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Hand discomfort in production assembly workers

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Abstract. The purpose of this study was to evaluate subjective hand discomfort in female production assembly workers. Thirty-seven females, working as assembly workers, aged from 22 to 54 years (with mean ± SE age of 36.4 ± 10.4 years) participated in this study. The mean (± SE) height, body mass and body mass index of the subjects were 166.8 ± 4.2 cm, 61.04 ± 9.5 kg and 21.9 ± 3.7 kg $(m^2)^{-1}$, respectively and their general employment stage as manufacturing worker was 7.35 ± 5.5 years. Thirty-five workers were right-handed. In the chosen factory was implemented the Lean manufacturing production together with a number of ergonomically designed work places. For the most part of the workday assembly workers sit on a chair or stand behind their working desk, driving screws into an aluminium plate with a pneumatic screwdriver. Discomfort in six regions of the hand, both right and left, was subjectively estimated by the Cornell Hand Discomfort Questionnaire. Total discomfort score was calculated. The results indicated that the female assembly workers felt work-related discomfort the most in the right wrist (79.2%), left wrist (6.2%) and in the right thumb joint area (3.6%). Discomfort was less pronounced in the left pinkie and ring fingers (0.01%), left thumb (0.2%) and in the right thumb (0.7%). In conclusion, this study indicates significant feeling of discomfort in the right wrist. In order to avoid the problems caused by overload it is advisable to do special exercises during short brakes. According to the results further research is needed on the relationship between hand discomfort and the effect of exercise.

Key words: female assembly workers, physical workload, hand discomfort

INTRODUCTION

Comfort is a major factor in hand tool ergonomics, thus discomfort is frequently assessed as a predictor of musculoskeletal injuries, which should always be reduced in any situation. In the use of hand tools, comfort is associated with positive feelings of reliability, safety, ease, and satisfaction, whereas discomfort is associated with negative feelings of pain, pressure, hardness, and irritation (Hughes & Ferrett, 2003). Tool design may play an important role in the development of work-related problems in the hand and forearm. By improving the ergonomic properties of hand tools the health of users and their job satisfaction might be positively affected (Kadefors et al., 1993).

For example the relationship between objective measurements and subjective experienced comfort and discomfort in using handsaws was studied. The results of this study showed that productivity is closely related to comfort and discomfort. The

productivity was higher for handsaws that were assessed as more comfortable and the productivity was lower for handsaws which caused discomfort (Kuijt-Evers et al., 2007).

To prevent discomfort, there have been investigations about the effects of wearing typical industrial gloves on hand performance capabilities (muscle activity, wrist posture, touch sensitivity, hand grip and forearm torque strength) and subjective assessments for an extended duration of performing a common assembly task (wire tying with pliers) which required a combination of manipulation and force exertion. Three commercially available gloves (cotton, nylon and nitrile gloves) were tested and compared with a bare hand condition while participants performed the simulated assembly task for 2 h. The results showed that wearing gloves significantly increased the muscle activity, wrist deviation, and discomfort whilst reducing hand grip strength, forearm torque strength and touch sensitivity (Vink, 2005).

Powered hand tools are widely applied in various operations, particularly those requiring a highly repetitive, strong force. Using powered hand tools instead of man-powered hand tools, although increasing productivity, will also increase the risk of musculoskeletal injuries and diseases due to a more rapid pace, heavier tool weight, and greater tool vibration. In industry, long-term repetitive use of powered hand tools is the cause of most musculoskeletal injuries: It is a result of repeated micro traumas, also known as cumulative trauma disorder (CTD). Force, repetition, awkward posture and insufficient recovery time are general risk factors associated with CTDs (Silverstein, 1986; Putz-Anderson, 1988).

For operating in-line pneumatic screwdrivers, Johnson and Childress (1988) found that a small diameter (28 mm) was worse than a large one (38 mm) under a higher torque level (2.82 Nm).

Carpal tunnel syndrome (CTS) is by far the most common entrapment neuropathy. Although many factors may increase pressure on the median nerve as it passes through the carpal tunnel, idiopathic CTS far outnumbers all other types (Freeland, 2005). Idiopathic CTS often occurs in middle-aged women without other known pathologies. Because CTS occurs more frequently in women, particularly around menopause, it is suspected that sex-specific risk factors influence the incidence of CTS. Furthermore, the use of combined oral contraceptives, bilateral oophorectomy, and pregnancy appear to be associated with CTS (Ferry et al., 2000).

The purpose of this study was to evaluate subjectively hand discomfort in female production assembly workers.

