International Journal of Engineering & Technology, 7 (3.20) (2018) 30-34

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

A Review on Prevalence and Risk Factors of Musculoskeletal Disorders (Msds) Among VDT Users

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Abstract

This review aims to to identify the prevalence of computer work related to musculoskeletal disorders among Video Display Terminal users.The association between risk factors and musculoskeletal disorders was also identified. Data from 1990 until 2015 was retrieved using electronic databases. The review was done based on computer work, office risk factors, musculoskeletal disorders, working posture, office components and office environment. Epidemiology studies show that physical exposure has a moderate and to strong association with Computer Work-Related Musculoskeletal Disorders. Sixteen risk factors for office workstation swith significant associations with body part exposure outcomeswere identified. Through the studies, it was found that computer-related risk factors correspond with Musculoskeletal Disorders (MSDs) including awkward postures, long duration of computer use, work involving repetitive processes and the office environment

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

1. Introduction

Ergonomic Risk Factors (ERFs) are considered as the main source of occupational injuries among workers.

[1,2]. 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 or Visual Display Terminal(VDT) work poses a high risk of musculoskeletal disorders (MSDs) [5, 6].Computer users with long duration of computer use experienced more muscuosleteal symptoms compared to those whose used computer for a short duration [7,8]. Futhermore, in the review of VDT studies stated, VDT work indicated high prevalence of disorders in the neck, upper extremities and lower back of the body compared with non VDT-work [7-10]. 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 [11– 13]. In addition, problems associatied with the eyes could also occur due to constant use of computer such as eye strain, blurriness, dryness and difficulty in focusing[14,15]. Thus, this paper aims to identify the prevalence of computer work related to musculoskeletal disorders among VDT users. Besides that, the association between risk factors and musculoskeletal was also identified.

2. Methods

2.1 Selection of Literature from the Database

The selection of literature was conducted usingelectronic databases and publications. The databases included ScienceDirect, Scopus, Malaysian Standard, British Standard, Google and 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(chair, desk, keyboard, mouse, monitor, telephone, document holder, and wrist rest), office environment (lighting, noise, temperature, awkward posture, repetition, and force. Exactly 115 journal articles and review reports were screened by M.S.S. and R.M.N.A as shown in Figure 1.

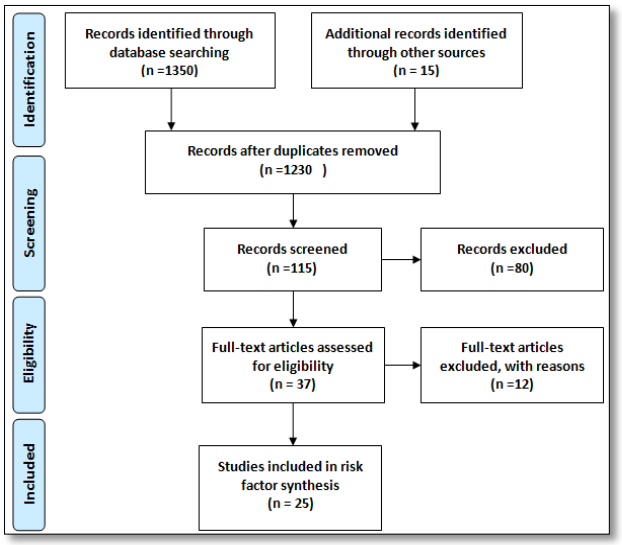

Figure 1 Flow diagram of study selection process

2.2 Developing the Evaluation Criteria

The evaluation criteria for these review methods were developed by the researchers. 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 outcoms of risk factors related to office workstations (physical factors, 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 Hemingway & Marmot and Hartvigsen*et al.*, [16, 17]. Three categories of strength include low significant positive association with ($p>0.05$) or Odd Ratio ($OR<1.00$) or 95% of Confidence Interval (95% CI $\leq$ 1.00), moderate association ($1.01<OR<2.00$ or $0.01<p<0.05$) and strong association where $OR >2.00$ or ($p<0.01$).

3. Results and Discussions

Table 1 shows the the summary of 10 studies of risk factors for computer work-related musculoskeletal disorders. These studies evaluate the relationship between computer use and symptoms of Work-related Musculoskeletal Disorders (WMSDs). Most of the studies are cross-sectional and longitudinal studies. The studies have been conducted on industrial populations. Workplace factors were 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 outcomesofOdd Ratio (OR)and 95% Confidence Interval (CI).

