The Effects of Workplace Office Ergonomic Intervention on Work-Related Posture and Musculoskeletal Symptoms: A Systematic Review

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Abstract

Introduction: Office computer workers' sedentary lifestyles and improper posture increase the risk of musculoskeletal symptoms. Previous studies have conducted research regarding the effect of ergonomics on musculoskeletal symptoms, however, there is still some debate on which ergonomic interventions, either a combination of workstation adjustment and educational components or educational components alone give a positive effect on improving the posture and decreasing the musculoskeletal symptoms. **Objective:** This study was conducted to review the effects of ergonomic interventions; workstation adjustments, and/or educational components on work-related posture and musculoskeletal symptoms among office computer workers. **Method:** This review analysed articles from ScienceDirect, Taylor & Francis, The Cochrane Library, and PubMed between the year 2003 to 2023. The study screened articles, assessed eligibility using PICOS criteria, and assessed bias risk using RoB2 tools. The data was descriptively analysed. **Result:** Out of three studies that are included in this systematic review, two studies (one study on the effect of educational components alone; one study on the effect of workstation adjustment with educational components) showed a significant reduction in musculoskeletal symptoms, whilst another study (the effect of workstation adjustment with educational components) showed no significant effect on musculoskeletal symptoms. Besides, only one study (the effect of workstation adjustment with educational components) showed a positive effect on work-related posture. **Conclusion:** The result showed that there is a positive effect of ergonomic intervention on improving work-related posture and reducing musculoskeletal symptoms, however, it is still inconclusive due to the lack of studies being reviewed.

Keywords: Ergonomic Intervention, Workstation Adjustments, Educational Components, Posture, Musculoskeletal Symptoms

Introduction

Musculoskeletal symptoms are known as pain in the muscles, tendons, and nerves caused by repetitive, prolonged, and unnatural movement. As musculoskeletal disorders (MSDs) are among the most common occupational injuries and impairments in both developing and industrialized countries, the World Health Organization (WHO) has listed MSDs as the second most common work-related illness in 2013 (Safarian et al., 2018). Office computer work is one of the professions that contribute to musculoskeletal symptoms due to its nature of work. According to Calik et al. (2020), prolonged computer use in the workplace increases musculoskeletal issues among workers, with most experiencing problems after over 6 hours (Borhany et al., 2018). Lee et al. (2021) reported that prolonged use of computers with poor back posture, static neck position and repeated hand and wrist movements are common issues among office computer workers. Moreover, a lack of workplace ergonomics will eventually lead to musculoskeletal disease (Mansor et al., 2022).

Ergonomics is the study of adjusting jobs, equipment, and persons to one another for maximum safety and production (Mansor et al., 2022). It is essential to understand ergonomics to improve comfort and safety in the workplace. Ergonomic interventions include both

workstation adjustments and ergonomic training. These interventions involve rest breaks, physical activity, and adapting the workplace to the worker's anthropometric data. Workstation adjustments should be based on ergonomic recommendations, such as changing table height, chair height, screen height, and keyboard and mouse positions. Ergonomic training is also involved in this intervention, which includes workshops and follow-up educational programmes incorporating instructional videos, distributed pamphlets, and group activities. The education programme usually consists of customised email notifications. It is crucial to provide ergonomic training to workers to increase their understanding of workplace ergonomics and encourage them to apply this intervention in their work environment.

Amick et al. (2003) found that office ergonomic chairs and training resulted in less pain and discomfort during the workday compared to those who only received instruction or neither. Adjusting chair height and armrest with keyboard and mouse positions helps maintain neutral posture, reducing static muscular load and forearm flexor forces. A flexible back support allows for different torso positions while keeping hands in contact with the keyboard. This improves chair matching to upper body gravity, allowing for more reclining postures and less static strain on erector spinae. Lee et al. (2021) found that ergonomic intervention, including workstation adjustment, reduced neck, upper back, upper limb, shoulder, wrist, and hand pain, but not lower back and elbow pain.

