Safety and Health at Work 11 (2020) 207–214

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.net

Original Article

It is Time to Have Rest: How do Break Types Affect Muscular Activity and Perceived Discomfort During Prolonged Sitting Work

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ARTICLE INFO

Article history:
Received 4 December 2019
Received in revised form
20 March 2020
Accepted 31 March 2020
Available online 9 April 2020

Keywords:
Intervention
JASA method
Muscle discomfort
Office ergonomics
Surface EMG

ABSTRACT

Background: Prolonged sitting at work can lead to adverse health outcomes. The health risk of office workers is an increasing concern for the society and industry, with prolonged sitting work becoming more prevalent.
Objective: This study aimed to explore the variation in muscle activities during prolonged sitting work and found out when and how to take a break to mitigate the risk of muscle symptoms.
Methods: A preliminary survey was conducted to find out the prevalence of muscle discomfort in sedentary work. Firstly, a 2-h sedentary computer work was designed based on the preliminary study to investigate the variation in muscle activities. Twenty-four participants took part in the electromyography (EMG) measurement study. The EMG variations in the trapezius muscle and latissimus dorsi were investigated. Then the intervention time was determined based on the EMG measurement study. Secondly, 48 participants were divided into six groups to compare the effectiveness of every break type (passive break, active break of changing their posture, and stand and stretch their body with 5 or 10 mins). Finally, data consisting of EMG amplitudes and spectra and subjective assessment of discomfort were analyzed.
Results: In the EMG experiment, results from the joint analysis of the spectral and amplitude method showed muscle fatigue after about 40 mins of sedentary work. In the intervention experiment, the results showed that standing and stretching for 5 mins was the most effective break type, and this type of break could keep the muscles' state at a recovery level for about 30–45 mins.
Conclusions: This study offers the possibility of being applied to office workers and provides preliminary data support and theoretical exploration for a follow-up early muscle fatigue detection system.

1. Introduction

The nature of work has changed dramatically from working with physical demands to working with cognitive demands as the computer work has become more widespread, which results in high levels of workplace sedentary (sitting) time, particularly in office environments [1]. Studies found that people spend half to 86% of their workdays doing sedentary work depending on the occupation [2–4]. Consistent evidence has supported an association between sedentary work and the risk of adverse health outcomes [5–10]. The research expands from highly physical demanding work to sedentary work [11,12], especially because sedentary work has become a focus for public health research and policy [13]. Recently, guidance for employers to reduce sedentary behavior in the workplace has been provided [14], but the translation of such guidance to effect sustained behavior change remains a challenge to researchers, employers, and policymakers [7].

Office work is sedentary work, which is defined as any seated or reclined posture is characterized by an energy expenditure ≤1.5 METs (metabolic equivalents) [15], and occupational sitting is a primary contributor to daily sedentary time for white-collar workers [13,16]. Prolonged sitting has been proved a potential hazard for workers' health including low–back pain [5,8,17,18], decline in cognitive function [5,19,20], diabetes [21], cardiovascular disease [14,20], and all-cause mortality [22]. Increased prolonged sitting time has also been shown to negatively correlate with work

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2093-7911/$ – see front matter
https://doi.org/10.1016/j.shaw.2020.03.008

Table 1
The general characteristics of the respondents

Characteristics	Categories	N	%
Height	M±SD	168.6 ± 8.69 cm	
Weight	M±SD	61.8 ± 12.78 kg	
BMI	<18.5	13.8%	
	[18.5, 25)	68.8%	
	≥25	17.4%	
Occupations	Office clerk	141	37.5%
	IT worker	75	20%
	Scientific researcher	70	18.75%
	Others	89	23.75
The duration of a sitting position to feel discomfort	<30 min	33	8.9%
	30-60 min	55	14.75%
	60-90 min	126	33.61%
	90-120 min	138	36.89%
	≥120 min	23	5.85%
Sitting time per day	<3 h	9	2.4%
	3-5 h	56	14.81%
	5-8 h	208	55.56%
	≥8 h	102	27.16%

Table 2
The general characteristics of the intervention groups

Groups	Age (mean ± SD)	Height (m)	Weight (kg)	BMI (mean ± SD)
PB5	20.3 ± 0.5	1.71 ± 0.08	62.3 ± 12.61	21.2 ± 2.4
PB10	20 ± 0.6	1.68 ± 0.08	58 ± 9.70	20.4 ± 1.89
AB5	20.7 ± 0.5	1.71 ± 0.08	61 ± 13.05	20.6 ± 2.65
AB10	20.5 ± 0.55	1.67 ± 0.08	57.3 ± 11.18	20.5 ± 2.05
SS5	20.2 ± 0.75	1.71 ± 0.07	62.2 ± 14.72	20.9 ± 2.87
SS10	20.5 ± 0.54	1.70 ± 0.07	61.6 ± 12.01	20.8 ± 2.25

