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Investigation of Ergonomic Issues in the Wisconsin Construction Industry

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Biography

Sang D. Choi, Ph.D., CPE, is an associate professor in the Occupational and Environmental Safety & Health Department at the University of Wisconsin-Whitewater. Dr. Choi coordinates the Occupational Ergonomics Emphasis & Certificate Program, and teaches graduate and undergraduate courses in construction safety & health, ergonomics and systems safety. An award-winning author and researcher, Dr. Choi is a frequent keynote and session speaker at conferences in the U.S. and internationally. Dr. Choi is an OSHA-approved outreach instructor for construction and industrial safety, and serves as ASSE faculty advisor for the Student Safety Organization. He is a member of National Safety Council, American Society of Safety Engineers, and Human Factors and Ergonomics Society.

Abstract

The objective of this study was to report the current workplace ergonomic issues in the construction industry, and to identify current safety practices associated with the prevention of work-related musculoskeletal injuries in the construction field. A two-page survey was designed and sent to commercial construction contractors in Wisconsin. Of the 45 construction firms asked to participate, 25 completed the survey. Total number of workforce of the participating companies was 10,879 employees. All of the construction contractors surveyed had a safety program; however, most of the contractors did not have a site-specific ergonomics program. Findings from this study indicated that sprain/strain and back injuries due to the heavy manual materials handling, and hand/fingers injuries due to cutting operations to be the most frequent construction task/injury combination. Most common source of injury was overexertion, followed by motion/position and slip/trip. The survey findings also show that the construction workers were usually walking/working on the ground and ladder, and spent significant amount of time for the manual lifting or carrying heavy materials. This study highlights the need for more site-specific ergonomic interventions to prevent work-related musculoskeletal disorders and injuries in construction. Furthermore, the findings may aid SH&E educators and practitioners to enlighten the benefits of ergonomics in terms of improving health of employees and increasing the company's profits. Methods for mitigating work-related musculoskeletal injuries in construction are also discussed in the paper.

Keywords: Construction, Ergonomics, Musculoskeletal Injury, Prevention, Questionnaire

Introduction

The construction industry is consistently ranked among the most dangerous occupations and accounts for a disproportionately large percentage of all work-related illnesses, injuries, and deaths in the United States (Center to Protect Workers' Rights, 2005). The U.S. Bureau of Labor Statistics (2005) shows that construction's overall lost-days nonfatal occupational injury and illness incidences rate (239.5 cases per 10,000 full-time workers) was higher than any other industry sector. Working in the building and construction trades has been linked to serious and costly health risks, including risks for musculoskeletal disorders (Rosecrance et al., 1996). For years the construction industry has been associated with increased rates of work-related musculoskeletal disorders (WMSDs), a condition involving the soft tissues of the body, including muscles, tendons, nerves, cartilage, and other supporting structures, that is caused by exposure to work-related factors (U.S. Department of Health and Human Services, 2000). Work-related musculoskeletal disorders and injuries are very important and costly national health problem as they account for nearly 70 million physician office visits in the United States annually and an estimated 130 million total health care counters including outpatient, hospital, and emergency room visits (National Research Council and Institute of Medicine, 2001). According to the National Occupational Research Agenda (2001), conservative estimates of the economic burden imposed by WMSDs in the United States (as measured by compensation costs, lost wages, and lost productivity) are between $45 and $54 billion annually. Some experts estimate an even higher economic burden reaching up to $210 billion for low back pain alone (Jones and Kumar, 2001).

The existing data show construction workers to be at significant risk of musculoskeletal injury, specifically related to the work they do (Schneider, 2001). In a recent survey by the Laborers' Health and Safety Fund of North America (2006), 40 percent of construction workers said "working while hurt" is a major problem. Many of the injuries that occur in the construction industry are due to the manual material handling that is required in the construction industry (The Eastman Kodak Company, 2004). As pointed by the U.S. National Institute for Occupational Safety and Health (NIOSH), material handling incidents account for 32% of workers' compensation claims in construction, and 25% of the cost of all claims (NIOSH, 2007). Another contributing factor is that the workers' bodies must be in awkward postures (such as bending or twisting the trunk). These positions can be work below the knees, work above the head, on their backs (Schneider, 2001). In construction, the job is always changing. There are new situations each day as the job or project progresses. These jobs can range from above the shoulder work, to below the knees work, and a variety in between. The surfaces that workers work on change all the time and also change throughout the day (The Eastman Kodak Company, 2004).