Prolonged computer use in a sitting position can lead to musculoskeletal disorders and affect comfort and productivity. Lack of awareness about proper posture and neck and upper limb alignment can cause this issue to persist among office workers. Therefore, this study aims to reveal the effects of ergonomic interventions; workstation adjustment and/or education components on posture and musculoskeletal disorders among office computer workers.

Previous studies conducted by Esmaeilzadeh et al. (2012), Gerr et al. (2005) and Delshad et al. (2019) regarding the effect of ergonomics on musculoskeletal symptoms showed inconsistent results as some studies used both workstation adjustment and educational components as interventions, while some studies only used either one. Thus, the present study will systematically review the effect of ergonomic intervention, including workstation adjustment and/or education components on posture and musculoskeletal symptoms among office computer workers to improve their work performance and improve their comfort when performing their work.

Materials and Methods:

Study Design

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed in writing and reporting this systematic review. The steps applied in this guideline include identification, screening, eligibility, and included studies.

Identification

Online databases, which are PubMed, The Cochrane Library, Taylor & Francis and ScienceDirect were used in searching for the relevant articles. Boolean operators like 'AND' or 'OR' were applied. During the article's search, some keywords such as "ergonomic intervention", "workstation adjustment", "education", "posture" and "musculoskeletal symptoms" were used to identify relevant studies. The identified studies/articles then were recorded.

Screening

Relevant articles were screened to remove duplicate studies, and the remaining articles were flagged for inclusion. Then, the titles and abstracts of the remaining articles were screened based on the topic of this study to determine whether they should be retained or removed. Finally, the full texts of the selected articles were screened based on the inclusion and exclusion criteria presented in Table 1. The screening process including the reasons for the exclusion of articles and the number of articles remaining shown in Figure 1.

Table 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
• Studies involved office workers with prolonged computer use, aged between 18 to 60 years old. • Studies that used ergonomic intervention included adjustment of workstations and/or educational components. • Studies that report on the effect of ergonomic intervention on musculoskeletal disease throughout parts of the body include the neck, upper limb; shoulder, elbow, hand/wrist and back. • Studies with randomized control trial study design, which consist of control and experimental groups • Studies that have an initial assessment and follow up • Studies in which written in the English language • Studies listed from 2003 and above	• Studies only require the participant to fill out the questionnaire without giving any intervention to know the effect.

Eligibility Criteria

Article eligibility criteria were reviewed based on specific study characteristics; PICOS style, includes population, intervention, control, outcome, and study type. The PICOS criteria for this study are listed in Table 2.

Table 2: PICOS criteria

PICOS criteria	
Population (P)	Office workers with prolonged computer use
Intervention (I)	Ergonomic intervention; workstation adjustment and education
Control (C)	Other than workstation adjustment and education
Outcome (O)	Work-related posture and musculoskeletal symptoms
Study Design (S)	Randomized control trial study

Quality Assessment/ Risk of Bias

Before reporting the outcome, the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2) was used as a risk-of-bias assessment tool to obtain more precise and relevant results. This tool is relevant for assessing the risk of bias in randomized trials. This instrument included five domains, including: 1) randomization process, 2) deviations from planned interventions, 3) missing outcome data, 4) measurement of outcome and 5) selection of reported outcome.

Reporting Result/ Data Extraction

The information obtained from the selected articles was presented and tabulated in a table. The table consists of seven main components, including author/year, study design, risk of bias, participants, outcome measure, intervention, and study outcome.

Results:

Study Selection

In selecting the study, EndNote was used to store and organize the articles. Online databases were used to retrieve 394 articles, primarily from PubMed (n=41), The Cochrane Library (n=2), Taylor & Francis (n=39) and ScienceDirect (n=312). Three duplicate studies were identified and removed from the list, leaving 391 articles that were screened based on their title and abstract. After screening for the title and abstract, 373 articles were excluded because they were not related to this study. The remaining 18 articles were then evaluated according to the inclusion and exclusion criteria of this study. After the final screening, 15 articles were excluded, allowing the remaining 3 full-text articles to be included in this systematic review.