PB = passive break; AB = active break; SS = stand and stretch.

engagement [20,23,24] and performance [25]. Although prolonged sitting work is characterized by low-level muscle loading [26], musculoskeletal disorders are the most common problems among the office workers or people who sit for prolonged periods [27]. Therefore, exploring how to alleviate these risks would benefit a large population of the workforce.

Electromyography (EMG) is a valid and reliable tool for investigating the relationship between muscle muscular force production and fatigue state [28], such as EMG in the trapezius muscle [1,29], upper extremity [1,30], and lower extremity [5,8,17,18,31]. EMG amplitude and spectral parameters were two indexes to assess the muscle state [1,28,29,32], but most often they are considered separately and independently. In the newly developed method for joint analysis of the spectral and amplitude (JASA) of EMG [28], JASA is considered a real work situation and is applicable in work cycles or repetitive tasks [33]. There are numerous studies about measuring muscle activity of computer work or sedentary work, but fewer studies have assessed EMG variation to determine the intervention time and investigated the effectiveness of break types [1,34–36]. How to eliminate the risks of muscle fatigue or discomfort is, and will continue to be, one of the core occupational challenges in the future [37]. Currently, breaks are recommended for mitigating the adverse effects of prolonged sitting with poor postures and can be either passive or active [38,39]. However, what is the effective kind of break and what should the worker do to alleviate the risks of muscle symptoms are still unclear.

To the best of our knowledge, these problems have not yet been fully investigated. Although a lot of researchers investigated the assessment of muscle activity by EMG, the conclusions about where and what changes occur remain unclear. In addition, fewer articles evaluate the effectiveness of breaks on low back pain, discomfort, and work productivity in office workers, and more evidence is needed to verify the effectiveness of breaks [39]. Therefore, this study aims to investigate the prevalence of muscle discomfort in office workers, explore the variation in EMG activity in these body muscles, and compare the effectiveness of different break types. The intervention time point was determined based on the variation in EMG activity. Then, different types of breaks were promoted and compared, which workers can easily access.

2. Methodology

2.1. Preliminary survey

A preliminary study with an internet-based questionnaire was conducted to collect self-report musculoskeletal symptoms in upper and lower extremity, neck, and back based on the Standard Nordic Questionnaire [40]. The Standard Nordic Questionnaire responses have been found to have high reliability and validity

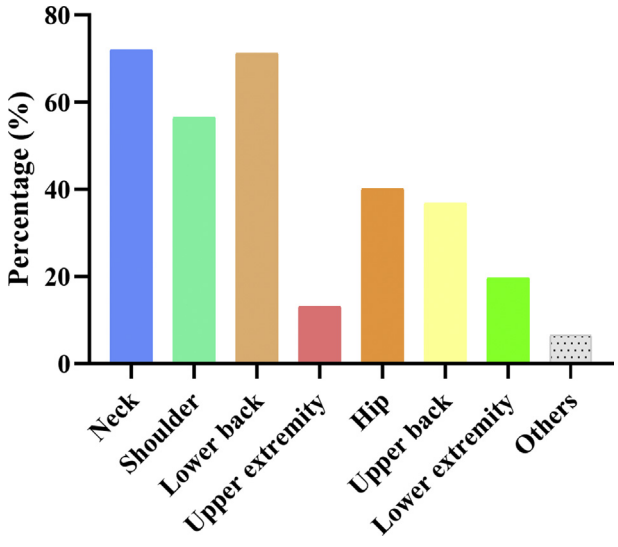

Fig. 1. Symptom reports of body regions.

