EFFECTS OF BACKPACK LOADS ON NECK-TRUNK MUSCLE ACTIVATION AMONG OFFICE WORKERS

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The main purposes of this study were to investigate the effect of weight carriage on neck-trunk muscle activation during standing and walking among office workers and to compare electromyography activation between healthy and symptomatic office workers. Twenty-one participants were recruited. Three load trials (0%, 10%, and 15% BW) and two conditions (standing and walking) were encountered. Repeated measure ANOVA was used to test main effect of load and condition on kinetic data. There was a significant condition*load interaction on right trapezius. Significantly increasing activation of right abdominis was found as carrying 15% BW. There was a significant decrease on activation of left erector spinae while carrying 10% BW. Considering to electromyography data, we suggest the backpack load under 10% BW was suitable for office workers.

KEY WORDS: backpack, electromyography, office workers, computer user.

INTRODUCTION: Backpack use is common in the general population. Faulty posture has been recognized as an important risk factor for musculoskeletal symptoms (Cho, 2008). According to physical and physiological data, 10-15% of body weight (BW) is an acceptable load in children and adolescent (Chow et al., 2006; Singh and Joh 2009; Hong et al., 2008; Heuscher et al., 2010). However, this recommended range is likely to be impractical for office workers who have a mature musculoskeletal system.

Kim et al. (2008) found forward head angle and forward head distance significantly increase during carrying a backpack for schoolchildren, and higher muscle activation of upper trapezius, sternocleidomastoid (SCM) and midcervical paraspinals muscles were also found at the same time. Devroey et al. (2007) reported a significant decrease on erector spinae muscle activation and an increase on abdominal muscle activation during standing and walking for college students. These findings suggested that the presence of imbalance and abnormal strain on the musculoskeletal system during backpack carriage.

After reviewing the related literature, there is scarcity of studies investigating muscle activation of the neck and trunk muscles during backpack carriage amongst office workers. Further. there was no study to explore the differences between standing and walking conditions. Therefore, the main purposes of this study were to investigate the effect of weight carriage on neck-trunk muscle activation during standing and walking among office workers and to compare the differences of muscle activation between healthy and symptomatic office workers.

METHODS: Twenty-one participants recruited by advertisement needed to use a computer for more than 6 hours daily and had to be aged between 20 to 40 years. Body height and mass were measured. Then, participants filled out the Musculoskeletal Symptom Questionnaire (MSQ) (Cho et al., 2003). The participants with musculoskeletal symptoms should have ever experienced pain or discomfort (VAS$\geq$2) (Andersen et al. 2011) over neck or back region in the past preceding months ($\geq$ 3 days). Three load trials (an empty backpack 0%, 10%, and 15% of the subject's body weight) and two conditions (standing and walking conditions) were conducted. A two-strap backpack without internal frame is chosen. Load trials were conducetd in randomized order.

Participants stood for 30 seconds first and electromyography data were simultaneously collected. Then, participants were asked to walk with a self-chosen velocity between a 10 m distance back and forth for 5 minutes and three trials of 10 seconds electromyography data were collected in laboratory. The site of surface EMG was placed on bilateral side of upper trapezius (UT), midcervical paraspinals (MCES) (Cram et al., 1998; Kim et al., 2008), rectus abdominis (RA), and lumbar erector spinae muscles (ES) (Motmans, Tomlow, & Vissers

2006). Root mean square was analyzed. The average EMG amplitudes of all muscle activities are normalized and expressed as the percentage relative to average amplitude during 0% BW.
Descriptive statistics were used to analysis the anthropometric measures and questionnaire. Repeated measure ANOVA was used to test main effect of condition and load amount on muscle activity. The significant level was p<0.05.

RESULTS: Twenty-one participants completed all examinations. There were no significant differences of the baseline characteristics between two groups except hour of daily VDT use (Table 1). There was a significant condition*load interaction on right trapezius. The subsequent univariate ANOVA demonstrated right trapezius activation significant increase in walking condition when carrying 10% BW (p=.013) and 15% BW (p=.017) compared to 0% BW (Figure 1). Significant main effects of condition (p=.06) were found on left trapezius (Figure 2). There was no significant main effect on bilateral cervical erector spinae. Significantly increasing muscle activation of right abdominis muscle was found when carrying 15% BW as compared to 0% BW (p=.011) (Figure 3). For left abdominis, there was a significant condition*load*group interaction (p=.04) (Figure 4). Subsequent univariate ANOVA demonstrated no main effect on two groups. A significant load*group interaction was found on right lumbar erector spinae (p=.036). In symptomatic group there was a significant increase of right erector spinae as load over 10% BW (p<.001) (Figure 5). There was a significant decrease on muscle activation of left lumbar erector spinae while carrying 10% BW (p<.001) as compared to 0% BW (Figure 6).