MATERIAL AND METHODS

Subjects

Thirty-seven females, working as assembly workers, aged from 22 to 54 years (with mean ± SE age of 36.4 ± 10.4 years) participated in this study. The mean (± SE) height, body mass and body mass index of the subjects were 166.8 ± 4.2 cm, 61.04 ± 9.5 kg and 21.9 ± 3.7 kg $(m^2)^{-1}$, respectively and their general employment stage as manufacturing worker was 7.35 ± 5.5 years. 35 workers were right–handed.

The subjects participated in the research voluntarily and the selection of manufacturing workers was random. In the chosen factory was implemented the Lean

manufacturing production practice together with a number of ergonomically designed work places. The production process was organised in two shifts. During the 8–hour working day there were two short 10–min breaks for recovery and one 30–min break for lunch. The subjects were familiarised with the essence and the aims of the survey.

Data collection

Cornell Hand Discomfort Questionnaire (CHDQ) was used in this study (Fig. 1). Test–retest reliability for CHDQ at a 3–week interval found a 7% difference in responses for upper body parts and a 1% difference for lower body parts (Hedge et al., 1999). Respondents indicated the frequency of discomfort on an ordinal scale from 0 (none) to 4 (daily) and severity of discomfort from 1 (slightly uncomfortable) to 3 (very uncomfortable). A pain level of at least 'moderately uncomfortable' was selected as a severity threshold for determining prevalence and frequency. The level at which the discomfort interferred with work was scored from 0 (no interference) to 2 (substantial interference). Total discomfort score was calculated by using the following formula: frequency x discomfort x interference = discomfort score.

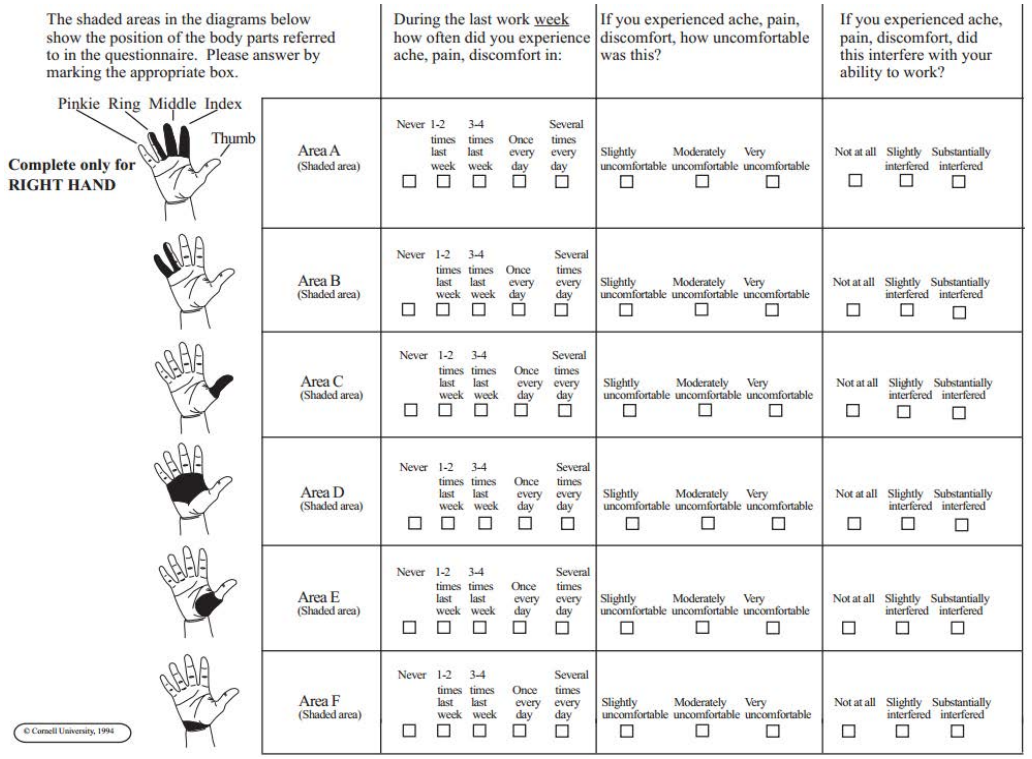

Figure 1. Cornell Hand Discomfort Questionnaire, female. (Reproduced with permission from the Human Factors and Ergonomics Laboratory at Cornell University (http://ergo.human.cornell.edu/ahmsquest.html).)