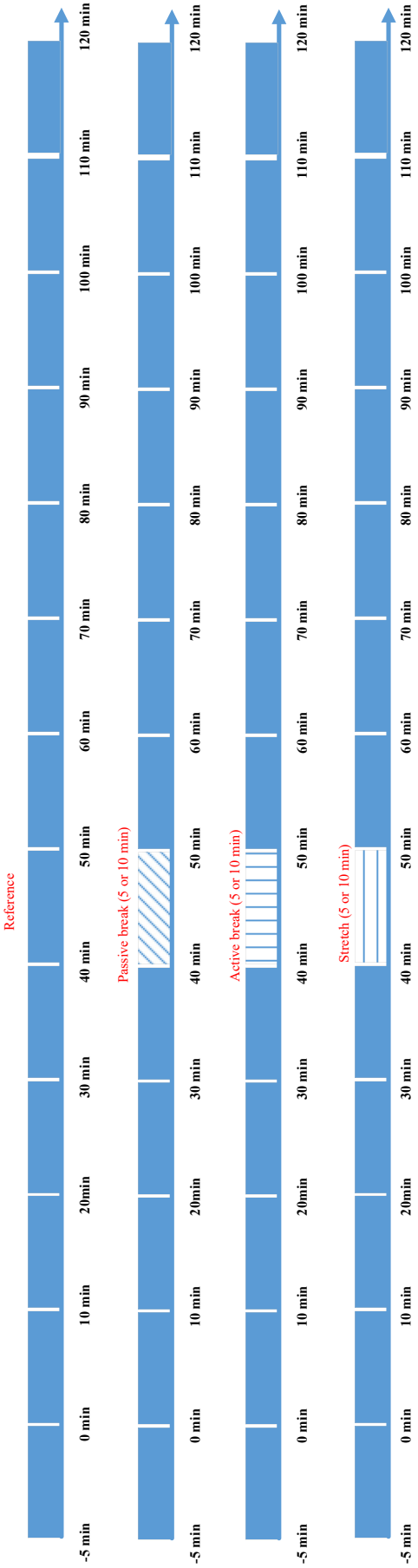

Fig. 2. The procedure EMG measurement and rest break intervention. EMG = electromyography.

(Kappa values: 0.83−1.0) [40]. The questionnaires were distributed to 430 workers, and the response rate was 87%. Forty-five questionnaires were deleted for the completion time below 120 seconds and outliers of the data via the boxplot [41]. A final sample of 375 office workers (216 women and 159 men, aging from 20 to 45 years, Mage = 25.9 years, SDage = 5.8) were recruited, and the survey was conducted between April 10 and May 7 in 2018. The EMG measurement experiment and active breaks were conducted based on this survey.

The general characteristics of the respondents are presented in Table 1. The results showed that 70.5% of prolonged sitting workers feel discomfort if they kept sitting for 1−2 h at a position. Therefore, the experiment duration was scheduled to last 2 h. The survey results showed that half of the sitting workers kept sitting for 5−8 h every day. Moreover, neck, shoulder, and lower back are the most common locations of pain or discomfort (Fig. 1). Hence, the upper trapezius and the latissimus dorsi were chosen to record the EMG activity during prolonged sitting work. Our results showed no significant difference between men and women.

2.2. Participants

During the preliminary survey, we asked whether the respondents want to participate in the 2-h experiment. Finally, we recruited 24 participants (half men, 20 to 25 years old, Mage = 23.7 years, SDage = 1.01) to participate in the EMG activity measurement experiment, in which the EMG variation will be investigated to determine the intervention time of break. The participants' mean height and weight (±SD) were 166.7 (±8.3) cm and 59.75 (±11.5) kg, respectively.

Then, 48 participants (half men, 19 to 24 years old, Mage = 22.8 years, SDage = 1.1) took part in the intervention experiment, and none of them participated in the EMG activity measurement experiment. They were randomly divided into six groups (Table 2), and each group will take a type of break to compare the effectiveness of breaks.

The 72 participants are office workers (half of them are university students coming from laboratoriess, who do similar work tasks in this study) and are normally subjected to prolonged sitting in their workday. They are all right-handed, healthy individuals with normal or corrected-to-normal vision, without a history of musculoskeletal, neurological, or vascular problems that hinder the ability to perform sedentary work for more than 2 hrs. None of the participants were allergic to the electrodes used in the experiment. They all had a good rest and had no strenuous exercise before the experiment. All participants provided written informed consent before the experiment and received financial compensation for their involvement in the study.