Table 1: Baseline characteristics of 2 groups.

	Health group (N=8)	Symptomatic group (N=13)	P value
Age (years)	23.5±1.5	25.0±4.2	0.3
Gender (male/female)	4/4	6/7	0.8
Height (cm)	164.8±6.6	165.5±9.8	0.8
Weight (kg)	61.1±9.9	66.6±12.8	0.3
Bag weight (kg)	3.3±2.1	3.6±1.9	0.7
Hour of weekly bag usage	8.5±3.5	10.3±7.7	0.5
Hour of daily VDT use	10.2±2.3	7.0±2.2	<0.001*

*p<0.05

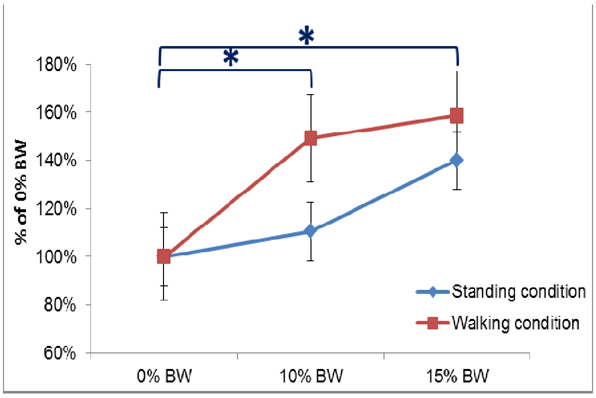


Figure 1: Right trapezius activation during standing and walking condition

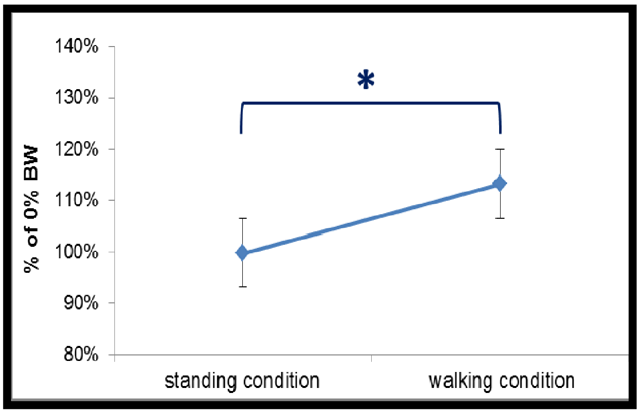
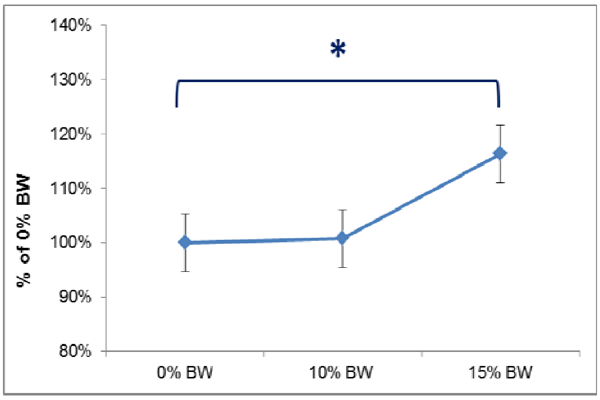