The purpose of this paper is twofold: (1) to report the current workplace ergonomic issues in the construction industry, and (2) to identify current safety practices associated with the prevention of ergonomic injuries and illnesses in the construction field.

Methods and Procedures

To achieve the study objectives, the author first researched injury and illness trends in the U.S. construction fields. This research was conducted through many different sources: books, electronic copies of books, scholarly journals articles, magazines, abstracts from safety conferences, and web sites. Upon the completion of the literature reviews, a draft survey was developed, and then distributed to the construction contractors. The preliminary survey instrument was administrated in person to nine construction contractors. These contractors involved in highway or road construction projects in Wisconsin, which is in the upper Midwestern United States. Based upon the responses of these contractors, the survey instrument was further refined. This pilot survey was very helpful in the fact it enlightened the author on the finer points of conduction a final survey. The biggest point would be to have more exact questions; meaning that the responses are more catered to analytical results. This could be achieved by: (1) providing the respondent with specific responses to choose from (e.g., multiple choice questions), (2) have the table/questions based in excel thus allowing for a more simple process, (3) making the survey more user friendly/ easier to complete, and (4) if one has to use an open ended question ask for more specifics (example one response or their top choice do not allow multiple responses). Approximately 45 construction contractors were asked to complete the survey (see Appendix for the survey used). The questionnaire was distributed over a time period of 5-6 weeks. Distribution methodology involved faxing or e-mailing the survey to companies and having them filled out by a safety manager or director.

Survey Results

Of the 45 construction companies asked to participate, 25 completed the survey. This represents a response rate of 56%. The size of the participating companies greatly varied, with some employing as few as 15 workers, and others as many as 3000. The workforce and type of work of participating construction firms included 9 highway/road construction (6,387 employees), 6 general contractors (2,095 employees), 3 electrical contractors (500 employees), 2 concrete/precast structures (230 employees), 2 steel erection (135 employees), 2 signs/street lighting/traffic signals (67 employees), and 1utility construction (1,465 employees). The participants were primarily from Wisconsin. The average time that the companies had been in business was 58 years, and 80% of respondents (20 of 25 companies) were unionized. Looking at the gender distribution of the companies surveyed, the percentage of male employees had a wide margin over female employees. The women population represented 12% of the total number of workers.

Safety and Ergonomics Programs

The companies were asked whether or not safety/ergonomics programs were maintained at their companies. All of the firms surveyed (25 of 25) had a written safety program, and

