To Which Extent do Combinations of Office Tasks Influence Variation in Upper Extremity Muscle Activity? A Simulation Study

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SUMMATIVE STATEMENT

In a simulation study, we showed that replacing seated computer work by other office tasks has some potential to increase variation in trapezius and wrist extensor muscle activity in office workers.

KEYWORDS: Office work, Job Variance Ratio, muscle activity variation.

PROBLEM STATEMENT

The use of computer information technology is now pervasive, and largely dominates several work sectors, in particular, office work. Excessive time at the computer is associated with a low physical workload with little variation (Straker & Mathiassen, 2009). This may increase the risk of musculoskeletal disorders in the upper extremities and neck. In addition, prolonged sitting *per se* is another concern, in being associated with metabolic risks such as increased risk of obesity. Interventions including introduction of sit-stand tables (SST) can be effective in decreasing sitting time and, thus, increasing standing (Commissaris et al., 2016). However, only a few studies have investigated the concurrent effects of shifting between sitting and standing on muscle activity in the shoulders and upper extremities. In a previous study of office workers, we found no major differences in upper body postures between sitting and standing tasks (Barbieri, Srinivasan, Mathiassen, & Oliveira, 2019), but no study has addressed the effects of combining productive office tasks in different time proportions on muscle activity.

RESEARCH OBJECTIVE/QUESTION

This study among office workers aimed at investigating to what extent combining seated computer work with other office tasks can increase muscle activity variation.

METHODOLOGY

Twenty-four office workers (16 females, 8 males; age 41 (SD 3) years) participated. Workers received a SST and ergonomics information/training, and then used the table for two months. Muscle activity of the dominant upper trapezius and dominant wrist extensor muscles (DUT and DWE, respectively) was recorded using surface electromyography (sEMG) during three consecutive days, for two hours each day, in the last week of SST usage. Six different tasks (computer and non-computer work while sitting or standing [CWsit, CWstand, NCWsit and NCWstand], work away from the table [NonTableW], and informal breaks [Break]) were identified and recorded by an experienced physiotherapist in a customized app during on-site observations, and synchronized afterwards with the sEMG recording. For each worker, day, muscle and task, activity was normalized to that during a maximum voluntary contraction (MVC) performed in the morning or afternoon of that day, depending on the preference of the worker. Recordings were summarized for each day in terms of the Mean (%MVC) and the variability (min-min SD across 1-minute bins, %MVC), then for each worker as the mean value across days for these two metrics, specific to each muscle and task. Using these variables, we estimated, for each worker, the maximum

hypothetical muscle variability in four scenarios combining tasks in different time proportions (adding up to 100%). In scenario A, CWsit and CWstand were both allowed to vary from 0-85%, while 15% of time was strictly allocated to Break. The other three scenarios were: B: 30-85%CWsit, 0-55%NCWsit and 15%Break; C: 30-85%CWsit, 0-55%NCWstand and 15%Break; and D: 30-85%CWsit, 0-55%NonTableW and 15%Break. For each of the simulated task compositions leading to maximum variability, we calculated a Job Variance Ratio (JVR; Barbieri, Srinivasan, Mathiassen, Nogueira, & Oliveira, 2015) as a measure of the variability relative to that in a situation with 85% CWsit and 15% break.

RESULTS

For DUT the maximal JVR was larger in scenarios B [Median JVR 1.23 (IQR, 1.14 - 1.39)] and D [1.10 (IQR 1.01 - 1.23)] than in scenarios A [1.00 (1.00-1.05)] and C [1.02 (1.00 - 1.18)]. The four scenarios differed significantly (Friedman test, $p<0.001$), with statistically significant *post-hoc* pairwise differences between scenarios A and B, and between B and C. The same tendency was observed for the DWE; i.e. larger maximal JVRs in scenarios B [1.19 (1.02 - 1.34)] and D [1.16 (1.03 - 1.49)] than in A [1.00 (1.00 - 1.04)] and C [1.08 (1.00 - 1.31)]. Scenarios differed significantly for the DWE ($p=0.027$), while *post-hoc* paired tests showed statistical significance only for scenario A vs. D.

DISCUSSION

In the context of office work, interventions promoting variation have been suggested to prevent musculoskeletal disorders (Barbieri et al., 2015; Straker & Mathiassen, 2009). We demonstrated that replacing CWsit by other office tasks appears to have a potential to slightly increase variation in both the Upper Trapezius and Wrist Extensor muscles, compared to only doing CWsit+Break. The most pronounced effect was found when CWsit was replaced by NCWsit or NonTableW. This was a result of NCWsit and NonTableW having higher Mean exposure and larger within-task variability (min-min SD) than the other two alternative tasks, i.e. CWstand and NCWstand. Notably, the ineffectiveness of combining CWstand or NCWstand with CWsit mimics the effect of using a SST, compared to working only seated. Thus, introduction of SSTs cannot be expected to increase variation in shoulder and upper extremity muscle activity.

CONCLUSIONS

We showed that replacing seated computer work by some other non-computer office tasks has a potential to increase variation in upper extremity muscle activity among office workers, while only changing between sitting and standing at a sit-stand table was ineffective.

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