The questionnaires were filled in at the workplace. The subjects wrote the values of height and body weight themselves and the body mass index kg $(m^2)^{-1}$ was calculated.

For the most part of the workday assembly workers sit on a chair or stand behind their working desk, driving screws into an aluminium plate with a pneumatic screwdriver (Fig. 2). It is important to emphasise that the torque level of the pneumatic screwdriver was not recorded.

Figure 2. Pneumatic screwdriver.

Statistical analysis

When processing the data, the usual methods were used for calculating the mean and the standard error (± SE).

RESULTS AND DISCUSSION

Quality in production is partly dependent on healthy workers with high work satisfaction and low absenteeism. As discussed before, women are more susceptible than men to get joint, tendon and especially nerve–related problems of the wrist and hand in assembly work of this type.

Furthermore, many studies indicate that women have a significantly higher risk for carpal tunnel syndrome (CTS) than men do. Also the study's results, a high discomfort score in the right wrist, confirms the fact that women assembly workers have a higher risk of CTS. According to the National Institutes of Health, women are three times more likely than men to have CTS. The explanation for this greater risk is unknown, but it may be related to the smaller size of women's carpal tunnel. Hormonal changes also appear to play a major role in CTS.

According to the total discomfort score of CMDQ (Table 1) of this study, 79% of the subjects experienced discomfort in the right wrist. Discomfort score in the right wrist is significantly higher than in other parts of the hand. It can be explained that most of the subjects were right handed and in their work they use power tools which are mostly operated by one hand. Discomfort score was also higher in the left wrist (6.2%), right thumb joint (3.6%), right index, middle and ring fingers (3.4%) and in the

right palm (2.4%). Discomfort was less pronounced in the left pinky and ring fingers (0.01%), left (0.2%) and right (0.7%) thumbs.

As discussed, long–term repetitive use of powered hand tools in industry may lead to musculoskeletal injuries. Because of that it is important to analyse and study how to avoid these kinds of health disorders. If an employee already has discomfort in a hand and more specifically in the wrist, then in many cases wrist support has been chosen to relieve discomfort and pain.

Table 1. Total discomfort score

Body parts referred in the questionnaire	Frequency	Discomfort	Interference	Discomfort score	%
	75.3	30	36	79,380	79.22
	32.5	12	16	6,240	6.23
	28	10	13	3,640	3.63
	20	13	13	3,380	3.37
	20	12	10	2,400	2.39
	19.5	7	9	1228.5	1.23
	21	8	7	1176	1.17
	16.5	9	7	1039.5	1.04
	13.5	8	7	756	0.75
	13	7	8	728	0.73
	8	4	7	224	0.22
	5	1	2	10	0.01

Chih-Hong et al. (1999) studied the effects of wearing a glove and wrist support on hand–arm response while operating an in–line pneumatic screwdriver. Hand–arm response was investigated in terms of triggering finger force, flexor digitorum EMG and hand–transmitted vibration. Four glove levels (barehanded, cotton, nylon and open–finger), and two wrist support levels (wearing, and not wearing) were evaluated. Thirteen healthy male subjects drove screws into a horizontally mounted iron plate with pre–tapped screw holes using an in–line pneumatic screwdriver in the randomly ordered experimental conditions. The results indicate that wearing a nylon glove and not using a wrist support is the best combination among the eight evaluated experimental conditions. The use of a wrist support required a greater triggering force and a 9.9% greater hand–transmitted vibration in the *y*–axis than when not using a wrist support. The use of a wrist support required greater index finger exertion for triggering. This might be due to the fact that wearing the wrist support increases the

pressure on the nerves passing through the wrist, thus reducing the feedback sensitivity of muscle contraction in trigger finger exertion. Wearing a wrist support seems to be more appropriate for protecting an injured wrist by providing arm support around the weakened or strained area. However, it is not recommended for an ordinary assembly task like using a powered screwdriver (Chih-Hong, 1999).

Avoiding negative health effects and providing more job satisfaction for workers are not the only reasons to pay attention to the design of comfortable hand tools. Employers also want their employees to achieve high work efficiency. Therefore, hand tools should stimulate high work efficiency too. Providing comfort and avoiding discomfort on the one hand and a high productivity on the other hand are not necessarily contradictive (Kuijt-Evers et al., 2007).

CONCLUSION

In conclusion, this study indicates significant discomfort in the right wrist. To avoid the problems caused by overload, during short brakes it is advisable to do special exercises for the hand. According to the study results further research is needed on the relationship between hand discomfort and the effect of exercises.

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