2.3. Experimental design

Firstly, participants were asked to sit in a quiet room with normal light. The desk and chair used in the experiment are shown in the supplementary material (Fig. 1). Then electrodes were put on the participant's skin and the experiment was introduced to the participants. They were asked to conduct computer works composing of typing 800 words, finding ten research articles about “musculoskeletal symptoms” and copying the title and abstract of the aticles to Word, and making a PowerPoint presentation of the topics. In the EMG measurement experiment, the 24 participants were not required to have substantial body shaking during the two hours of prolonged sitting computer work. The participant's muscle discomfort was measured with the Borg's CR-10 scale [38] every ten minutes. The participant worked and assessed his subjective

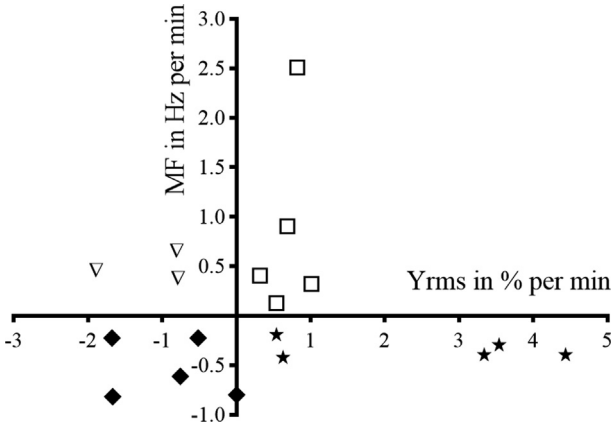

Fig. 3. A graphical explanation of the JASA method. MF = the derivative of the median frequency (MF); Yrms = the root mean square of EMG; triangle = right deltoideus; circle = right trapezius; square = left trapezius; EMG = electromyography; JASA = joint analysis of the spectral and amplitude ([[28], [43]]).

discomfort on a laptop (HP ZHAN99 G1 with a screen of 1920 × 1080 resolution).

In the intervention experiment, 48 participants were asked to conduct the tasks in two hours in the rest break intervention experiment. Two break types (i.e., a passive or an active break) separated working periods based a research [42]. Passive breaks consisted in remaining seated on an armchair for the required time (5min or 10 min, marked as PB5 and PB10). Active breaks consisted of the following two activities: (1) change their posture and have a walk for 5 or 10 min (marked as AB5 and AB10) and (2) stand and stretch their body for 5 or 10 min (marked as SS5 and SS10) (Fig. 2) at the intervention time node. After having the break, the participant's muscle discomfort was measured with the Borg's CR-10 scale every ten minutes. The signal was divided into 0–5 min before the experiment, 0–10 min, 10–20 min, …, 110–120 min, which were marked with T0, T1, T2, …, T12. The rest break time node was set based on EMG variation analysis in the intervention task (section 3.1). The experiment was conducted between May and July 2019.

2.4. EMG signal recording and analysis

EMG signals were recorded by using the ErgoLAB human-machine-environment test cloud platform (Kingfar International Inc., China). EMG signals were collected by noninvasive wearable sensors from the latissimus dorsi muscle and the trapezius muscle based on the preliminary survey. Three Kangren® pregelled disposable AgCl electrodes with an active area of 6.15 mm^2 (type: CH3236TD) were placed on the right and left upper trapezius muscles with a distance of 20 mm between the center of the middle electrode and the center of each of the two lateral (active) electrodes. And three electrodes were placed along the muscle fiber of the latissimus dorsi muscle. The reference electrode was placed at the center of the two active electrodes (Fig. 2 displayed in the supplementary material). The sample rate of EMG was1024 Hz with a band-pass filter of 5~500 Hz and a noise level of 1.6μV. The root mean square of the signal was determined using a time constant of 120 ms. All electrode impedances were maintained below 5 kΩ during the experiment. Skin was prepared to reduce impedance by using scrubbing cream and cotton swab.

Raw EMG signals were recorded during the experiment, as well as 5 min before the experiment. The recorded raw data were processed with electrocardiography reduction and full-wave rectification. They were then averaged within 200 ms to determine root mean square marked by Yrms. In spectrum frequency analysis, the fast Fourier transform was used to estimate median frequency (MF). The signal processing was conducted by using ErgoLAB man-machine-environment synchronization platform (Beijing Kingfar technology co. LTD, China).

