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Ergonomic interventions for the furniture manufacturing industry. Part II—Handtools

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Abstract

The objectives of this intervention research project were to develop and evaluate engineering controls for the reduction of the upper extremity injury risk in workers in the furniture manufacturing industry. The analysis of OSHA Form 200 logs and surveys of furniture workers revealed that upholsterers, workers who use random orbital sanders and workers who use spray guns are at higher levels of risk of illness than the rest of the working population. An on-site ergonomic analysis of these three jobs was performed and the following risk factors were identified for each of these three work groups: upholsterers—repetitive, high-force pinch grips; sanders—long-duration static grip forces; and sprayers—awkward postures (ulnar wrist deviations and wrist flexion). Engineering interventions in the form of new or modified handtools were then evaluated in the laboratory to assess their effectiveness in reducing exposure to these risk factors. For sanding, an interface was created that secured the hand to the sander with the intention of reducing the need for static grip forces during sanding. A new handtool was created for upholsterers that replaced the repetitive pinch grips with a power grip. Finally, a commercially available spray gun with ergonomic features was evaluated. Each of these modified tools/methods was compared with the standard methods typically used in industry. The results show that most of the intended beneficial effects were realized. The random orbital sander interface reduced extensor muscle activities by an average of 30%. The upholstery handtool reduced the intrinsic hand muscle activities by an average of 51%. The effects of the adapted spray gun were most prominent when working on horizontal surfaces and showed an average reduction of 40° of wrist flexion and 14° of ulnar deviation as compared to the standard pistol grip spray gun in this activity.

Relevance to industry

The ergonomic intervention research described in this report documents a reduction in exposure to risk factors for upper extremity cumulative trauma disorders for three work activities in the furniture manufacturing industry.

Keywords: Cumulative trauma disorders; Upper extremity; Intervention research; Furniture industry; EMG

1. Introduction

Cumulative trauma disorders of the upper extremity continue to be a problem for many in

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the manufacturing sector. The statistics describing the incidence of carpal tunnel syndrome (CTS) and tendinitis show that the furniture manufacturing industry also has experienced these types of problems. On average, CTS incidence rates for the furniture manufacturing industry are 10.64/10,000 workers (as compared to 8.8 for the manufacturing industry and 4.36 for all private sector industries) and tendinitis incidence rates are 7.62/10,000 workers (as compared to 6.56 for the manufacturing industry and 2.88 for all private sector industries) (BLS, 1992–1996).

Furniture workers have exposure to many of the recognized occupational risk factors for upper extremity cumulative trauma disorders: overhead work, static shoulder postures, pinch grips, vibrating hand tools, awkward wrist postures (both radial/ulnar deviation and flexion/extension), high grip force, and repetitive hand/wrist motions (Bovenzi et al., 1991; Osorio et al., 1994; Silverstein et al., 1987; Sommerich et al., 1993; Tanaka et al., 1995). Unfortunately, there is little literature specifically related to work-related musculoskeletal injuries/illnesses among furniture industry jobs or related to interventions aimed towards the prevention of these disorders among these workers.

There are three control strategies at the disposal of practising ergonomists: engineering controls, work practice controls and administrative controls. The OSHA final rule (Federal Register, 2001) defines engineering controls as "… controls that physically change the job in a way that controls or reduces MSD hazards". It goes on to say that "work practice controls involve procedures and methods for safe work". Finally, the final rule states that "Administrative controls are work practices and policies implemented by the employer that are designed to reduce the magnitude, duration, and/or frequency of employee exposure to risk factors by changing the way work is assigned or scheduled (p. 68360)." Engineering controls include workstation modifications, changes to the tools or equipment, and altering production processes. Work practice controls include use of neutral positions or postures (keeping wrists straight, lifting close to the body) and team lifting. Administrative controls include employee rotation and job enlargement. The final rule goes on to say that "…engineering controls are the preferred method of controlling MSD hazards in cases where these controls are feasible. In contrast to administrative and work practice controls or personal protective equipment (PPE), which traditionally have occupied lower tiers of the hierarchy, engineering controls fix the problem once and for all (p. 68360)." This is not to say that work practice and administrative controls do not have their place. In some instances, this is the only reasonable/feasible solution. But what it does say is that, given the choice, engineering controls are preferred since they have the ability to reduce stress at the source instead of reducing levels of exposure or relying on the individual operator to monitor the ergonomics of their activity. With these principles in mind, the specific objectives of this intervention research project were to develop and evaluate engineering controls for the reduction of upper extremity injury risk in workers in the furniture manufacturing industry.

2. Methods

Analysis of the industry-provided OSHA Form 200 logs and surveys of industrial participants (details appearing in Mirka et al., 2002) revealed that upholsterers, users of random orbital sanders and users of spray guns were at elevated risk for hand and wrist problems. Biomechanical analysis, both on-site and videotape, of these tasks revealed the specific risk factors for each job type. The principle risk factors for hand/wrist stress in upholsterers were the repetitive (up to 40 pinches/min), forceful (up to 65 N of pinch force) and static pinch grip exertions performed by the operators' non-dominant hand (Fig. 1a). Specifically, the operators would pull the fabric to a specified tension with their non-dominant hand using a pinch grip between their thumb and index finger and then would secure the fabric using staple gun held in their dominant hand. The operators would then release the grip on the fabric and move their hand down to ~ 5 cm and repeat the process. Each one of these grips required a forceful pinch grip