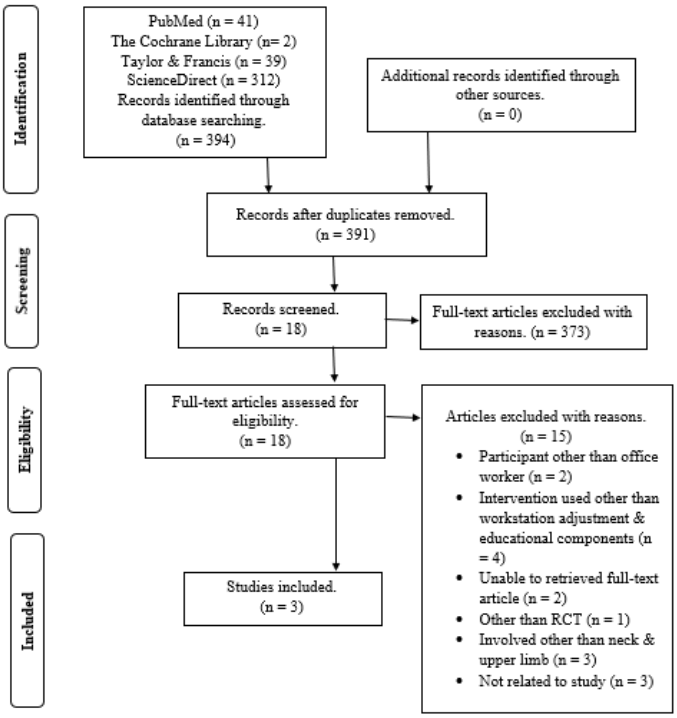

Figure 1: PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) flow diagram of each stage of the study selection

Description of Included Studies

Three articles were included in this study, and all the articles were randomized control trials (RCTs). The number of participants in these articles ranged from 87 to 375, and their ages ranged from 18 to 60 years old. All of them were office workers who used computers for prolonged periods; the time range was between 4 and 15 hours per day. Besides, the participants in the three articles had musculoskeletal symptoms at the beginning of the studies. In the study conducted by Esmailzadeh et al. (2012), the participant presented with musculoskeletal symptoms in the neck and upper extremities for which the VAS score was 3 within the past 12 months in the preliminary study, while in the study by Gerr et al. (2005), the participants were also presented with musculoskeletal symptoms in the neck, shoulder, and hand or arm for which the VAS score was less than 6. Other than that, the intervention used for these three articles were all ergonomic interventions; either the intervention includes both workstation adjustments and an education component like the study by Esmaeilzadeh et al. (2012) and Gerr et al. (2005) or the intervention that only include educational component alone like study by Delshad et al. (2019). The other characteristics include list of participants, interventions, outcome measures, and results were tabulated in Table 4.

Methodological Quality

The quality assessment of included studies was evaluated using RoB2: A revised Cochrane risk of bias tool for randomized trials and the result was reported in table 3. Based on the result, all the three articles were judged to have low risk of bias.

Table 3: Quality Assessment of Included Studies using RoB2

Study	Risk of Bias Domain					
	Domain 1: Bias due to randomisation	**Domain 2: Bias due to deviation from intended intervention**	**Domain 3: Bias due to missing data**	**Domain 4: Bias due to outcome measurement**	**Domain 5: Bias due to selection of reported result**	**Overall**
Delshad et al. (2019)	+	+	+	+	+	+
Esmaeilzadeh et al. (2012)	+	+	+	+	+	+
Gerr et al. (2005)	+	+	+	+	+	+

High Risk (×), Some Concern (-), Low Risk (+)

Discussion:

