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RESEARCH ARTICLE

IDEALWORK-RESTSCHEDULEFOR COMPUTERUSERS

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ABSTRACT

Background: Musculoskeletal disorders are the most common health problems for computer users who work for an extended period. The aim of this study was to identify the best work-rest schedule with the three different work-rest groups: no rest break, mid-rest break, and multiple- rest breaks, which was associated with the least EMG activities of the upper trapezius muscle and would be beneficial for musculoskeletal health

Methods: Forty-five right-handed females complaining of neck discomfort were randomly assigned into three equal groups, Group1 (no rest break) they were to be engaged in sixty minutes of typing followed by ten minutes break (60-10), group 2 (mid-rest break) thirty minutes of typing followed by five minutes break (30-5), and group 3 (multiple rest breaks) fifteen minutes of typing followed by 2.5 minutes break (15-2.5). Surface EMG was used to pick up the electrical activity of right and left upper trapezius throughout the computer typing task.

Results: There was a statistically significant reduction of normalized RMS ($p<0.05$) between the three groups for both right and left upper trapezius. Also, our results demonstrated a positive effect of mid and multiple rest breaks regarding reduced muscle activity in the upper trapezius muscle during a computer work.

Conclusion: There is a positive effect of mid and multiple rest breaks regarding reduced muscle activity in the upper trapezius muscle throughout a computer work in subjects with neck and shoulder discomfort.

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INTRODUCTION

Computer work tasks are often outlined by lengthened exposure to the monitor while keeping static position with continuous arm movements. Computer work is also tedious and needs a constantly protracted attitude with low muscle contraction. Musculoskeletal syndromes are the most common health problems for computer users who works for an extended period (Rempel *et al.,* 2006; Buckle and Devereux, 2014; Strøm *et al.,* 2009). The liability factors for musculoskeletal disorders (MSD) mainly belong to the improper head position, poor extremity postures and protracted exposure time to display unit (Burr, 2000). Female computer users are more affected than male computer users regarding musculoskeletal discomfort. Several studies have reported a positive association between the amount of vulnerability to computer work and the acerbity of discomfort (Tsauo *et al.,* 2007). Furthermore, some authors observed that the duration of mouse use was strongly about the ongoing of hand–arm syndrome than the total computer and keyboard time usage (Ekman *et al.,* 2000) Work-related MSD in the dispersion of office employees is a convincing problem for the head, neck, and shoulder areas (Janwantanakul *et al.,* 2008). They prevailing perturb the trapezius muscle and afford pain, numbness, tingling, and wreckage of the work time, diminish production rates, decline performance, and cause health problems by generating a variety of symptoms called fatigue (Buckle and Devereux, 2002). Work fatigue is a normal sensation. However, in a case of intense fatigue, it may influence the person's performance on the activity of daily living both at work and home. Moreover, severe long-term fatigue may lead to work impairment and skip (Beurskens *et al.,* 2000). Rest breaks (pauses) may boost time for muscle recovery and also discontinue static posture duration, time of exposure and continuance in computer work. Also, metabolic and circling materials within the muscles may be intensified, and local muscle load may decline (Janwantanakul *et al.,* 2008; Westgaard and Winkel, 1996). Pauses during computer work possibly may be an active or passive pause. During the active pause, the computer workers are needed to accomplish some specific movements such as shoulder elevation and neck exercises while during passive pauses, they fence their computer work, sit back and rest throughout this time (Nakphet

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et al., 2014). Surface electromyography (EMG) is a non-invasive method giving direct data about muscle activity during the occupational task. Picking up of surface EMG activity have therefore been widely used in ergonomic researchers to assess the internal biomechanical vulnerability of the shoulder region. Most of these studies have incorporated the recordings from the upper trapezius (UT) muscle activity because it is the main site of work-related pain and it is easily reachable with surface electrodes (Mathiassen *et al.,* 1995). Nonetheless, there is bounded scientific declaration aboutthe efficiency of summating rest breaks throughout computer operators with work-related MSD. So, the aim of this study is to identify the best work-rest schedule throughout the different three work-rest times: sixty minutes of work followed by ten minutes break (60-10), thirty minutes of work followed by five minutes break (30-5), and fifteen minutes of work followed by 2.5 minutes break (15-2.5) which is associated with the least EMG activities of the UT muscles and would be beneficial for developing musculoskeletal health.