From the review, the risk factors for office workstations were divided into two domains and sixteen items were identified as shown in Figure 2and Table 2. About 67 documents fit the criteria and about 15 papers were potential reference materials based on the guidelines. The domains identified consist of office components (body part, repetition, and force) and office environments

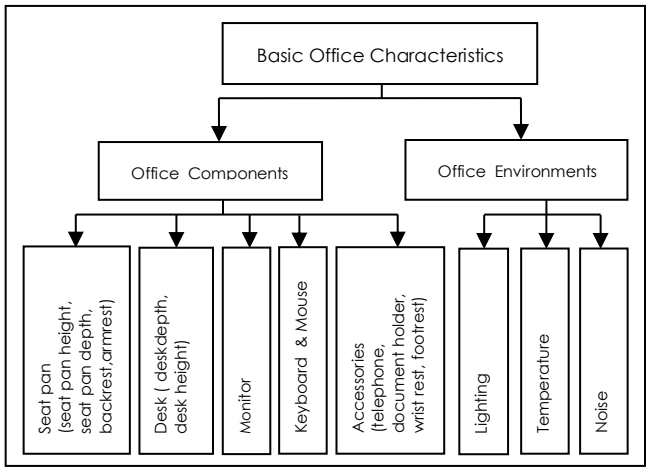

Figure 2 Characteristics of office components and nvironment

Table 1 Summary of 10 studies on risk factors for computer work-related MSDs.

References	Study designs	Study Population	Outcome Measures	Significant risk factor observed	Body Area	OR	95% CI
Blatter and Bongers [9]	Cross-sectional	5400 office employees	An increasing duration of computer use was associated with Work-related Upper Limb Disorders (WRULDs).	Employees working with computers more than 6h/day	Anybody region	1.95	1.61-2.36
					Neck or shoulder	1.88	1.48-2.38
					Elbow, arm or wrist	2.01	1.28-3.15
Jensen et al., [10]	Cross-sectional	11 Danish companies and institutions (n=5033 employees)	The duration of computer work was positively associated with symptoms in the neck, shoulder and hand.	Full-time working employees	Neck	1.92	1.21-3.02
					Shoulder	1.83	1.13-2.95
					Hand	2.76	1.51-5.06
Korhonen et al., [18]	Longitudinal	Three administrations units in Finland (n=515).	Poor physical work environment and poor placement of the keyboard increased the risk of neck pain	Physical work environment	Neck	1.2-1.4	1.0-3.9
				Ergonomics of office workstation	Neck	1.0-1.9	0.4-3.9
Juul-kristensen et al., [19]	Cross-sectional	Office workers in Denmark (n=3475)	Frequency of intensity of low back pain (17-23 month)		Lower back	2.4	1.70-3.39
Cagnie et al., [20]	Cross-sectional	Office workers in ten companies in	Significant associations were found between neck pain	Posture bent	Neck	2.01	1.20-3.38
				Sitting	Neck	2.06	1.17-3.62

		Belgium N=720	and often holding the neck	Same movement/ min	Neck	1.68	1.02-2.76
N.Turhan. et al., [21]	Longitudinal	N=173 operators (14 males and 159 females)	Thirty six percent of workers had chronic pain in at least one region of the upper body.	Workstation and workload	Fingers	3.40	1.05-10.99
					Wrist	1.47	1.11-1.96
					Forearm	1.90	1.20-3.04
					Elbows	5.81	1.61-20.94
					Shoulders	5.44	1.46-20.28
					Neck	18.4	2.18-151.8
Lapointe et al., [22]	Cross-sectional	White-collar workers at 3 large public services organizations in Quebec City, Canada (n=2431)	6-month incidence of lower back symptoms	Low postural risk factors and high job strain	lower back	2.53	1.09-5.85
				High postural risk factors and low job strain	lower back	2.51	1.23-5.09
				High postural risk factors and high job strain	lower back	5.51	2.33-13.03
Angelo d'Ericco et al., [23]	Cross-sectional	Seven call centers in Turin area (n=775 workers)	High prevalence of upper limb musculoskeletal symptoms	Full time call center worker	Neck and Shoulder	1.25-1.83	0.98-2.16
					Elbow Hand/wrist	1.34-2.99	0.73-7.79
Cho et al., [24]	Longitudinal	3 companies and 1 university (n=254 subjects)	High psychological distress with shoulder and upper back pain, whereas high workload was associated with lower back.	Psychological distress	Shoulder	3.46	1.38-8.64
					Neck	2.08	0.94-4.63
					Upper back	2.24	1.15-4.74
					Lower back	1.47	0.77-2.78
				Workload	Shoulder	1.70	0.91-3.18
					Neck	1.55	0.84-2.88
					Upper back	1.61	0.91-2.84
					Lower back	1.89	1.07-3.36
Hanvold et al., [25]	Longitudinal	135 media/ Design students 167 students hairdressers, 118 student electricians,	Neck and shoulder pain among young adults entering working life increase the tendency towards moderate /severe pain levels	Whole group	Neck and Shoulder	1.02	1.01-1.03
				Media/ design students		1.01	1.00-1.02
				Electrician/ hairdressers students		1.02	1.01-1.03