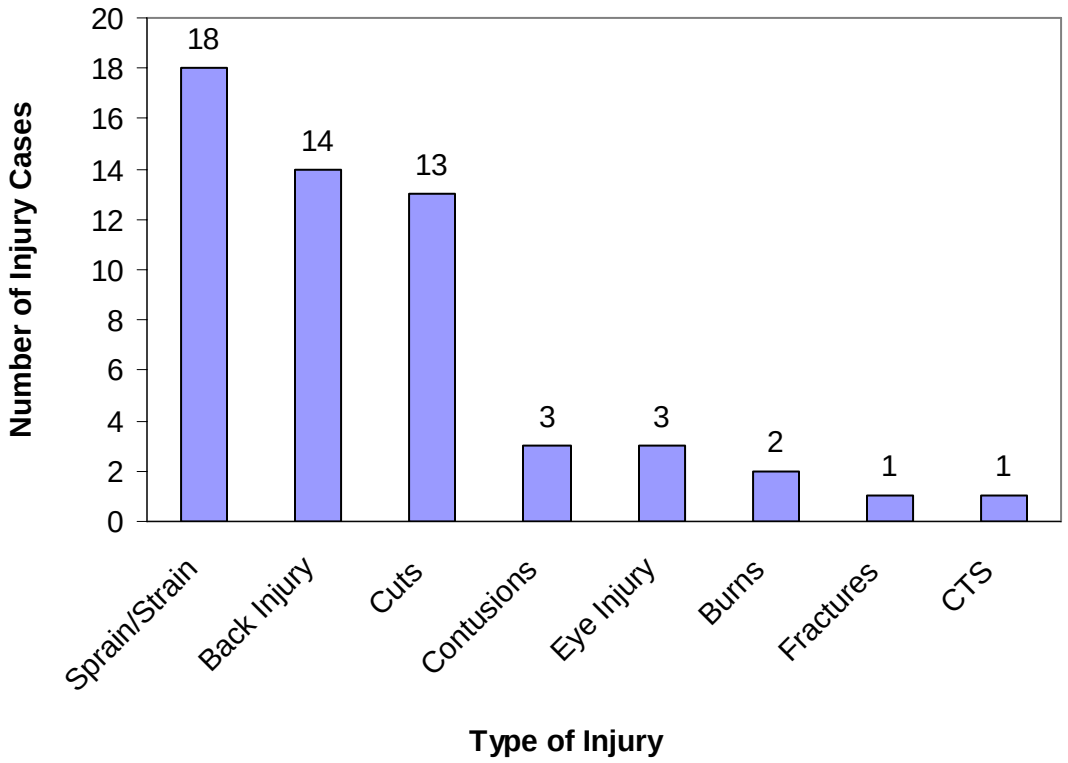
68% of the respondents have had a safety program for more than ten years. However, only 40% of the respondents (10 of 25) had an ergonomics program. Seventy-two percent of the respondents (18 of 25) said they had a lifting training program. Fifty-six percent (14 of 25) had weight restrictions on single-person lifting. Forty percent of the respondents (10 of 25) encouraged the use of back belts. When the companies were asked if their employees did stretches prior to the beginning of their shift, 48% of respondents (12 of 25) said that they implemented the stretching program. When the companies were asked if they measured the handle of the tool when purchasing new tools, 80% (20 of 25) said that they considered ergonomic handle of the new tool before purchasing. Fifty-two percent of respondents (13 of 25) indicated that they employed personal protective equipment (e.g. anti-vibration gloves) for vibrations.

All of the firms surveyed (25 of 25) had at least one full time (ranging from 1 to 10) safety professional in their company. Most of the respondents (22 of 25) sent their safety reports (injury reports) to president or vice-president. All participants expressed that there was a high level of concern if safety procedures were not adhered to. They also expressed and encouraged a high level of feedback from site employees. They stated that the feedback from the site employees was extremely important. Sixty-four percent (16 of 25) firms had a reward system to help motivate employees to be safer; some examples include bonus, safety bucks, T-shirts, peer recognition, paid days off, and safety points redeemed at year-end.

