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Title: The prevalence of upper limb work related musculo-skeletal disorders (WMSDs) related to occupational tasks involving torque and power grip

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FINDINGS

Work Related Musculoskeletal Disorders (WMSDs) are collectively used for symptoms characterized by discomfort, impairment or prolonged pain in muscles, tendons, joints and other soft tissues caused by occupational or non-occupational tasks involving forceful exertions with awkward postures. In line with efforts to reduce risk of WMSDs, present research investigated experimental outcomes regarding risk of developing WMSDs for combined gripping with torqueing task, so that findings may help to redesign tools/tasks or workplace with reduce risk of WMSDs leading to increase in productivity. The present research was divided into four studies.

Study 1 was comprised of two experiments: main and supplementary. Main experiment was designed to investigate the effects of grip force, stroke rotation and frequency of exertions on perceived discomfort and electromyography (EMG) activities of forearm muscles for repetitive combined gripping with torqueing task. In this experiment, twenty-seven male participants volunteered for performing repetitive upper limb exertions for 5 minutes duration at three levels of stroke rotation (30^0, 45^0 and 60^0); grip force (50N, 70N and 90N); and frequency of exertions (10, 15 and 20 exertions/min). Results of analysis of variance (ANOVA) showed that both stroke rotation and frequency of exertion were significant on discomfort. Multivariate analysis of variance (MANOVA) was performed on EMG parameters i.e percentage normalised EMG and slope of median frequency. Results showed that extensor muscles were more fatigued. Also, a supplementary experiment was conducted to investigate the effects of grip force and stroke rotation on self-pace cycle time (SPCT). SPCT is sometimes used to predict productivity in such type of tasks. Results of ANOVA showed that all main factors were highly significant on SPCT

($p<0.001$). Also, discomfort score was recorded at the end of each treatment to verify the effects of grip force and stroke rotation on SPCT.

In Study 2, the effects of grip force, frequency, stroke rotation and grip-span on discomfort was recorded for simulated task. Results of ANOVA showed that frequency, stroke rotation and grip-span were significant on discomfort score. Also, grip force, frequency and stroke rotation were found significant on EMG activities of forearm muscles using MANOVA. It was also found that extensor muscles were more activated than flexor muscles during the given task.

Study 3 was conducted to investigate the effects of grip type, stroke rotation and handle size of screw driver on human performance (discomfort & productivity) as well as EMG activities of forearm muscles in screwing task. There were two grip types, three levels of stroke rotation and two levels of handle size of a screw driver. The ANOVA results revealed that stroke rotation and grip type were significant on discomfort whereas, handle size was not. MANOVA results showed that flexor muscles were more activated than extensor muscles.

Study 4 was performed to investigate the effects of stroke rotation on human performance in terms of discomfort and productivity (duration required to perform given task) in assembly tasks. Two types of assembly task were considered in this study i.e. socket and threaded pipe assembly, and nut and bolt assembly. The results of ANOVA showed that stroke rotation was highly significant on discomfort ($p<0.001$) and duration ($p<0.001$) for both assemblies. It was noticed that stroke rotation of 60° was very much comfortable with lowest discomfort and highest productivity.

This research comprising of four studies provided a significant direction for reducing the risk of WMSDs. The limitations of present research are that experimental findings are only applicable for tools/tasks having torqueing combined with power grip. Although it is very useful because most of the assembly tasks in industries are completed by using repetitive torqueing with gripping exertions.