Table 2 Summary of Risk Factors of Office Workstations

Domain	Items	References	Risk Outcomes	Body Area
Office Components	Seat pan height	Kroemer et al.,[1]; Sonne et al., [11]; McKeown, [26]; Mirzae et al.,[27]; BS 3044[28]	Seats which are too high will create pressure on lower limbs. Seats which are too low cause greater flexion of the spine, leading to backache and may put excessive pressure on the lower back	Spine and lower back
			Seated with the feet dangling or sitting on one foot caused contact stress to the back of the knees and soft tissue of the legs	Knees and legs
	Seat pan width	Kroemer et al.,[1]; MS ISO 9241-5 [29]	The seat width must be wider than the width of the hips and the thighs positioned approximately in a horizontal position and the lower legs vertical	Thigh and leg
	Backrest	M.Roberston et al., [14]	Suffer from musculoskeletal diseases if the back posture when performing the task or sitting at work is not proper	Back
	Armrest	Sonne et al., [11]; McKeown, [26]; MS ISO 9241-5 [29]	Support the muscular system of neck and shoulder.	Neck,shoulder
			Reduce risk for arm region and provide comfort for users' arms	Arm
	Desk depth	OSHA [6]; McKeown, [26];	Provide sufficient space to prevent awkward hand posture and reduce energy consumption.	Hand
	Desk height	OSHA [6];McKeown, [26];BS EN 527-1[31]	Provide adequate relief to the feet of office workers and avoid high muscle activity	Feet
	Monitor	Shikdar & Al-Kindi [32]; Delleman et al., [33]	Distance of the monitor and the eyes is too close and causes eye strain	Eye
			Screen height relevant for the musculoskeletal system of head, neck and shoulder	Head, neck, shoulder
	Keyboard	Sonne et al., [7]; Shikdar & Al-Kindi[30]	The awkward posture of the wrist, arm and shoulder may occur when the the keyboard is too high or too low.	Wrist, arm and shoulder
	Mouse	Kroemer et al.,[1]; Wahlstrom [4]; OSHA [6];Sonne et al., [11];Tint et al.,[37]	The size of the mouse is able to accommodate the size of the workers' hands to avoid clutching which causes pressure on the wrist.	Hand and wrist
			Clicking the mouse leads to fatigue in forearm muscles	Forearm
	Telephone	OSHA [6]; Sonne et al., [11]	The telephone can cause awkward posture – static contractions that occur at the neck and shoulder.	Neck and shoulder
	Document Holder	Kroemer et al.,[1]; McKeown,[26]; Mirzae et al.,[27]; MS ISO 9241-5 [29]	Prevent the neck and head of the workers from bending excessively. Prevent eye strain when the individual is referring to documents while interacting with the computer screen and keyboard.	Neck and head, Eye

	Footrest	OSHA [6]; Mirzae et al.,[25]; MS ISO 9241-5 [27]	Additional support for user's feet when feet do not touch the floor even when user is in a seated position.	Leg and feet
	Wrist rest	Clifton et al., [3]	Wrist rest can help maintain a straight wrist posture and reduce contact stress while typing or clicking mouse.	Wrist
Office Environment	Lighting	McKeown, [26];	Illumination or lighting level at the computer workstation must be lower than that required in an ordinary office. If it is high it may cause glare.	
	Temperature	Kroemer et al.,[1]; McKeown, [26]	Temperature can be one of the problems for a computer workstation where the equipment emits heat.	
	Noise	McKeown, [26]	Reverberation level affects people's perception of how noisy they find their office.	

From the studies, the workers working with computer for about 6 to 8 h/day were moderately associated with neck symptoms (OR=1.92, CI:1.21-3.02) and shoulder symptoms (OR=1.83, CI:1.13-2.95) among women and strongly associated with hand symptoms (OR=2.76, CI:1.51-5.06) among men [10]**.** Studies showed increase in upper body problems occuring among those working for longer hours on a computer [7,9] Besides that, many studies reported increase prevalence of neck and shoulder pain among VDU workers working under improper working conditions such as inadequate lighting, uncomfortable chairs and lack of wrist support [7,12,21,23]. Inappropriate placement of the screen, keyboard, mouse and telephone at workstations, have been associated with musculoskeletal problems [18].