This systematic review reported three RCTs studies on the effects of ergonomic intervention on work-related posture and musculoskeletal symptoms among office computer workers. All participants in the three studies had musculoskeletal pain as symptoms that were assessed using VAS score. At the beginning of study, all participants are those with musculoskeletal pain. Participants in the studies by Esmailzadeh et al. (2012) and Gerr et al. (2005) were presented with musculoskeletal symptoms (neck and upper extremities) for which the VAS score was 3 and less than 6, respectively. However, the VAS score for participants' musculoskeletal pain was not stated at the beginning of the study that was conducted by Delshad et al. (2019).

Effect of Ergonomic Intervention on Musculoskeletal Symptoms

Out of three studies, two studies; Delshad et al. (2019) and Esmailzadeh et al. (2012) reported significant results of reduction in pain intensity while one study by Gerr et al. (2005) showed no significant pain reduction occurred throughout the study time range. Delshad et al. (2019) found that the participants from the intervention group who received workstation adjustment

and educational components such as presentation regarding ergonomic content and stretching practice did experience pain reduction after 6 months follow-up ($p < 0.001$) compared to the control group who did not receive any ergonomic intervention. Similarly, the study by Esmaeilzadeh et al. (2012) showed a significant reduction in intensity of pain at 6 months ($p < 0.001$) after receiving educational program (ergonomic training lesson) and ergonomic training brochure combine with workstation adjustment (based on OSHA recommendation) compared with the group who receive nothing. On the other hand, a study by Gerr et al. (2005) who also emphasized educational component such as discussion on proper posture combine with workstation adjustment (based on protective factor identified during preliminary analyses result from prospective study and recommendation by OSHA, NIOSH, and private industry) found no significant differences in the intensity of pain compared to non-intervention group.

The ineffectiveness of ergonomic intervention in reducing musculoskeletal symptoms among office computer workers may be due to presence of other factors that may trigger and make the symptoms become worsen. One of the factors include prolonged working hours per day which present in the participants involved in the study conducted by Gerr et al. (2005) where the time range of working hour was more than 15 hours compare to study by Delshad et al. (2019) who the worker spent only more than 4 hours and study by Esmaeilzadeh et al. (2012) only spent more than 3 hours. Park et al. (2022) in their study found that the chance of having musculoskeletal problems among workers who exposed to ergonomic risk factors steadily rose when working hours exceeded the typical hours of work which is more than 60 hours per week. Stanam et al. (2019) also found that the risk of getting musculoskeletal symptoms (neck pain, upper back pain, shoulder pain and wrist pain) increased as working hour using computer increased, with low exposure group (those working hour using computer < 4 hr/day) having a lower risk. Thus, it is proven that too prolonged working hours can increase risk of musculoskeletal symptoms, so the number of working hours per day must be considered to accurately measure the effect of ergonomic intervention.

According to Hoe et al. (2018), ergonomics refers to interactions among workers and other elements in the working environment, which includes physical, organisational and cognitive components thus this aspect has to be emphasized when doing an intervention to reduce risk of musculoskeletal symptoms among office workers. For organizational component treatment, it includes providing adequate workplace and rest time for the musculoskeletal system to recuperate from exhaustion, hence lowering the risk of long-term damage (Hoe etal., 2018). Thus, other than ergonomic intervention such as workstation adjustment and educational component, there are other factors that need to be emphasized such as the rest break as this factor might influence musculoskeletal symptoms. Putsa et al. (2022) has stated that office computer workers who work 150 min/week should take a break from extended sitting at work by shifting their posture from sitting to standing or walking every hour to avoid MSDs. Taking a break after 40 minutes of sedentary work with no body movement has been shown to be beneficial in altering muscle activity and relieving pain (Ding et al., 2020). As there is evidence that having a regular short rest break can reduce musculoskeletal symptoms, a combination between ergonomic interventions which is workstation adjustment and

educational components with having regular rest breaks by changing posture to standing and doing brief walking need to be emphasized.