METHODS

Design

This study was implemented in a lab which was constructed to be identical to the computer center and an office work circumstances. The experiment was handled at 9 o'clock am. Forty-five right-handed females working with a computer for more than four hours daily and sense of neck discomfort or shoulders or both of them. They were initiated through written announcement submitted to six offices at Wolaita Sodo city, Ethiopia. They were asked to answer the questionnaire (a standardized Nordic musculoskeletal questionnaire) concerning muscle discomfort, general health, and work profile (current position at work, daily time for computer use).
Physical examination of musculoskeletal symptoms was done to reject any other pathological causes of neck embarrassment. The subjects were randomly assigned into three equal groups, Group1 (no rest break) they were to be engaged in sixty minutes of typing followed by ten minutes break (60-10), group 2 (mid-rest break) thirty minutes of typing followed by five minutes break (30-5), and group 3 (multiple rest breaks) fifteen minutes of typing followed by 2.5 minutes break (15-2.5). The typing task was achieved at their normal pace for sixty minutes. The electrical activity of right and left UT was recorded throughout the computer typing task (one hour). The task was composed of typing a document in English which was settled on the right side at document holder. The computer workstation was individually constructed during the study following the guidelines of the Occupational Safety and Health Administration (Borg, 1990). Standard computer desk with a flexible glide out board for the key board, a chair with flexible armrests was used. The computer workstation was adapted to presume a good posture for computer users. Seat height was adjusted in relation to the subject popliteal lengths with subject's feet were rested flat on the floor. The keyboard and screen were placed centrally in front of the subjects with the screen top adapted to the subject's eye level and the screen distance equal to their arm length.

Subjects

Female computer workers were selected in this study. They were university office employees. Sixty computer operators accepted to participate. Fifteen subjects were rejected because they did not match the inclusion principles of the study. Forty five subjects were chosen according to the coming principles: their age ranged from 25 to 35 years, work at a computer office for more than four hours daily, have symptoms of neck or shoulder muscle discomfort or both of them at least three on Borg's CR-10 scale (Borg, 1990) (0= nothing at all, 10 = extremely strong), muscle discomfort for over than three months. They were right-handed, working at the same position for at least two years. Subjects were rejected if they were pregnant, overweight i.e. (BMI) was over 25kg/m2 or they had a visual deficit.

Interventions

The subjects in all groups were advised to achieve neck and shoulder muscles active exercises during the rest break period as shoulder shrugging, neck flexion, and extension. During the trial, all subjects followed the exercise sequences provided by a video play.

Outcomes

Surface electromyography (SEMG) signals were picked up from the right and the left UT because they are the large muscles involved during computer work (Nakphet *et al.,* 2014; Choi and Vanderby, 1999). Cleaning of the skin at the site of electrode contact was done with an alcohol pad. Two pairs of bipolar silver chloride surface electrodes with six millimeters diameter and a center-to-center length of two cm were put at the anatomical landmarks of the trapezius muscles (two centimeters lateral to the midpoint between the spinous process of C7 and the acromion process) (Jensen *et al.,* 1996).

A ground electrode was located on the acromion process. Each cable electrode was securely attached with a regular tape to avoid artifacts from cable movement. The Noraxon Telemyo System was used to pick up the EMG signals. Raw EMG signals were transported through a high-pass filter at 20Hz, a low-pass filter at 200Hz. These signals were achieved through a differential amplifier positioned at active leads with a common mode rejection ratio of more than 100 dB, the input impedance of over 100 MΩ and base gain at 500 times to gain a high-quality signal. Baseline noise was filtered below 1 μVroot mean square (RMS). During the computer typing task, raw EMG signals were recorded and averaged within 200 ms to determine RMS.

The electrical activity of both the right and the left UT were picked up during the computer typing task. RMS was analyzed regarding normalized EMG and expressed as a ratio of maximum voluntary electrical activity. The surface EMG normalization procedures were done before the sixty minutes typing task. Each subject achieved three trials each five seconds of isometric maximal voluntary contractions (MVCs) for the chosen muscles. Before MVC measurement achievement, active neck and shoulder muscles stretching was done for warming up. EMG normalization of the UT muscles was done while the subject was sitting in the upright position and the shoulder was abducted 90°with palms facing down. They were asked to do shoulder abduction against fixed perpendicular resistance which was applied through vertically adaptable belt fixed to motionless resistance placed above the elbow, and a straight belt was settled to the trunk of the subject to limitlousy movement.

Statistical Analysis

SPSS version 20.0 was used, the level of significance was set at $p<0.05$. The subjects were selected regarding work profile (current work duration and the daily working hours), anthropometry and age. Analysis of variance ANOVA was done to examine the efficacy of rest-break time for the dependent variable, Root Mean Square (RMS) within groups. Post hoc Bonferroni test was used for pair wise comparison to detect the difference between groups. Nonparametric Kruskal-Wallis test was used to test the muscular discomfort difference between all groups before proceeding of the rest-break plan time during sixty-minute computer tasks.

RESULTS

Participant's baseline characteristics are outlined in Table. It showed that there were no statistically significant difference ($p>0.05$) throughout all groups concerning age, anthropometric measures (weight, height, and BMI), and work profile measures (current work duration and daily working time) which indicate homogeneity of the three groups. Moreover, there was no statistically significant difference between all study groups regarding the subjects' perception of discomfort of both right and left UT muscles ($p>0.05$) as illustrated in table (2). UT muscle's electrical activity (RT, LT) during sixty minutes computer task are granted in the table (3).