Figure 2: Left trapezius muscle



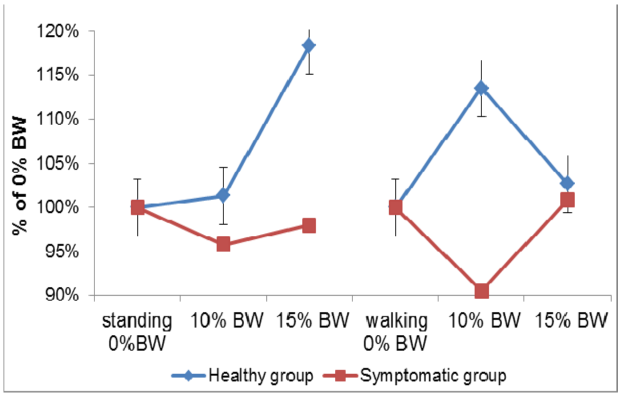
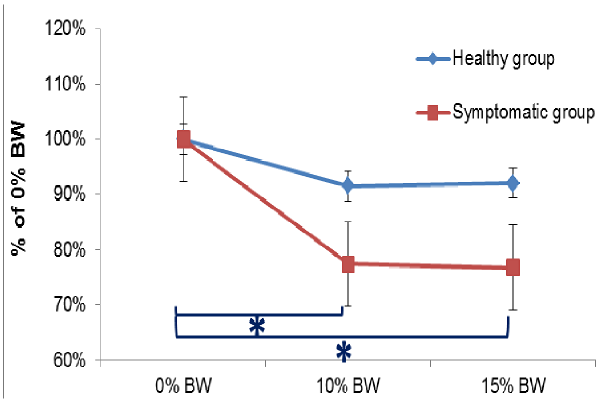


Figure 3: Right abdominis muscle activation

Figure 4: Left abdominis muscle activation



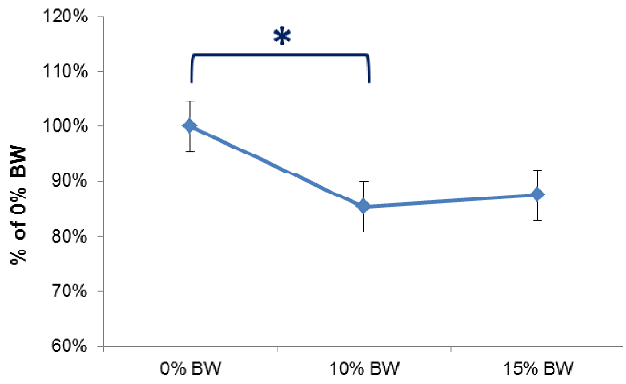


Figure 5: Right lumbar erector spinae activation

Figure 6. Left lumbar erector spinae activation

DISCUSSION: Based on the analysis of the electromyography data, muscle activation of right trapezius significantly increased as the load of the backpack increased during walking condition. The increase can be explained by Kim et al's study. (2008). They reported the forward head angle and trapezius muscle activation increased significantly for the backpack carrier, which resulted from the combined centre of gravity of the body and backpack load shifting backward moment. Moreover, peak extension moment was larger in walking condition than static condition. These responses may lead to activation of bilateral trapezius increasing significantly with heavy load in walking.

Significantly increasing activation of right abdominis as carrying 15% BW was found in current study, but significantly decreasing activation of bilateral lumbar erector spinae as carrying 10% BW. Similar results were reported by Motmans, Tomlow, & Vissers (2006). These responses can be interpreted as a compensation strategy to stabilize the whole-body center of gravity. However, the increase of left abdominis and the decrease of right lumbar erector spinae were interfered by other factors (group, condition, or load) were found in current study. Therefore, we suggest that discussing these muscles should consider all factors (groups, condition and load) during backpack usage.

According to the results of the current study, carrying a backpack over 10% BW resulted in significant differences of most muscles, which might mean an imbalance of spinal muscles may be present. The more unbalanced muscle activation was found on symptomatic group as compared to healthy group. Although we did not compare pain pressure threshold between two groups in current study, the uncomfortable level which self-reported by visual analog scale was higher on symptomatic group than healthy group. This result was supported the muscles were more sensitive and impaired muscle control for symptomatic group than healthy group.

CONCLUSION: This study showed that carrying a backpack over 10% BW resulted in increase of muscle activation on bilateral trapezius and abdominis but decrease on bilateral lumbar erector spinae. Muscle activation of bilateral trapezius and left abdominis significantly increased during walking condition as compared to standing. However, the increase of left abdominis and the decrease of right lumbar erector spinae should consider other factors (groups, condition and load) during backpack usage. The more unbalanced muscle activation was found on symptomatic group as compared to healthy group during backpack usage. Considering to electromyography data in current study, we suggest the backpack load under 10% BW was suitable for office workers.

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