Effect of Ergonomic Intervention on Work-Related Posture

For the effect of ergonomic intervention on posture, Esmaeilzadeh et al. (2012) found the intervention group had a significant reduction in postural abnormalities and improper equipment location after receiving educational program and workstation adjustment compared to the control group that were not given any intervention. However, the other two reviewed studies (Delshad et al., 2019 and Gerr et al., 2005) do not report the effect of ergonomic intervention on posture as their outcome. Thus, this shows that there is a lack of study evaluating the effects of ergonomic interventions on work-related posture, which causes further discussion of this issue could not be made.

There are few limitations that were found throughout this study. First, only a few articles were reviewed because there is still a lack of articles on RCT studies on the effects of ergonomic interventions on work-related posture and musculoskeletal symptoms. This limitation caused only one article in this systematic review that discussed the effects of ergonomic intervention on posture. Another limitation of this study was that only an instrument based on a questionnaire was used as a measurement for work-related posture, although there is a more advanced instrument to be used.

Conclusion:

This systematic review concluded that the positive effects of workstation adjustment and educational components of ergonomic intervention on improving work-related posture and reducing musculoskeletal symptoms are uncertain. Although there is a study that showed ergonomic intervention which includes workstation adjustment and educational components did improve the office worker posture, the evidence on this effect is still cannot be confirmed as only one RCT study analyzed work-related posture as an outcome. For the effects of workstation adjustment and/or educational component of ergonomic intervention on musculoskeletal symptoms, positive effect had been shown however, there is still uncertainty present as one of the studies that provide both workstation adjustment and educational component shows no significant reduction of musculoskeletal symptoms. Hence, a larger systematic review is needed to get an accurate outcome.

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Table 4: Characteristic of Included Studies

Author /Year	Study Design	Participants Inclusion criteria Study Setting	Intervention	Outcome measures	Results
Delshad et al. (2019)	RCT	Participants N=87 Inclusion criteria 1) Working in the SBUMS as an employee. 2) working with a computer > 4 hours/day as a job. 3) Being satisfied to be studied. Study setting Two health networks affiliated with Shahid Beheshti University of Medical Sciences (SBUMS) in Tehran, Iran.	Intervention group (n=44) • 1st session (120 minutes): Educational program regarding the musculoskeletal system, right posture, occupational factor causes skeletal pain, complication, and benefit of SE (lecture, slide shows, role playing). • 2nd session (120 minutes): Discuss ways to reduce barriers and improve self-efficiency to do SE (60 minutes) and practice SE for different muscles (60 minutes). - Provide CD (contain whole educational program). - Installation of autoregressive software application in all participant's computers (as reminder). - Recommended to do SE for 10-30mins/day, 2-5 days/week, up to 10 weeks.	Musculoskeletal symptoms • Pain – Visual Analog Scale (VAS) • SE behaviors - Stretching Exercise Predicting Scale (SEPS) All participants were evaluated 3 times (baseline, 3- and 6-month follow-up).	Musculoskeletal symptoms • Pain severity significantly less in Intervention group compared to Control group at 6-month follow-up ($p<0.001$) SEPS score significantly improve in Intervention group compared to Control group at 3- and 6-month follow-up ($p<0.001$), indicating Intervention group had better SE behavior after the educational program