Injuries and Illnesses

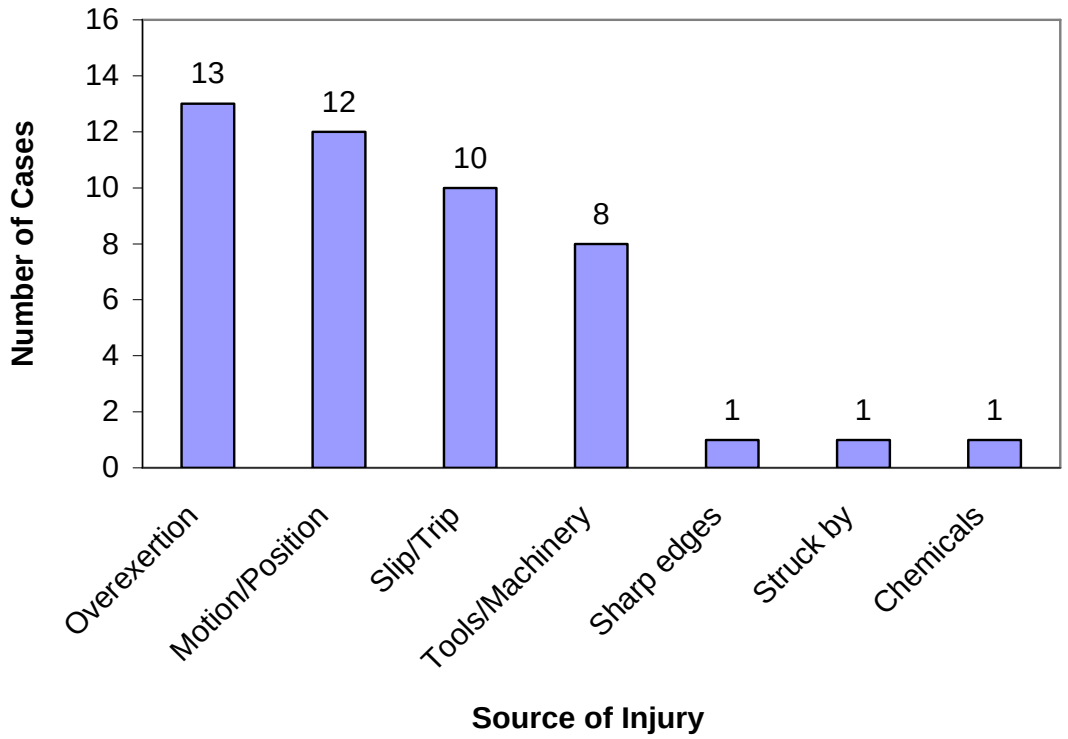
Companies were asked to pick from a list as well as to list common injuries that occur on their work sites. Participants could also list other injuries that were not included selections in the given list. Choices included sprain/strain, back injury, fractures, burns, cuts, and Carpal Tunnel Syndrome (CTS). Other types of injuries specified included contusions and eye injuries. Sprain/strain was the majority of the selected injuries totaling 33% (18 of 55 total cases) of the listed types of injuries. Back injury followed with 25%, and cuts made up 24% of the selected injuries. The other types of injuries reported contusions (5%), eye injury (5%), burns (4%), fractures (2%), and CTS (2%) respectively (see Fig. 1).

Figure 1: Number of Injury Cases by Type of Injury



Options included in the source of injury section included overexertion, motion/position, slip/trip, tools/machinery, and chemicals. Participants again were able to specify other types of sources that were not included in the given list and these included sharp edges and struck by. The most prevalent source of injury was overexertion totaling 28% (13 of 46 total cases) of the selected sources, followed by motion/position (26%) and slip/trip (22%), respectively. Other sources included tools/machinery (17%), sharp edges (2%), struck by (2%), and chemicals (2%) (see Fig. 2).

Figure 2: Number of Cases by Source of Injury



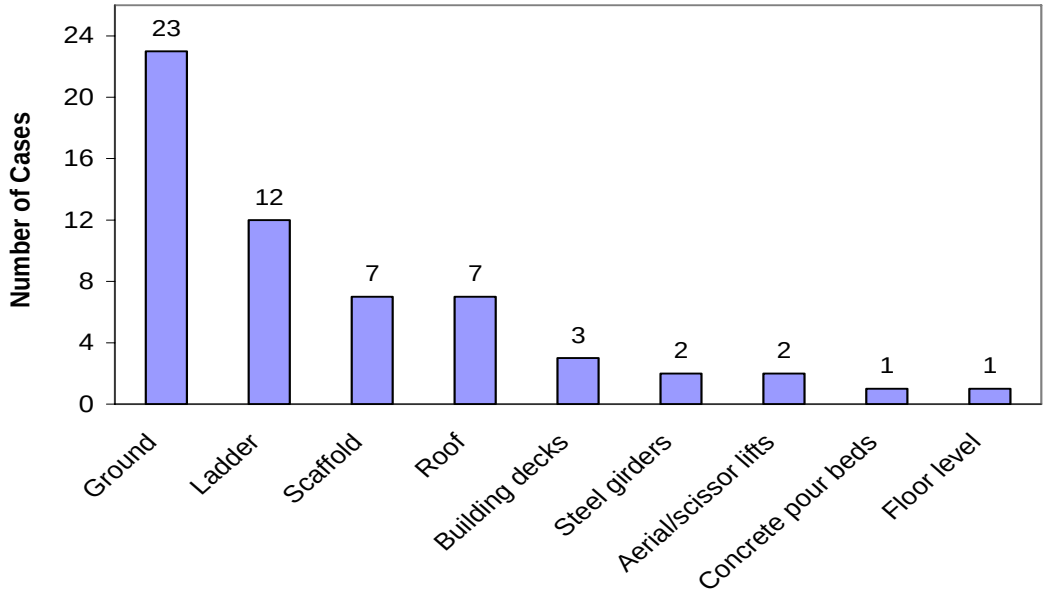
The survey also contained a section in which participants were asked to rank the frequency at which certain parts of the body were affected with injury and illness. Seven parts of the body were listed: (1) knees; (2) hand/fingers; (3) back; (4) shoulders; (5) eyes; (6) foot/ankle; (7) head/neck. The participants were asked to rank the relative frequency on a scale of 1 to 7, with 1 being the most frequent. Both back and hand/fingers injuries had the highest ranking with a mean response value of 2.7. Shoulder and foot/ankle had the third and fourth highest ranking with a mean value of 3.7 and 3.8, respectively. The other three parts of the body were assessed rankings of 4.2 (knees), 4.8 (head/neck), and 5.0 (eyes).

