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Original Article

Effect of postural angle on back muscle activities in aging female workers performing computer tasks

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Abstract. [Purpose] This study investigated the effects of postural angle on back muscle activity during a computer task in aging women. [Subjects] Seventeen women ≥50 years old participated. [Methods] The participants were instructed to perform computer-related tasks for 20 minutes on a workstation that simulated typical office working conditions. Back posture was measured from the measured trunk and pelvic angles. Electromyography activities were recorded simultaneously from the cervical erector spinae, longissimus, and multifidus muscles. [Results] The lowest mean percentages of maximum voluntary contraction for the cervical erector spinae and longissimus muscles were obtained when the upper trunk and pelvic angles were between 0° to −5° from the sagittal plane. The back muscle activities increased as the upper trunk and pelvic angles exceeded 0°. Statistical analysis showed significant correlations between upper trunk angle and cervical erector spinae and longissimus muscle activities. Similarly, pelvic angle was significantly correlated with cervical erector spinae and multifidus muscle activities. [Conclusion] A neutral back posture minimizes muscle activities in aging women performing computer tasks.
Key words: Postural angle, Muscle activity, Aging

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INTRODUCTION

The aging-related deterioration of an individual's physique including posture and muscle strength may influence work performance and productivity[1)]. Hence, the involvement of the aging population in economic development is a vital issue, considering that the retirement age in Malaysia was raised from 58 to 60 years in 2011[2)]. In 2013, there were more than 1,111,600 employees aged 50 years and above in Malaysia[3)]. In addition, the widespread use of computers at work makes tasks physically and cognitively less demanding, which encourages aging workers to remain working[4)]. Nowadays, various office tasks such as retrieving files, collecting mail, and attending meetings can be performed by using a computer without moving from one's workstation. Microsoft recently found that the average worker spends seven hours per day in front of a computer[5)]. Most previous studies related to computer tasks only involved young computer users[6, 7)]. Accordingly, it is imperative to investigate the behavior of aging workers performing computer tasks, because computer tasks constitute an increasing part of sedentary work in industrialized countries. Repetitive computer tasks such as typing and using a mouse as well as the adoption of poor posture at work lead to symptoms of the neck, thoracic spine, and low back[8)]. A thorough understanding of human limitations forms the basis of ergonomics interventions, which can correct awkward postures and reduce problems exacerbated by stress and fatigue, which affect the performance of aging workers.

Determining the ideal levels of back muscle activation during low-load tasks such as sitting is challenging and remains controversial. Back muscle activation is proposed to vary according to the context and complexity of the task being performed[9)]. Dealing specifically with seated trunk muscle activation, Dankaerts et al.[10)] found that low back pain is associated with both increased and decreased trunk muscle activation. Thus, there may be situations in which reduced and increased muscle activation is desirable.

To date, no studies have specifically investigated the back posture of the aging population at work. Therefore, this study examined the effect of postural angle on back muscle activities in aging female workers performing seated computer tasks.

SUBJECTS AND METHODS

A total of 17 women (mean ± SD age: 55 ± 3.22 years, range: 50–61 years) 50–61 years old were recruited to participate in the study. The participants were staff from various departments within the university, whose work duties mainly involve sitting in front of a computer for more than 4 hours per day. Each participant was given a standard information sheet at the beginning of the session, and informed consent was obtained prior to participation. This study was approved

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by the Medical Ethics Committee of the University of Malaya.

The participants were required to perform 20 minutes of standardized computer tasks. In the first task, participants typed the text of a document for 10 minutes, which only involved interaction with the keyboard. Next, an exercise involving the use of mouse and keyboard, such as selecting and dragging items on the computer screen with the mouse, was performed for 10 minutes. These tasks are similar to the standardized tasks implemented by Delisle et al.[11] and Dumas et al[12]. The participants spent an average 20% of the experimental task using the mouse, while the remaining time was spent working with the keyboard. These proportions are close to those reported previously for regular computer work[13].

