey results

3.4 Work Conditions

The final section of the survey focused on work-related conditions. The participants were given seven work surfaces in which they most commonly walked or worked on while completing their job. The results in order were ground (67%), scaffold (57%), ladder (45%), steel beam (37%), roof (18%), and tree (3%). The top ten commonly used tools the participants utilized to complete their tasks included: grinders (87), drills (35), hammers (34), wrenches (34), pliers (21), band saws (18), screwdriver (17), tape measure (15), pens/pencils (10), and knife (9). Less than half (90 of 193) of the participants responded that they felt they were exposed to ergonomic hazards while at work. When the participants were instructed to check all applicable occupational risk factors from a list of choices, they selected (number of participant responses) awkward body postures (53%), high repetition or frequency (46%), excessive manual force (34%), extended task duration (33%), cold temperatures (25%), vibration (23%).

The final survey question inquired about the participants' manual lifting task requirements during a typical work shift. The participants were asked to check off from a list of categories the total time they spent manual lifting during a typical day, the total distance traveled for each manual lift or carry, and the approximate weight of the load they were required to lift or carry. For "total time lifting/carrying," the category of 1-2 hours was chosen the most (34%), followed by less than 1 hour (26%), 3-4 hours (18%), 5-6 hours (12%), and 7-8 hours (10%). However, managers chose the category of less than 1 hour (38%) and 1-2 hours (38%) more than the other categories, while relatively more workers chose 5-6 hours (14%), and 7-8 hours (12%). For "total distance traveled," about two-thirds of the responses chose the categories of < 10' (32%) and 11'-30' (31%). Overall, workers reported longer total distance traveled for each manual lift/carry than managers. For "weight of load required," the 31-50 lbs. category of "approximate weight of the load" was the most common response (37%). Twenty-one percent of participants chose more than 51 lbs., a weight higher than the NIOSH recommended limit of 50 lbs. Twenty-five percent of workers reported this high weight of the load, while only 6% of managers did.

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