Work Conditions

The first question in this section designed to examine various characteristics of the walking/working surface that construction workers will commonly walk/work on. Other questions concerning manual lifting/carrying were also important to the study in determining information about common loads carried and load handling techniques when working on construction sites. Relevant issues included time spent on lifting/carrying per day, number of repetitions performed per day, distances traveled while handling loads, weight of the loads carried, and method of carrying the common loads.

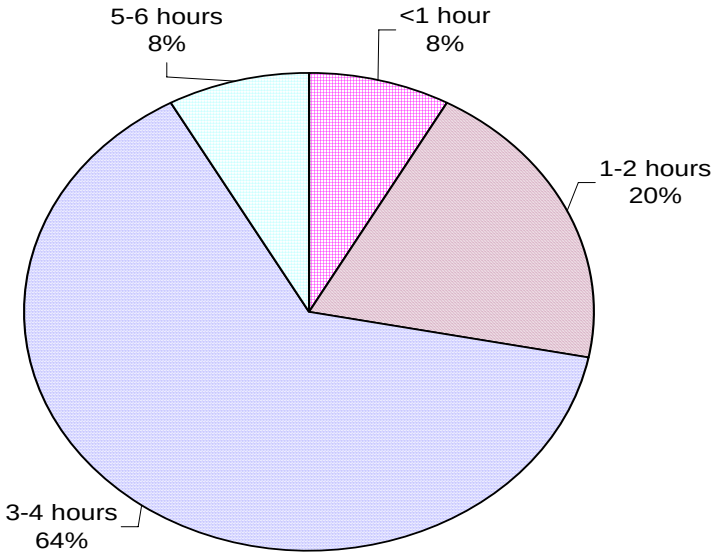
The participants were asked to pick from a list as well as to list common working surface conditions of their construction field workers. These surfaces included roof, ladder, scaffold, and ground. Other types of working surfaces that were specified included building decks, aerial/scissor lifts, concrete pour beds, floor level, and steel girders. Ground made up the most common type of surface that the construction workers work/walk on; totaling 40% (23 of 58 total cases) of the listed types of surface conditions (see Fig. 3). The next common type of work surface recorded ladders (21%), followed by scaffold (12%) and roof (12%) respectively. The other types of working surfaces included building decks (5%), steel girders (3%), aerial/scissor lifts (3%), concrete pour beds (2%), and floor level (2%).