2.5. JASA method and statistical analysis

The simultaneous increase of the EMG amplitude and decrease of MF means muscle fatigue or risk onset based on the research

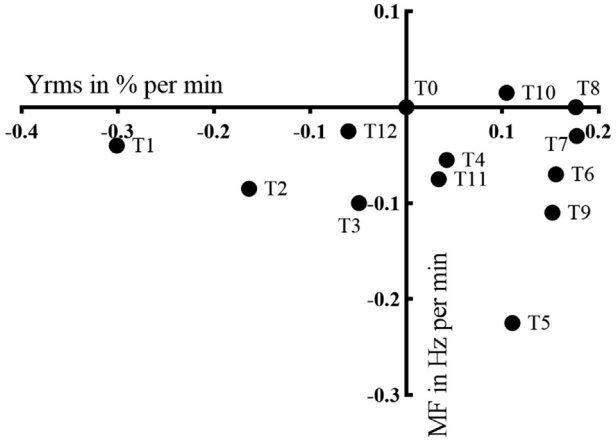

Fig. 4. JASA plot of the trapezius muscle. T0, T1, T2, …, and T12 denote 0–5 mins before the experiment, 0–10 mins, 10–20 mins, …, and 110–120 mins in the experiment, respectively. JASA = joint analysis of the spectral and amplitude.

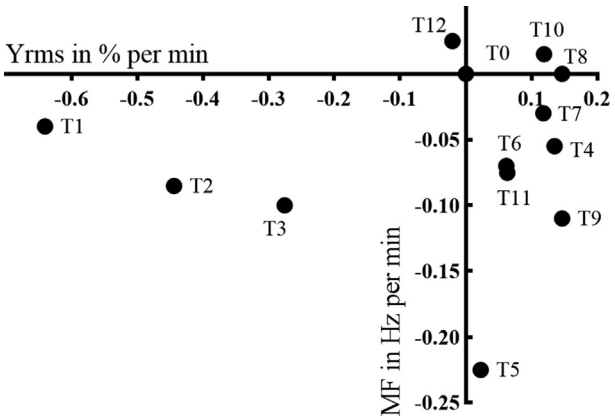

Fig. 5. JASA plot of the latissimus dorsi. T0, T1, T2, …, and T12 denote 0–5 mins before the experiment, 0–10 mins, 10–20 mins, …, and 110–120 mins in the experiment, respectively. JASA = joint analysis of the spectral and amplitude.

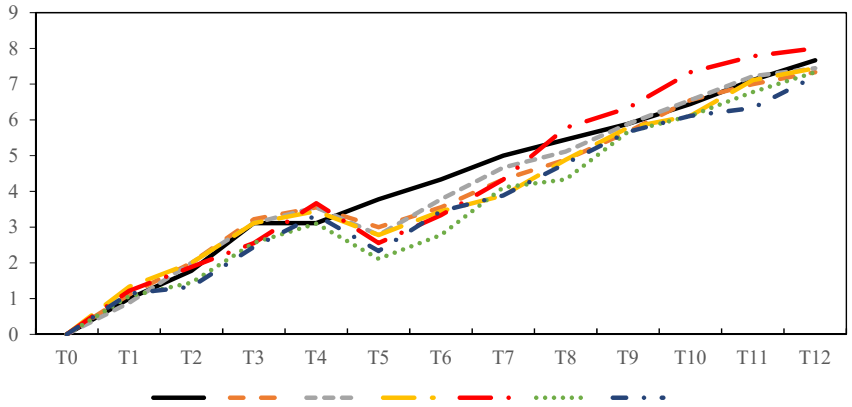

Fig. 6. The fitting analysis of perceived muscle discomfort. y = 0.060x + 0.60 (R^2 = 0.9839) is the fitting analysis of perceived discomfort from the reference group; y = 0.088x + 0.08 (R^2 = 0.9428) is from intervention groups by data during 0-40 mins; Y = 0.071x-0.83 (R^2 = 0.9495) is from intervention groups by data of after 40 mins. PB = passive break; AB = active break; SS = stand and stretch; 5 or 10 mins mean the duration of break.

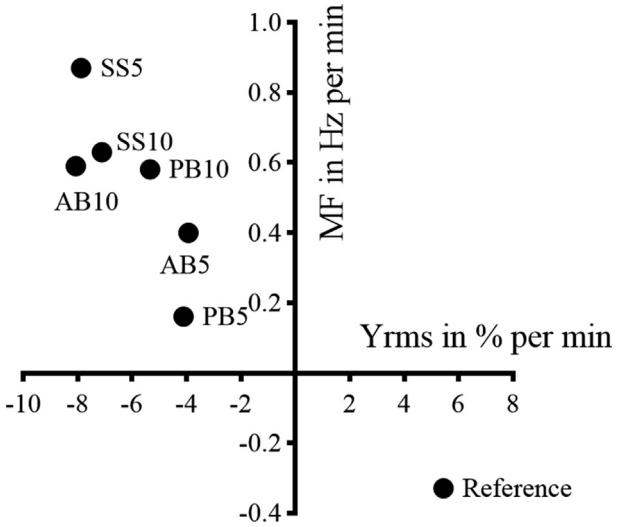

Fig. 7. Comparison of different breaks in the following 10 mins after the break from the trapezius muscle based on JASA. PB = passive break; AB = active break; SS = stand and stretch; JASA = joint analysis of the spectral and amplitude.