Back postural angles were measured from the upper trunk and pelvis. Inline 2D inclinometers (Noraxon USA, Inc.) were attached at the T2 level and sacrum by surgical tape to record movements in the sagittal plane[14]; the inclinometer sensors are 3.05 × 3.05 × 3.05 cm and weigh 45.5 g. Bony landmarks were identified manually. Back postural angles were measured as reference body postures and during the experimental tasks. Reference body postures were recorded over 45 seconds both before and after work. The average of the recorded angles was determined and used for calibration as well as a reference for recording occupational seated back posture. Back postural angles were recorded continuously during the experimental task. The participants sat on an office chair adjusted to their preferences and comfort. The back postural angles of each participant during the computer tasks were analyzed in terms of the mean angle deviation from the sagittal plane; a positive value indicates upper trunk flexion and forward pelvic rotation, whereas a negative value indicates upper trunk extension and backward pelvic rotation. An example of a positive upper trunk and pelvic angle is shown in Fig. 1.

Electromyography (EMG) and a sensor system (Noraxon USA, Inc.) were used to record the activities of the low back muscles including the cervical erector spinae (CES), longissimus, and multifidus muscles. This study focused on these muscles, because low back injuries and chronic back pain due to problems with the erector spinae and multifidus muscles are frequently reported. To detect muscle activity, Ag/Ag Cl/solid adhesive pre-gelled disposable surface electrodes were attached to the skin of the participants. The transmitter sent real-time EMG and inclinometer signals wirelessly to a desktop PC. Time, rate, and other acquisition parameters were recorded using Myo Research XP software. Muscle activity measurements were recorded during back extension and experimental tasks. Back extension was performed in the prone lying position as described previously by Konrad to determine the maximum voluntary contraction (MVC) of the back muscles[15].

The raw EMG data were sampled during test contraction at a sampling rate of 1,600 Hz and band-pass filtered at 20–800 Hz in parallel to the postural angle recordings. Electrocardiography spikes due to EMG artefacts were filtered without affecting the actual EMG amplitude or power spectrum. The most reliable method for analyzing EMG is monitoring the changes in root mean square (RMS) amplitude; therefore, the RMS values of the EMG data were analyzed in this study. The data were normalized with respect to the highest MVC value derived from the previous MVC test and expressed as the percentage of maximum voluntary contraction (%MVC). The normalized EMG RMS (%MVC) obtained during the experimental tasks were analyzed and used to represent muscle activity.

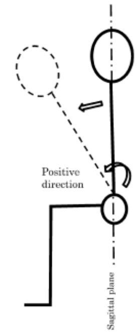

Fig. 1. Positive direction of postural angle

The data were initially tested for normality using the Shapiro-Wilk test. Spearman's ρ correlation was used to determine the correlations between postural angle and muscle activities. One-way ANOVA was performed to identify whether there were significant differences in muscle activities between different ranges of postural angle. The level of statistical significance was set at $p < 0.05$.

RESULTS

The mean upper trunk angles of the participants during upper trunk flexion and extension while performing computer tasks ranged from 0.26° to 7.75° and −2.12° to −5.81°, respectively. Spearman's ρ analysis revealed significant correlations between the upper trunk angle, and CES and longissimus muscle activity, indicating these muscles were affected by the upper trunk angle of the participants when performing the computer tasks (Table 1).

The lowest mean %MVC values for the CES and longissimus muscles were produced when the upper trunk angle deviated between 0° and −5° from the sagittal plane. The highest mean %MVC for all muscles was obtained when the upper trunk angle exceeded 0°. The activities of the CES, longissimus, and multifidus muscles with respect to the range of upper trunk angle are shown in Table 2. ANOVA indicated there were significant differences in CES ($F_{(2, 49)}$ = 39.75, $p < 0.05$) and longissimus ($F_{(2,49)}$ = 28.568, $p < 0.05$) muscle activity among the three conditions; ($\theta < -5°$, $0° \leq \theta \leq -5°$ and $\theta > 0°$).

The mean pelvic angles of the participants during forward and backward rotation while performing computer tasks ranged from 0.77° to 13.9°and −0.11° to −12.3°, respectively. Pelvic angle was significantly correlated with CES and multifidus muscle activities (Table 3).

The lowest mean %MVC value for the CES and longis-

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