Figure 3: Number of Cases by Type of Working Surface: Survey Results



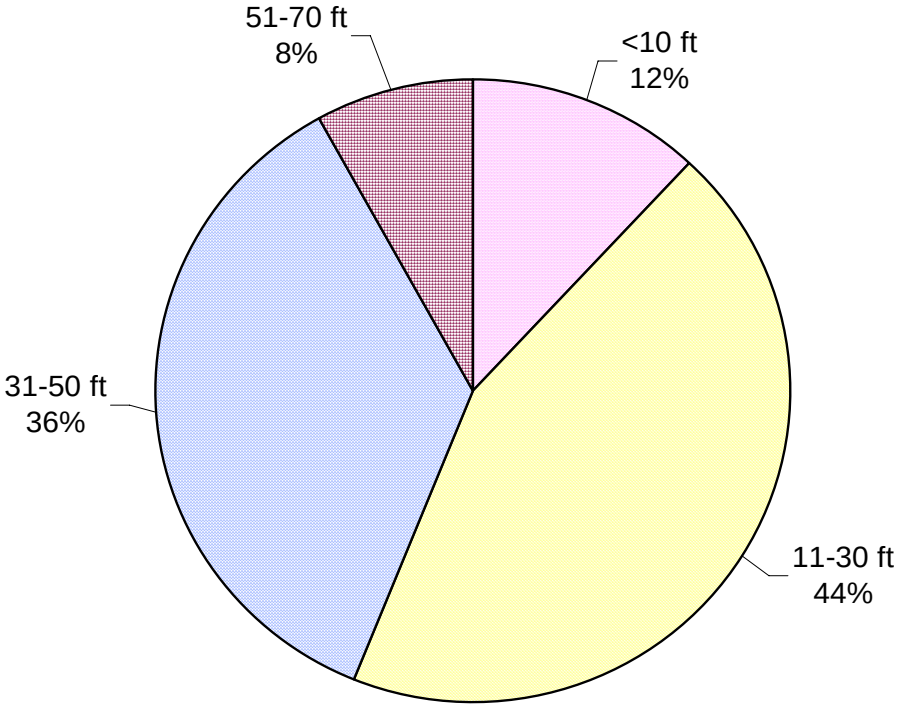
Responses from the survey determined that the most favorable accumulated time designated to manual lifting/carrying during a day per employee was within the range of 3-4 hours. Sixty-four percent of the respondents (16 of 25 companies) chose this range as the most common (see Fig. 4). Other choices and response rates included 1-2 hours (20%), 5-6 hours (8%), less than 1 hour (8%), and 7-8 hours (0%), respectively.

Figure 4: Time spent on manual lifting/carrying – survey results.



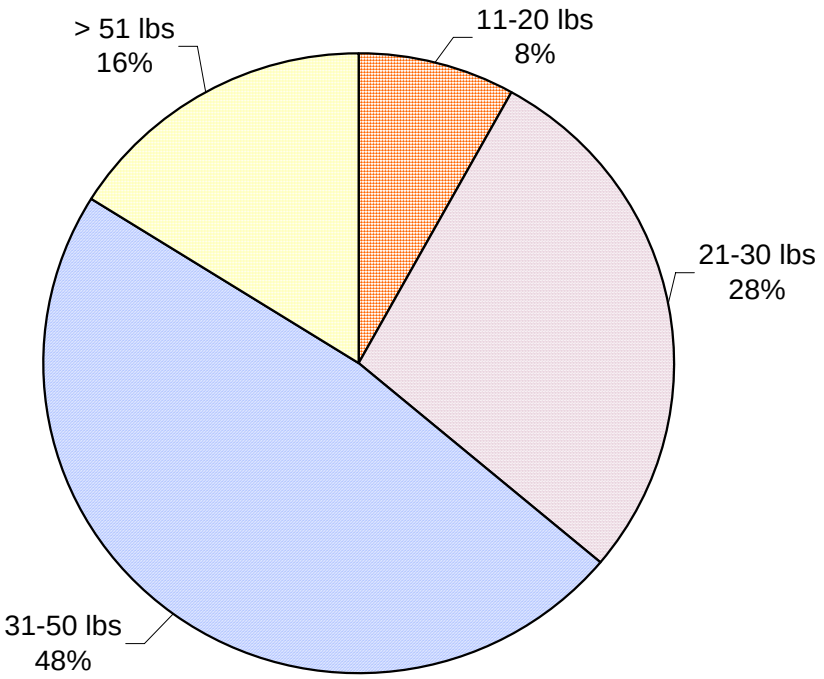
Forty-four percent of the respondents (11 of 25 companies) selected a range of 11-30 ft as the most common distance traveled for a manual carry (see Fig. 5). Other choices and responses included a range of 31-50 ft (36%), less than 10 ft (12%), 51-70 ft (8%), and more than 70 ft (0%), respectively.

Figure 5: Distance traveled for manual carry – survey results.



The approximate weight of the most common types of load was designated to weigh 31-50 lbs (see Fig. 6). Forty-eight percent of the respondents (12 of 25 companies) agreed on that choice. Other choices and response rates included 21-30 lbs (28%), more than 51 lbs (16%), 11- 20 lbs (8%), and less than 10 lbs (0%), respectively.