There was statistically significant group effect of rest break times on normalized RMS during sixty minutes of computer work ($p<0.05$). The pairwise comparison asdemonstrated in the table (4). Post-hoc analysis registered a significant difference in normalized nRMS of right and left UT muscles between subjects who had no rest-break, mid-rest break or those who had multiple rest breaks ($p<0.05$) humor the later. However, these results showed a non-significant difference between mid-rest break group and multiple-rest breaks group ($p>0.05$).

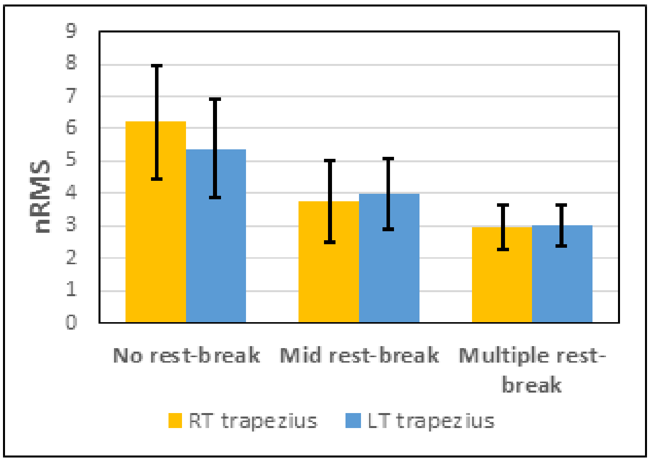

Fig. 1. Normalized root mean square (nRMS) of RT and LT upper trapezius muscles

Table 1. Characteristics of the study participants (Mean±SD)

	Groups			F (2,42)	P-value
	No-rest break (n=15)	Mid-rest break (n=15)	Multi- ple-rest breaks (n=15)		
Age(years)	28.53±3.18	30.20±3.62	28.67±3.11	1.447	0.247
BMI	24.12±0.65	23.97±0.93	24.02±0.74	0.737	0.458
Weight(kg)	57.13±7.85	54.74±7.67	56.27±7.10	0.640	0.532
Height(cm)	153.73±8.10	151.27±8.56	154.20±7.96	0.549	0.582
Currentwork duration (years)	6.67±1.98	5.73±2.12	4.93±1.58	3.095	0.056
Dailyworking time(hours)	6.20±0.94	5.87±0.74	6.20±1.12	1.212	0.308

F: variance between sample means(one-way ANOVA test) P: level of significance

Table 2. Perceived discomfort of RT and LT upper trapezius muscles on Borg's CR-10 scale at the baseline.

Perceived discomfort	Groups			Chi- Square	P-value
	No-rest break (n=15)	Mid-rest break (n=15)	Multiple-rest (n=15)	(X^2)	
(RTupper trapezius)	5(5-6)	5(4-6)	5(3-6)	1.299	0.522
(LTupper trapezius)	4(4-6)	5(3-6)	4(3-4)	3.452	0.178
(RTupper trapezius)	5(5-6)	5(4-6)	5(3-6)	1.299	0.522

Data are expressed as Median (Inter quartile ranges) X2Chi-Square value (Kruskal-Wallistest) P: level of significance

Table 3. UT muscle's electrical activity during sixty minutes computer work (RT, LT)

nRMS	Groups			F (2,42)	P-value
	No-rest break (n=15)	Mid-rest break (n=15)	Multiple-rest (n=15)		
RTupper trapezius	6.20± 1.75	3.78± 1.27	2.96± 0.67	28.148	<0.001*
LTupper trapezius	5.38± 1.52	3.98± 1.10	3.01± 0.61	16.378	<0.001*

nRMS: normalized Root Mean Square; F: variance between sample means (one-way ANOVA test) P: level of significance<0.05

Table 4. Post hoc Bonferroni test for multiple comparisons of nRMS during sixty minutes of computer work