conducted by Luttmann et al. [28]. Luttmann et al. [28] named this method JASA and used this method to discriminate between fatigue-induced and force-related changes in the EMG. The JASA method is based on this assumption that only static muscle contractions occur [43]. In the JASA plot, x and y axes are representative of temporal changes in EMG amplitude and spectral parameters, respectively [28,33,43]. The values of MF and Yrms changes were calculated at the marked time of work. In this method, four quadrants were obtained based on the value of MF and Yrms changes (Fig. 3) [28,43]: (1) a simultaneous increase in MF and Yrms is classified into force increase (upper right-hand quadrant), (2) an increase in MF and a decrease in Yrms points to recovery from muscle fatigue (upper left-hand quadrant), (3) a decrease in MF accompanied by a decrease in Yrms is classified into force decrease (lower left-hand quadrant), and (4) an increase in Yrms simultaneous with a decrease in MF can be regarded a sign of muscle fatigue (lower right-hand quadrant). Mean values of MF and Yrms for succeeding short periods of time (e.g., 5s or 10s) can be calculated, and time series of MF and Yrms were summarized by regression analyses.

Finally, the time series models (i.e., curve fitting models, tables in the supplementary material) were applied to analyze the regression coefficient of Yrms and MF changes during the 2-hour sedentary computer task. According to the JASA method [28,33,43], the regression coefficients of Yrms and MF were

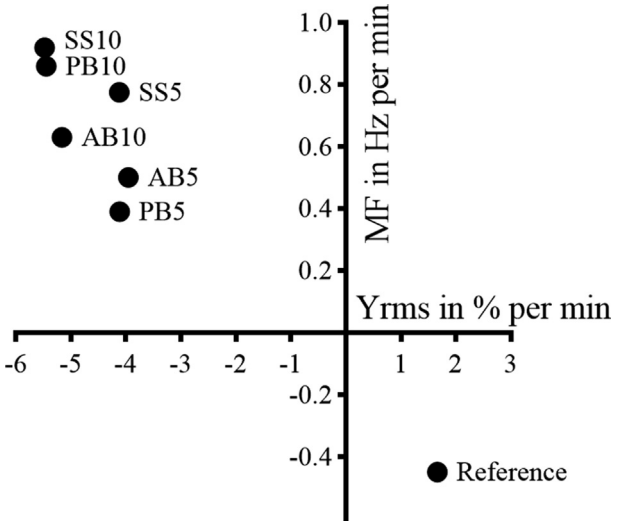

Fig. 8. Comparison of different types of break in the following 10 minutes from the latissimus dorsi based on JASA. PB = passive break; AB = active break; SS = stand and stretch; JASA = joint analysis of the spectral and amplitude

calculated. Then each pair value of Yrms and MF was figured as a dot in the JASA plot. The effectiveness of the break was categorized by using JASA.

3. Results

3.1. The determination of intervention time

In the EMG measurement study, participants were asked to complete several computer tasks, and there were no dynamic exertions in their muscles. Intervention time was determined based on the JASA method. The horizontal coordinate represents the change of Yrms per min, and the vertical coordinate means the change of MF per min. Fig. 4 and Fig. 5 showed the JASA plots of the trapezius muscle and latissimus dorsi muscle, respectively. The results showed that the muscles were most likely to be fatigue in 40–50 min. Therefore, 40 min was set as the intervention time node to conduct the rest break experiment.

3.2. Subjective rating of overall discomfort

We also collected the subjective ratings of perceived discomfort every 10 minutes. Further, the results showed that overall discomfort increased with sedentary tasks continuing for all 6 conditions, which supports the findings of previous literature [5,44–46]. The fitting analysis of the data during each of the conditions followed a nominally identical trend between 0 and the intervention time (40 mins) (Fig. 6). The participants had a break and perceived an acute decrease of discomfort at 40 mins. Then participants left the seat to have a break for 5 or 10 min. The results showed decreases in the subjective rating of discomfort in the following time. The worst break type was PB5, in which subjects just remain seated and stop working. Upon returning to the sedentary task, a steady increase of perceived discomfort was observed for all of the conditions. Then the perceived discomfort went back to the preintervention level after about 30 min. However, higher perceived discomfort was observed after 30 min of break than in other groups in the condition of AB10. The independent sample t test showed that there was a significant difference between the reference group and SS5 at the T8 time point ($t(22) = 2.551$, $p = 0.018$), but no difference was obtained between the reference group and other groups ($p_s > 0.05$). The perceived discomfort from the group with AB10 was higher than that of the reference group and other groups but did not reach a significant level after T8.