Figure 6: Weight of load lifted/carried – survey results.



Discussion

It is interesting that about 40 percent of the construction contractors in the present survey encouraged the use of back belts. These companies should note that the U.S. National Institute for Occupational Safety and Health (NIOSH) does not recommend the use of back belts to prevent injuries among workers who have never been injured (NIOSH, 1994). Lifting hazards can very from job site to job site, thus lifting training programs must be site-specific. Before attempting to develop the training program the foreman and/or company safety personnel should evaluate the job site a materials that will be used throughout the construction project. Proper site set up from the beginning of the project could prevent back injuries (Laborers' Health and Safety Fund of North America, 2006). Adequate amounts of the proper mechanical material handling equipment such as forklifts and hand carts should be available so that workers do not feel they have to move everything manually. The employees should be trained on what material handling equipment is on-site, how they work and any other types that they could request if they feel it is necessary. Training on the specific types of materials that will be used throughout the job and the hazards associated with them are also needed (Cable, 2007).

Majority of the construction firms surveyed considered ergonomic handle of the new tool before purchasing. It is believed that something as simple as the handle could help to improve the safety and health of the employees while on the job (Laborers' Health and

Safety Fund of North America, 2006). Excessive hand and arm vibrations were another concern for the construction contractors. This is because there tends to be extensive usage of power tools on a daily basis. Without the proper protection, construction workers may develop injuries and diseases in the hands and arms, which can be painful and/or disabling. The most common type of personal protective equipment used when handing vibrating tools was anti-vibration gloves. These may help to lower the amount of vibration that affects the worker on a day-to-day basis. However, the construction contractors should note that the NIOSH does not offer recommended anti-vibration gloves to prevent injuries associated with vibrations. Using equipment that may produce less of a vibration would be the best solution before using personal protective equipment. Tool manufactures are also critical links in the ergonomics process. There is a great need for ergonomically designed hand tools for men and women in the construction trades. Poorly designed hand tools increase the amount of vibration transmitted to the hands, increase the forces required to operate the tool, and increase the awkward postures and positions taken when using them (The Eastman Kodak Company, 2004).

The current study also highlights that significant number of construction companies implemented the stretching program. Stretching has been part of a normal workout routine for many years, but it is now becoming part of the work routine for construction workers. The U.S. Occupational Safety and Health Administration (OSHA) has recommended that when working in a bent over position for the worker to take short and frequent breaks to stretch out the back muscles to help reduce injuries (OSHA, 2005). Construction companies are now taking this a step further by having their workers stretch before beginning work to loosen up the muscles (Cable, 2007). It is, however, important to note that the most positive support for exercise continues to be in the studies in which exercise was included as part of a more comprehensive ergonomics program approach to controlling musculoskeletal disorders, including engineering control (e.g., workstation and tool redesign) and administrative control (e.g., method training, job enlargement, job rotation and work scheduling) (McGorry and Courtney, 2006).

Findings of the survey also point out that most of the construction contractors did not have a site-specific ergonomics program. The application of ergonomic principles and methods is of primary importance for reducing the burden of occupationally related injuries and illnesses among construction workers (The Eastman Kodak Company, 2004). The construction workplace is always changing which makes it hard to reduce ergonomics injuries when new risks are created each day. The solutions would have to be industry-wide to really have an effect (Ringen et al., 1995). The solutions would also have to be for each construction discipline to have a long sustained effect in each construction discipline (Gillen et al., 1997). To do this, there would have to be task-based exposure for each construction discipline. This may also include long-term studies before and after possible implementation of solutions (Paquet et al., 1999). Another hurdle to overcome is criticism from fellow employees. One must change the view of safety or ergonomics in general, and teach everyone the advantages of ergonomics (Albers et al., 1997).

