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Influence of Experience, Stress and Screen Angle on Muscle Activity and Musculoskeletal Symptoms Among Student Tablet Users

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Abstract: Background/Objective: Use of touchscreen devices is now promoted in classrooms. Roughly 30% of the population use tablets for 90 minutes per day. As many as 68% of users experience musculoskeletal disorders (MSD). Posture, time, tasks and technique contribute to MSD, and stress may exacerbate symptoms. Normative kinematic data for touchscreen typing is lacking but may inform strategies to reduce injury incidence. The objective of this pilot study was to explore muscle activity and perceived exertion during a fatiguing typing task on a tablet, under discrete postural conditions.

Methods: Intake data included the Cornell Musculoskeletal and Hand Discomfort Questionnaires, Positive and Negative Affect Schedule (PANAS) and demographics, including smartphone usage habits. Surface electromyography (SEMG) was used to monitor muscle activity (neck extensors, upper trapezius, wrist/finger flexors/extensors) while transcribing a podcast onto a tablet, during two 15-minute trials; one with the tablet flat (F) on the surface, and one with the tablet positioned at the subject's choice (C), random assignment. Subjects rated difficulty of tasks with Borg's Scale.

Results: Thirteen subjects (10 female) participated. Moderate-very uncomfortable self-reported MSD noted for neck and shoulder (n=8). PANAS mean scores suggest a sample consistent with normative scores. Analysis revealed increased activity for all muscles in the C position compared to the F position, although per muscle variability was high. Over time, significant decreased activity was noted only for left upper trapezius in F position. No differences noted for Borg ratings regardless of trial or position.

Conclusion: The data suggest that choice posture (C) imposed a higher demand on muscle activity than did time.

Keywords: surface electromyography, tablet use, posture

1. Background and Objective

Issues of musculoskeletal discomfort and fatigue have been associated with keyboarding tasks.(Hoe, Urquhart, Kelsall, Zamri, & Sim, 2018) Some devices commonly used today for keyboarding including desktop/laptop computers, tablets, and smartphones. Studies have described the kinematics of typing using external keyboards, however there is limited kinematic data for touchscreen typing.(Gustafsson, Coenen, Campbell, & Straker, 2018) At Touro College, all students in the Doctor of Physical Therapy and Occupational Therapy programs receive an iPad at orientation, with an expectation that the learning experience will be enhanced. However, not all research substantiates this belief. Nearly 30% of students in one study never used the mobile device as a laptop substitute.(Pew Research Center & Internet and Technology, 2015) A study at Brown University's medical school revealed that students were less satisfied with their tablets as the academic year progressed.(George, Dumenco, Doyle, & Dollase, 2013) Yet another study showed mixed responses from students to the benefits of tablets.(Eurell, Diamond, Buie, Grant, & Pijanowski, 2005) Therefore, there is insufficient data that describes student satisfaction and comfort with tablet use as an educational tool. Other factors complicating our understanding of the benefits of tablet use is the variability in how they are used, how this may impact the mechanical demands on the musculoskeletal system, and the interplay of stress and musculoskeletal symptoms.(Xie, Szeto, & Dai, 2017) Neck, upper back and shoulder pain are commonly associated with tablet use. Therefore, it is important to understand the user/tablet interface, and the relationship with symptoms. Typically, individuals acquire tablets, and habits develop, with little data to help explain how individuals "learn" to interface with these devices.

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The objective of this study was to record muscle activity response and perceived exertion during a fatiguing typing task under different postural conditions. Baseline musculoskeletal symptom and mood surveys were administered.

2. Methods

Healthy subjects between 18 and 65 years were recruited at an urban college through flyers and announcements. Informed consent included a brief screening on the subjects' reported ability to withstand 15 minutes of continuous sitting and typing on a tablet, and subjective questionnaires including the Cornell Musculoskeletal and Hand Discomfort Questionnaires, and PANAS. Demographics and history of smartphone usage habits were recorded. Skin preparation procedures were completed and eight SEMG were applied to monitor muscle activity (right and left: neck extensors, upper trapezius, wrist/finger flexors, wrist/finger extensors). Subjects were instructed to transcribe a podcast onto a tablet, for two 15-minute trials; one with the tablet flat (F) on the surface, and one with the tablet positioned at the subject's choice (C). The tablet position used first was assigned randomly. At the conclusion of each trial, subjects rated difficulty of the transcription tasks with Borg's Scale.

All SEMG data processing was performed with custom code in MATLAB (v9.6 Mathworks; Natick, MA USA). Data import was done with open source functions provided by the Biomechanical Toolkit MATLAB Wrapper (biomechanical-toolkit.github; v0.3). All eight SEMG signals were processed identically across all subjects and trials.

3. Results and Conclusions

Thirteen subjects (10 female, 11 right hand dominant, mean age 35.67 years, mean smart phone usage 4.92 hours per day) participated. Moderate-very uncomfortable self-reported MSD noted for neck (n=4) and shoulder (n=4). PANAS mean scores were 33.38 (positive affect) and 18.46 (negative affect), suggesting that the sample was consistent with normative non-clinical samples in their self-report of the experience of affect. Twelve subjects were included in the repeated measures for most muscles and 11 subjects for comparison of muscle activity at START and END of trials F and C. Preliminary analysis revealed increased activity for all muscles in the C position compared to the F position, although per muscle variability was high. Over time, significant decreased activity was noted only for left upper trapezius for F position. No differences noted for Borg ratings (mean values 14.0/20 trial 1 and 13.6/20 trial 2; 13.6/20 C and 14.0 F. The data suggests that preferred posture (C) imposed an overall higher demand on muscle activity than did time. Handedness, MSD and electronic device habits may influence muscle performance during tablet use.

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