Table 3
The time required for muscles to return to the state of preintervention

Type of break	Trapezius muscle (mins)	Latissimus dorsi (mins)
PB5	59.29	68.13
PB10	61.45	63.80
AB5	61.43	58.53
AB10	63.89	59.03
SS5	71.19	85.12
SS10	66.78	74.46

PB = passive break; AB = active break; SS = stand and stretch.

3.3. EMG activity

Firstly, we analyzed the difference in muscle activity before the experiment. The independent sample t test showed that there was no significant difference in Yrms or MF ($ps > 0.05$). Therefore, states of the participants' muscles before the experiment had no impact on the following EMG measurement. We compared the effectiveness of break types by using the JASA method (Fig. 7 and Fig. 8). The regression coefficients forming pair values of Yrms and MF from the trapezius muscle and latissimus dorsi mainly distributed in the second quadrant, which indicated that the muscles were in the state of recovery [28,33,43] and the interventions were also effective to change the muscles' state. Moreover, pair values of Yrms and MF from the reference group distributed in the fourth quadrant, which meant a fatigue state of muscles [28,33,43]. Figs. 7 and 8 showed that all the pair values were distributed in the second quadrant (i.e., recovery state), so all the breaks were effective compared with the reference group, whereas in the previous studies [28,33,43], there was no investigation about comparisons among different types of breaks [33].

The temporal changes in EMG amplitudes and spectral parameters of the trapezius muscle and the latissimus dorsi are displayed in the supplementary material (Figs. 3 and 4). The results showed an increase of EMG amplitudes accompanied by a decrease of MF in the reference group with the task continuing.

According to the trend of Yrms and MF from each group (Figs. 3 and 4 in supplementary material) and fitting models (Tables 1 and 2 in supplementary material), JASA plots at each time node can be obtained. In addition, the time that muscles return to the state of preintervention (i.e., dots distributed in the fourth quadrant in JASA plots) can be calculated according to the curve fitting models. Table 3 gave the time that muscles needed to return to the state of prebreaks. The results showed that SS5 was the most effective break type and could keep the muscles at a nonfatigue level for about 30–45 min. However, there was no significant difference between the effectiveness of PB and AB, and these two types of break could keep the muscles at nonfatigue for about 20–28 min at most.

Furthermore, there were significant correlations between subjective ratings of perceived discomfort and EMG amplitudes (trapezius muscle and latissimus dorsi) with $r = 0.974$, $p < 0.001$, and $r = 0.993$, $p < 0.001$ and between subjective ratings of perceived discomfort and MF with $r = -0.977$, $p < 0.001$, and $r = -0.992$, $p < 0.001$ in the trapezius muscle and the latissimus dorsi, respectively.

4. Discussion

This article explored the variation of EMG activity during prolonged sitting work and compared the effectiveness of varied break types. The intervention time and effectiveness of breaks were analyzed based on the JASA method, a reliable method for ergonomic assessment of muscle fatigue [28,33,43]. In the experiment, six types of breaks that people can easily access were promoted and compared. The results showed that people should have a break after 40 min sedentary work and the most effective break type is SS5, and the muscles return to the state of preintervention after about 30 min.

Firstly, the results of the preliminary survey are in line with the findings of previous studies about muscle discomfort during prolonged sitting [39,47]. Vos et al. [47] reported from a global analysis that lower back and neck disorders have significantly increased during 2005–2015. Waongenngarm et al. [39] also reported that people perceived discomfort mainly in the neck and low back during sustained sitting. Our findings lend further support to the research about the relationship between prolonged sitting and musculoskeletal symptoms.