			(1-5 reps of neck, shoulder, and back SE). Control group (n=43) Not receive any educational program.		
Esmaeilzadeh et al. (2021)	RCT	Participants N=94 Inclusion criteria 1) Age between 18 – 60 years. 2) Full time working status (> 40 hours/week) 3) at least 1 year tenure in current position. 4) Minimum 3 hours/day of computer work or 15 hours/week. 5) Present of musculoskeletal symptoms in neck and upper extremity within past 12 months (VAS: 3). Study setting	Intervention group (n=47) • 1st session (90 minutes): Ergonomic training lesson theoretical and practical. • 2nd session: Receiving ergonomic training brochure regarding risk factor and prevention of WUEMSDs, workstation adjustment and workplace exercises. • 3rd session: Workstation evaluation by investigator based on OSHA and teaching on adjusting workstation. - Every month postintervention - Same investigator will visit to evaluate the workstation and give encouragement for participant to maintain the workstation adjustment. Control group (n=47)	Posture • Body posture and workstation layout - Ergonomic Questionnaire Musculoskeletal symptoms • Intensity of symptoms - Visual Analog Scale (VAS) • Duration of symptoms – Based on 5 categories: (a) < 1 day, (b) 1-7 days, (c) 8-30 days, (d) >30 days (not every day) and (e) > 30 days (every day).	Posture • Postural abnormalities and improper equipment location significantly reduced in Intervention group compared to Control group with ($p < 0.001$) and ($p = 0.002$), respectively. Musculoskeletal symptoms • Intensity of symptoms reduced significantly in Intervention group compared with Control group at 6-month follow-up ($p < 0.001$). • Duration of symptoms reduced significantly in Intervention group compared with Control group at 6-month follow-up ($p < 0.001$).

		Istanbul University Istanbul Faculty of Medicine.	• Not receive any ergonomic intervention.	• Frequency of symptoms – During last 3 months, based on 6 categories: (a) never, (b) one episode, (c) 2-4 episodes, (d) 5-10 episodes, (e) > 10 episodes and (f) always symptomatic. All participants were evaluated 2 times (baseline and 6-month follow up).	• Frequency of symptoms reduced significantly in Intervention group compared with Control group (p = 0.009).
Gerr et al. (2005)	RCT	Participants N=375 Inclusion criteria 1) Use single computer workstation for ≥15 hours/week. 2) Using a computer	Group A: Alternate Intervention group (n=126) • Provide with workstation adjustment (based on protective factor identified during preliminary analyses result from prospective study). Group B: Conventional Intervention group (n=130)	Musculoskeletal symptoms • Pain – Visual Analog Scale (VAS) All participants report musculoskeletal symptom	Musculoskeletal Symptoms • No significant difference in time to symptoms for neck/shoulder among the three groups. • No significant difference in time to symptoms for hand/arm

	workstation as many hours/weeks during previous job. 3) VAS < 6 in both neck/shoulder and hand/arm. 4) Not taking any analgesic for current musculoskeletal symptoms. Study setting Metropolitan Atlanta, Georgia (USA).	• Provide with workstation adjustment (based on recommendations from OSHA, NIOSH and private history). * Group A and B receive adjustment of workstation which include: - adjustment of location of keyboard (to achieve required distance between "J" key and edge of desk) - provide masking tape that contains intervention position of keyboard at work surface as visual reference. - replacement and adjustment of chair height (to achieve required angle of shoulder flexion and different between elbow height and "J" key height) - adjustment of chair armrest (to support arm) * Group A and B received educational component which include: - Instruction regarding desire posture verbally and written.	in weekly diary using VAS score for 6 months.	among the three groups.

		- Individual discussion regarding the importance of maintaining required posture. * 3rd and 7th day postintervention – researcher visited workplace to check and make sure participant maintains the desired posture.
	Group C: No Intervention group (n=119) • Not receive any ergonomic intervention.	

Note: RCT = Randomized Control Trial, SE = Stretching Exercise, VAS = Visual Analog Scale, SEPS = Stretching Exercise Predicting Scale, WUEMSDs = Work-related Upper Limb Musculoskeletal Disorders, OSHA = Occupational Safety and Health Administration, UEFS = Upper Extremity Function Scale, HRQoL = Health Related Quality of Life, WUEMSS = Work-related Upper Extremity Musculoskeletal Symptoms, Rt = Right, Lt = Left, NIOSH = National Institute for Occupational Safety and Health