3.1 Seat Pan / Chair

From the studies, chairs were found to be associated with musculoskeletal disorders particularly for the upper limb area such as back, shoulder, elbow, hand/wrist and neck (OR=1.2-18.40, 95%CI=0.6-151.8)[9-10, 18-23]. Besides that, workers who work in a sitting position have a twice the risk neck pain compared to workers who are not always sitting [20]. Therefore, the idea seat height is regarded as a neutral sitting posture where the knees bend about 90° (feet reach the floor)to avoid MSDs [11, 26, 28]. Besides that, the seat should have sufficient width and depth to support any user or worker comfortably [1]. Lapointe *et al.,[*22] stated, that white-collared workers are strongly associated with lower back symptoms (OR=2.51-5.53, 95%CI=1.09-13.03). Therefore, chairs need 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, 29]. Besides that, the studies found that lower back pain could be caused by the absence of adjustable backrests office chairs [24]. The armrest is part of a good chair design because it can support the muscular system of the neck and shoulders [30]. The ideal armrest allows the elbow to be supported at 90° where as the shoulders should be in a relaxed position[11, 28]

3.2 Desk

The surface of the table should provide sufficient space to accommodate office equipment used at a workstation. This prevent a awkward posture and reduces energy consumption [6, 26]**.** Insufficient working space has been consistently associated with increased risk of symptoms in the elbow-wrist/hand region(OR=1.78, 95%CI=1.15-2.76)[23].

3.3 Monitor

The studies show that visual discomfort and musculoskeletal strains, especially in the neck and shoulder area, are associated with computer height (OR=1.5, 95%CI=0.7-3.1)[18]. Therefore, the height of the top line of the display should not be higher than the user's eye level with an angular position of15° and 35° horizontally[26, 29, 30].

3.4 Keyboard and Mouse

Jensen *et al.,[*10] discovered that the keyboard has a strong association with musculoskeletal disorders [OR=2.1] for hands/wrists when workers type for about 6-8 h/day. Typing activity is cited as a risk factor associated with Cumulative Trauma Disorders, neck tension and tendon inflammations[21]. So, a neutral wrist angle should be less than 15° upward and downward. If wrist is bent more than 15°, it is considered as a wrist bend or flexion [4, 24, 27, 32-34]. Blatter *et al.,[*9] found a slight significant association between mouse use of 6-8 h/day and arm, elbow or wrist/hand disorders (OR=1.51, CI:0.65-3.53). In addition, location of the mouse is related with the design of keyboard and it may affect the shoulder and arm posture[18]. The mouse should be placed in a suitable position aligned with the users' shoulders and located right next to keyboard (to avoid reach)[6,11].

3.5Accessories

A telephone headset should be provided to avoid static contractions that occur at the neck and shoulders during telephone use [6,11]. Document holders should be provided when workers need to refer to documents while interacting with the screen or keyboard[1,26]. Cagnie *et al.,[*20] stated that, neck pain is significantly associated with neck in a forward bent posture after making the same movement per minute (OR=1.63, 95% CI=1.02-2.60). Thus, a document holder on the right hand side will minimise the pressure and amount of movement for the neck, head, back and eyes when scanning [27, 29]. Lack of forearm support has been associated with and increase in ulnar deviation of the wrist, also known as risk factor for hand/wrist disorders (OR=1.63, 95% CI=1.10-2.43)[23].Using a wrist rest can maintain a straight wrist posture and reduce contact stress while typing or doing work using the mouse [3]. A footrest should be provided if the user's feet do not touch the floor once they sit ona chair [6, 27].

3.6 Office Environment

According to Korhonen et al., [18] physical work environment / office environment are positively associated with the outcomes as follows: lighting (OR=1.4, 95%CI 0.7 to 2.8), temperature (OR=1.2, 95%CI 0.6 to 2.4), and noise condition (OR=1.4, 95%CI 0.7 to 2.8). Lighting condition are important for the reduction of visual discomfort for VDU work.In addition, poor lighting increases the risk of neck sympyoms among VDU users [23]. The ideal temperature for an office is between 20°C to 26°C [1, 26, 27]. The sound levels at an office should be kept as low as possible [1].

4. Conclusion

In summary, the studies show that physical exposure has a moderate to strong association with Computer Work-Related Musculoskeletal Disorder through 95 % Cofidential Interval (CI) and odd ratio (OR) value as shown in Table 1.Through the studies, it was found that computer-related risk factors have a consistent relationship with Musculoskeletal Disorders (MSDs) including awkward postures, long duration of computer use, work involving repetitive processes and the office environment. Besides that, it was found that VDT work resulted in a higher prevalence of disorders in the neck, upper extremities and lower back of the body comparef to non-VDT work

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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