Secondly, the results showed that after about 40–50 min of sedentary work, the trapezius muscle and latissimus dorsi were identified as fatigued according to the JASA plot (Figs. 4 and 5). To date, there is still a lack of consensus on when and how to take a break. Baker et al. [5] found that lower back discomfort had a clinically meaningful increase at the end of 120 min of prolonged sitting. In their study, participants had autonomy over the tasks undertaken, and as a result, there may have a difference in posture or movements (e.g., using a mouse or typing on a keyboard). In our study, participants were required to complete lots of computer work and hold a posture as long as possible to eliminate the effect of body movement. In addition, most of studies set the break every 30 min [48,49], 20 or 40 min [50], or 60 min [51], but there were no reasons for setting the break time in these studies.

Thirdly, different break types are recommended for mitigating the adverse effects of prolonged sitting with poor postures and can be either passive or active [38,39]. The results showed that all six breaks were effective for changing the muscles' state to nonfatigue states in the following 10 min (refer JASA plots in Figs. 7 and 8). We found that AB5 was the most effective break type followed by SS10, which could keep the muscles at a nonfatigue level for about 30–45 min (Fig. 6 and Table 3). There were few articles to identify which break type was more effective than others. Our findings were in line with a study of long-term driving comfort, which also showed that active break was more effective than passive break [52]. Our results were not consistent with the study conducted by Nakphet et al. [38]. They investigated the effect of different types of rest break interventions on the neck and shoulder muscle activity, discomfort, and performance in video display unit workers. The workers performed a typing task for 60 min and received 3-min breaks after each 20 min of work. They found that there were no significant differences between the types of activities during breaks on the neck and shoulder muscle activity, muscle discomfort, or productivity. The differences in task character, break type, and break time may contribute to this disparity. Both of the studies showed that breaks had a positive effect on the recovery of muscle discomfort. In addition, the review conducted by Waongenngarm et al. [39] supported our findings that active breaks with postural change, especially stretching, is most effective for sedentary work.

Our results also showed that a person's perceived discomfort is related to the effectiveness of their break (Fig. 6). The group with SS5 had significantly lower perceived discomfort than that of the reference group at T8, but no difference was observed in the following time after the break. The subjective assessment of discomfort was consistent with the EMG analysis. The EMG activity went back to the level of preintervention of about 71–85 min in the group with SS5. Moreover, there were significant correlations between subjective evaluation of discomfort and EMG activities.

5. Conclusions

As prolonged sitting work becomes more prevalent, the health risk for office workers is an increasing concern for the society and industry. This study tries to investigate the variation of EMG activity during prolonged sitting work and compare the effectiveness of varied break types. We find that people should have a break after 40 mins of sedentary work without body movement, but the time to have a break is arbitrary in previous studies. Moreover, passive breaks and active breaks are all effective for alleviating discomfort and changing the EMG activation. The findings provide support to the effectiveness of breaks on discomfort prevention. The most effective break type to reduce discomfort was SS5. Other breaks might be more advantageous for other outcomes such as energy expenditure, worker productivity, etc. In addition, there were correlations between subjective assessment and EMG.

There are some limitations in this study. The study was conducted in a laboratory with the advantage of carefully controlled experimental conditions. However, it is a limitation that the process and conclusions cannot be extrapolated to occupational settings. Moreover, participants from different backgrounds (e.g., work seniority and gender) should be included. In addition, different kinds of real-world workloads should be investigated, and other information from posture, heart, or neural signals can be helpful. In addition, Moshou et al. [42] pointed out that the JASA method has some limitations. For example, sometimes the dots are positioned on the x/y axis or are relatively aligned around the x/y axis, and only the location of the quadrants is critical but not the distance of the dots [33]. Last but not least, how to promote effective interventions to reduce muscle discomfort and at the same time maintain people's work performance in the long term are two critical issues. In the future, smart offices will be able to measure and identify people's physiological state automatically, then provide suggestions for the break.

All in all, this study investigated the muscle variation of people in daily sedentary behavior and compared the effectiveness of break types on discomfort and muscle activation. This study offers the possibility of being applied to office workers and provides preliminary data support and theoretical exploration for early muscle fatigue detection systems, whose implementation in the real world would give a great beneficial impact on worker's health and efficiency of companies.

Conflicts of interest

The authors have no conflict of interest to report.

Acknowledgments

This work is supported by the National Natural Science Foundation of China (No. 71801002, 71701003, 71802002), the Humanities and Social Science Fund of Ministry of Education of China (No. 18YJC630023), and the Natural Science Foundation of Anhui Province (No. 1808085QG228). The authors thank the research support plan (No. 201901024006) from Kingfar International Inc. (China) for providing related equipment and scientific and technological support and help from Purdue Writing Lab in the Department of English at Purdue University for checking our manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2020.03.008.

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