Conclusions

This study highlights that work in construction continues to have high potential risks for work-related musculoskeletal disorders and injuries. The survey indicates that strains and sprains are the most prevalent types of injury resulting in the back being the part of the body mainly affected. The majority of these injuries are due to overexertion in lifting and carrying heavy materials. The findings of the present survey are similar to those of other construction ergonomics publications. Data from the self-reported work-related illness surveys in Great Britain showed that construction was among the highest prevalence rates for musculoskeletal disorders including back pain, joint injuries and repetitive strain injuries (Health and Safety Executive, 2006). Another study in the Netherlands explained that approximately 35% of the workers in the construction industry reported to have experienced low-back pain in the past year and other musculoskeletal complaints were also prevalent. Manual materials handling and awkward back postures were important risk factors for low-back pain (Burdorf et al., 2007), and construction workers were frequently observed in heavy manual materials handling activities involving at least 30 lbs (Paquet et al., 1999).

With the implementation of an effective comprehensive ergonomics program, not only may the construction company's health and safety improve, but also the company's profits by decreasing the worksites related injuries and illnesses. However, it should be noted here that the results of the present study might be different from the other parts of the country when the survey is limited to one region. In the future, the author plans to survey a larger sampling of firms in an effort to develop a national database of ergonomic information for the construction industry. Overall, the findings of this study could still provide helpful direction and insights into ergonomic work practices and construction SH&E education augmentation (Choi et al., 2006) associated with the prevention of work-related musculoskeletal injuries in the construction field.

Appendix – Survey Questions

Background

- What are the primary types of work that your company does? _____
- How long have you been in business? _____
- How many employees do you employ? _____ Gender: Male ____% Female ____%
- Do you have a safety program? _____ If yes, do you have a written safety program _____
- How long has your safety program been implemented? _____
- What are your title and your job function in this company? Title _____ Job function_____
- How long have you worked in the company? _____

Ergonomics Program

- Do you have an ergonomics program? Yes_____ No_____
- Do your employees do stretches prior to the beginning of their shift? Yes_____ No_____
- Do you consider the handle of power tools when purchasing new equipment? Yes___ No___
- Do you have a lifting training program? Yes_____ No_____
- Do you have weight restrictions on single-person lifting? Yes_____ No_____
- Do you encourage back belts? Yes_____ No_____
- Do you have work practices or personal protective equipment for vibrations? Yes___ No___ If so, what do you use? _____
- How many (dedicated) full time safety individuals do you have in your company? _____

- Who does safety personnel report to? _____
- Does management expresses concern if safety procedures are not adhered to? (Please circle one)
  (not important) 1 2 3 4 5 (extremely important)
- Does management encourage feedback from site employees? (Please circle one)
  (not important) 1 2 3 4 5 (extremely important)
- Does your company have any reward systems to help motivate employees to be safer? Yes_____ No_____
  If so, what are they (e.g., bonus, promotion, peer recognition, safety bucks, etc.)?
  _____

Injuries and Illnesses

- What are the most common types of injury or illness in your line of work?

(Please circle all applicable)

Sprain/Strain Back injury Fractures Burns Cuts Carpal Tunnel Syndrome
Others _____

- How do these injuries or illnesses typically happen? (Please circle all applicable)

Overexertion Motion/Position Slip/Trip Tools/Machinery Chemicals
Others _____

- Please rank these parts of the body as to the frequency at which injuries and illnesses occur to them: (1-most frequent, 7-least frequent)
  ____Knees ____Hand/fingers ____Back ____Shoulders
  ____Eyes ____Foot/Ankle ____Head/Neck
- When are your employees most likely to get injured upon employment at your company? (1-most frequent, 4-least frequent)

_____< 3 Month _____3-11 Months _____1-5 Years _____>5 Years

Work Conditions

- What types of surface conditions are the workers commonly work/walking on? (Please circle all applicable)

  Roof Ladder Scaffold Ground Other (Please list):
  _____
- Please list the most common types of hand tools that you use at your work? (Please be specific)
  _____

- Circle the one appropriate value in each row for your company:

Accumulated time for manual lifting/carrying during a day per employee	< 1 hr	1-2 hrs	3-4 hrs	5-6 hrs	7-8 hrs
Total distance traveled for each manual carry	< 10 ft	11-30 ft	31-50 ft	51-70 ft	> 70 ft
Approximate weight of the load the individual lifts/carries manually	< 10 lbs	11-20 lbs	21-30 lbs	31-50 lbs	> 51 lbs

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