		RTuppertrapezius muscle		LTuppertrapezius muscle	
		(X1-X2)	P-value	(X1-X2)	P-value
nRMS	No-restbreak VsMid-rest break	2.41	0.001*	1.40	0.005*
	No-restbreak VsMulti- ple-rest break	3.24	0.001	2.37	0.001
	Mid-rest breakVs Multiple-rest break	0.83	0.218	0.97	0.073

nRMS: normalized Root Mean Square; (X1- X2): the mean differ

DISCUSSION

This study was conducted to detect the best work-rest time with the three different work-rest groups: no-rest break, mid-rest break, and multiple- rest breaks, which was associated with the least EMG activities of the UT muscle and would be beneficial for musculoskeletal health. About the UT muscle's electrical activity during sixty minutes computer work, the results showed that there was a statistically significant difference between the three groups on normalized RMS ($p<0.05$) for both right and left UT. This result may be referred to the given rest breaks which enhance the oxygen and nutrients supply to the muscles, remove the waste products specifically lactic acid (Nakphet *et al.,* 2014; Gallis, 2013). Also, our results demonstrated a positive effect of mid and multiple rest-breaks regarding reduced muscle activity in the UT muscle during a computer work in subjects with neck and shoulder discomfort. These results may be interpreted that frequent rest breaks may reduce the development of fatigue of the UT muscle during its static work. In contrast, rest-break of a quite long duration is shown to be improper to achieve total comfort of the UT muscle throughout computer task (Blangsted *et al.,* 2004). Gallis 2013, ascertain that multiple-rest breaks are more favorablethan single rest-break on work performance. Moreover, Rohmert 1973, found that short- term rest breaks are associated with fast recovery rate especially throughout the initial part of a rest time. Determination of the rest break time has been the entity of several studies. Østensvik *et al.* 2009 study were conducted to rule out the best work-rest schedule on telephone directory employees. The schedules tested were: thirty minutes work followed by five minutes break; sixty minutes followed by ten minutes break and one hundred twenty minutes without any break. They revealed that the achievement was declined with the increased work time from thirty minutes to sixty minutes by 11% more faults. If no rest break was given the achievement decline became great, and around 80% has increased the faults throughout one hundred twenty minutes of continuous work.

Henning *et al.* 1997 study aimed to detect if frequent short-term rest breaks (three times of thirty seconds and one time of three minutes) from computer task hourly, additional to daily rest breaks had a favorable effect on participant's productivity rate and wellbeing. They had reported that there was an increase in the productivity rate as well as eye, leg and foot comfort when the short-term breaks were joined. These results illustrate thatfrequent short-term breaks from lengthened computer work can improve work productivity rate and wellbeing when the rest breaks are correspondent with the work concerns (Crenshaw *et al.,* 2007). The definite results of rest breaks in this study may be due to the effect of active exercises performed during the rest time as supported by the study of Beurskens *et al.,* 2000, Mathiassen *et al.,*1997 and Madeleine *et al.* 2008. It is supposed that voluntary muscle contraction (active rest break) may result in enhancement of local circulation which helps the washout of the collected sub-stances throughout thecomputer work (Crenshaw *et al.,* 2006). Lactate removal rate was markedly quicker when aerobic exercises were done during recovery as compared with the results that noticed when the subjects are relaxed during recovery period (Beynon *et al.,*). Similarly, Samani 2010, has reported that active rest breaks improved the variability of the trapezius muscle activity throughout organized computer work. In this context, the general aim of frequent rest break is to give the overloaded motor units an opportunity to relax (Nakphet *et al.,* 2014; Rohmert, 1973). Crenshaw *et al.,* 2006 contradict our study as they did not report any significant effect of active rest breaks on surface EMG amplitude and discomfort level when compared with the passive rest break. Furthermore, regarding Cinderella hypothesis developed by Hägg 1991, neck and shoulder muscles disorders may occur as a result of the overuse of low threshold motor units throughout computer work (Westad *et al.,* 2003; Szeto *et al.,* 2005; Visser *et al.,* 2006).

This suggests that a shift in activity from a computer work to a specified activity of the neck and shoulder muscles during rest breaks could create muscle relaxation for computer workers with MSD (Crenshaw *et al.,* 2007). Proper timing of rest breaks is also of great value. Short, frequent rest breaks are adequate than longer rest breaks. Henning *et al.* 1997, found that short (30-60 seconds) rest breaks from computer work at fifteen minutes intervals during the day may assist in reducing musculoskeletal discomfort and improving work rate productivity. McLean *et al.* 2001,also examined the effects of micro rest breaks on computer terminal workers. They evaluated the myoelectric signals, behavior, perceived discomfort and work rate productivity while subjects performed their usual keyboard tasks. The study consisted of three groups: A control group with micro breaks at their attention, a group with micro breaks at twenty minutes intervals, and a group with micro breaks at forty minutes intervals. They concluded that micro breaks had a positive effect on diminishing discomfort during the computer terminal task especially when breaks were given at twenty minutes intervals. In this study, it is difficult to analyze that the significant difference between the tested groups was due to the rest break time effect or the active exercise effect, or both. Other re- searchers supported our results as they found that short rest breaks combined with exercise were more valuable than passive rest breaks for computer workers. This indicates that active rest break is more effective than passive one in reducing musculoskeletal discomfort.

Conclusion

There is a positive effect of mid and multiple rest-breaks regarding reduced muscle activity in the upper trapezius muscle during a computer work in subjects with neck and shoulder discomfort.

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