

# A SYSTEMATIC REVIEW OF ERGONOMIC RISK FACTORS ASSOCIATED WITH COMPUTER WORK-RELATED MUSCULOSKELETAL DISORDERS IN OFFICE WORKSTATIONS

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## Abstract

This review aims to give an overview of ergonomic risk factors associated with computer work-related musculoskeletal disorders in office workstations. Data from 1990 until 2015 was revised using electronic databases. The overview based on computer work, office risk factors, musculoskeletal disorders, working posture, office components and office environment. Epidemiologic studies show that physical exposure has a moderate and strong association with Computer Work-Related Musculoskeletal Disorders. Sixteen items of risk factors with significant associations with body part exposure outcomes were identified. Ergonomic risks factors involved awkward postures, repetitive movement, excessive force and office environment. This study describes recommended posture angles as well as appropriate distance between office workers and office equipment.

Keywords: ergonomic risk factors; computer work; musculoskeletal disorders; office workstation

## 1.0 INTRODUCTION

Ergonomic Risk Factors (ERFs) are considered as the main source of occupational injuries among workers such as discomfort in the neck, shoulders, spine, hands, fingers, legs and knees [1, 2]. In addition, injuries often caused by ERFs are Musculoskeletal Disorders, Cumulative Trauma Disorders (CTDs), Upper Limb Disorder (ULDs), and Repetitive Strain Injury (RSI) [3, 4].

Office work poses a high risk of musculoskeletal disorders (MSDs), with consequences for workers, employers and the society [5, 6]. Among the risk factors associated with MSDs are maintaining a static sitting posture for a long time and awkward postures of the head, neck and upper limb, wrist and forearm and repetitive movement of the fingers [7 – 9]. In addition, problems association with the eyes could also occur due to constant use of computers such as eye strain, blurriness, dryness and difficulty in focusing [10, 11]. This paper aims to give an overview of ergonomic risk factors associated with computer work related to musculoskeletal disorders in office workstations.

## 2.0 METHODS

### 2.1 Selection of Literature from Database

The selection of literature was conducted using electronic databases. The databases included ScienceDirect, Scopus, Malaysian Standard, British Standard, Google as well as Google scholar. The searches covered material from 1990 until 2015. The searches used a combination of terms related to observational methods for computer work using "OR" and "AND". The terms or keywords used were: methods based on computer work, office risk factors and musculoskeletal disorders, working posture, office components, office environment, awkward posture, repetition, and force.

### 2.2 Developing the evaluation criteria

The inclusion criteria used for this research included sample population such as computer users, office workers and customer service officers. Besides that, the exposure and outcomes of the risk factors related to computer work or office workstations (awkward posture, repetitive movement, and excessive force),

office components, and office environments) were identified.

### 2.3 Assessment of level of evidence and strength of association

The categorization for strength of association was done according to a method used by Hartvigsen *et al.*, [12]. Three categories of strength include nonstatistically significant positive association with Odd Ratio (OR<1.00) or called as low association. Moderate association with OR between 1.01 and 2.00. For third category is strong association where OR >2.00.

## 3.0 RESULTS AND DISCUSSION

Table 1 shows the epidemiologic studies of work-related musculoskeletal disorders in computer work. Epidemiologic studies evaluate the relationship between computer use and symptoms of WMSDs. About 10 papers were potential reference materials which included computer work case studies. Most of the studies are cross-sectional and longitudinal studies. For epidemiologic studies conducted on industrial populations, workplace factors are frequently assessed via questionnaires, job sampling methods, video analyses, or measurement of work posture and workstations to characterize exposure related to computer work use. The table showed the outcomes of Odd Ratio (OR) value.

### 3.1 Seat Pan / Chair

Choosing the suitable seat pan height is important because it carries the risk for office workers [7]. Seats too high will create pressure on the lower limb and when the feet is dangling it can cause contact stress to the back of the knees and soft tissue of the legs [23, 24]. If a seat is too low, this will cause greater flexion of the spine, leading to a backache and excessive pressure on the lower back [1, 7, 25]. Seat height is regarded as a neutral sitting posture when the knees bend about 90° and the feet contact to the floor [7, 23, 25].

The seat should have sufficient width and depth to support any user or worker comfortably. Usually, the design of the seat is horizontal, the seat depth is normally between 38cm to 42cm with a corresponding width of at least 45cm [1]. The seat width must be wider than the width of the hips and the thighs should be positioned approximately in a horizontal position and the lower legs vertical [26].

The office worker will suffer from musculoskeletal diseases if the back position during work is not proper [6, 26]. The chair needs to have a backrest to support the natural curve of the spine, again with special attention paid to properly support the lumbar region and allow the muscles to relax [6, 26]. To obtain good back support the chair should be able to recline between 95° to 110° [26, 27].

**Table 1** Epidemiologic studies of Work-related Musculoskeletal disorders in Computer work

References	Outcome Measures	Relative risk factor	OR
Blatter and Bongers [13]	An increasing duration of computer use was associated with WRULDs in any body region, neck or shoulder, and elbow, arm or wrist.	Any body region	1.95
		Neck or shoulder	1.88
		Elbow, arm or wrist	2.01
Jensen <i>et al.</i> , [14]	The duration of computer work was positively associated with symptoms in the neck, shoulder and hand.	Neck	1.92
		Shoulder	1.83
		Hand	2.76
Korhonen <i>et al.</i> , [15]	Poor physical work environment and poor placement of the keyboard increased the risk of neck pain	Neck pain	
		1) Physical work environment 2) Ergonomics of workstation	2.0 1.2
Juul-kristensen <i>et al.</i> , [16]	Frequency of intensity of low back pain (17-23 month)	Lower back	2.4
Cagnie <i>et al.</i> , [17]	Significant associations were found between neck pain and often holding the neck	Neck pain	
		1) Posture bent	2.01
		2) Sitting	2.06
		3) Same movement / min	1.68
N.Turhan. <i>et al.</i> , [18]	Questionnaire assessed pain in the upper body.	Fingers	3.40
		Wrist	1.47
		Forearm	1.90
		Elbows	5.81
		Shoulders	5.44
		Neck (females)	18.4
Lapointe <i>et al.</i> , [19]	6-month incidence of lower back symptoms	Low postural risk factors and high job strain	2.53
		High postural risk factors and low job strain	2.51
		High postural risk factors and high job strain	5.51
Angelo d'Ericco <i>et al.</i> , [20]	High prevalence of upper limb musculoskeletal symptoms was observed in call center workers	Neck	1.25
		Shoulder	-
		Elbow –	1.83
		Hand/wrist	1.34
		-	-
2.99			
Cho <i>et al.</i> , [21]	High psychological distress with shoulder and upper back pain, whereas high workload was associated with lower back	Shoulder	1.70
		Neck	1.55
		Upper back	1.61
		Lower back	1.89
Hanvold <i>et al.</i> , [22]	Neck and shoulder pain among young adults entering working life increase the tendency towards moderate.	1) Whole group	1.02
		2) Media/ design students	1.01
		3) Electrician/ hairdressers students	1.02

The armrest is part of a good chair design because it can support the muscular system of the neck and shoulders [26]. The good dimensions of armrest height are elbow supported at 90° and shoulders should be in a relaxed position [7, 25]. The angle for the armrest posture is between 70° and 135° and the height of armrest should be able to be adjusted accordingly [6, 7, 23, 26, 27].

### 3.2 Desk

The surface of the table should provide sufficient space to accommodate office equipment to be used at a workstation, prevent awkward posture and reduce energy consumption [6, 23]. A good desk design and corresponding adjusted should provide adequate relief to the feet of office workers to avoid high muscle activity with usual height of desk is 720mm [6, 23, 28].

### 3.3 Monitor

The most important to avoid eye complication and reduce ergonomic risk at neck and head, there need to considered the position and distance between eyes and monitor [23]. The distance of a computer monitor which is too close with worker can cause eye strain. If the distance is too far, the worker needs to bend forward to read the text and risk for trunk, and back [3]. Therefore, the height of the top line of the display should not be higher than the user's eye-height with an angular position of 15° and 35° horizontally [23, 26, 27].

### 3.4 Keyboard

The awkward posture and ergonomic risk of the wrist, and shoulder occurred when the position of the keyboard is too high or too low [7]. The neutral wrist angle during typing tasks should be less than 15° upward and downward to avoid wrist bent or flexion [29, 30]. Repetitive movements of the workers finger required during the typing activities is 38-40 per minute per finger [1, 27]. Excessive force occurs when the users press the keys on the keyboard [23].

### 3.5 Mouse

The mouse should be placed in suitable position of a line with shoulder and in a right next to keyboard. The size of the mouse accommodate the size of the hands of workers to avoid clutching that causes pressure on the wrist and the mouse easy to activate [6, 7]. Repetitive movements and excessive force occur when clicking the mouse and lead to fatigue in the muscle of the forearm [1, 4].

### 3.6 Accessories

The telephone should be placed within 300mm of the employee to eliminate the generality of reach. A

telephone headset should be provided to avoid the static contractions that occur at the neck and shoulders during telephone use [6, 7].

Document holders should be provided when the individual needs to refer the documents while interacting with the screen or keyboard [1, 23]. The document holder on the right hand side will minimise the pressure and amount of movement for the neck, head, back and eye when scanning [24, 26].

Wrist rest are a long section of gel-filled fabric intended to lie in front of the keyboard [23]. Using a wrist rests can maintain a straight wrist posture and reduce contact stress while typing or doing work using the mouse [3].

A footrest provided if the user's feet does not touch the floor once sitting on a chair or when the chair height is not adjustable to avoid the workers sit in uncomfortable condition [1, 6, 23, 24]. Besides that, footrests are the additional support for making a comfortable between leg and feet [26].

### 3.7 Office Environment

For computer work, use well-distributed diffuse light. Besides that, the illumination level at the computer workstation must be lower than that required in an ordinary office. If the illuminance level is high it may cause glare [23].

Temperature can be one of the problems for a computer workstation where the equipment used emits heat [1]. The range of effective temperature at an office should be between 20°C to 26°C for enhancing the efficiency and performance of office worker [1, 23, 24].

The accepted noise levels should not exceed 85dB (A). The sound levels should be kept as low as possible, such as 60dBA [1]. Noise level within an office depends not only on the loudness of a sound but also on the reverberation potential within the office area. The reverberation level affects people's perception of how noisy they find their office [23].

## 4.0 CONCLUSION

As a conclusion, the ergonomic risk factors for computer work studied from 1990 until 2015 were reviewed in this paper. Epidemiologic studies show that physical exposure has a moderate and strong association with Computer Work-Related Musculoskeletal Disorders through Odd Ratio (OR) value as shown in Table 1. Besides that, it was found the ergonomic risks involving awkward postures, repetitive processes, excessive force and office environments affect the ergonomic problems faced by office workers. This study describes recommended posture angles as well as appropriate distance between office workers and office equipment.

## Acknowledgement

This research is funded by the Ministry of Higher Education of Malaysia (MOHE) and Universiti Tun Hussein Onn Malaysia (UTHM) under the Fundamental Research Grant Scheme (FRGS, Vot 1475)

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