A COMPUTING TASK ERGONOMIC RISK ASSESSMENT TOOL FOR ASSESSING RISK FACTORS OF WORK RELATED MUSCULOSKELETAL DISORDERS

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Dedicate this especially to beloved family and my friends.

The encouragement and the sacrifices that given etched in the hearts

Forever

Thank you for the support that has been given

Will be remembered the sacrifices that given to the end of life

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ABSTRACT

Observation method remains to be the most widely applied method in assessing exposure to risk factors for work-related musculoskeletal disorders (WMSDs) related to office works because it is inexpensive and applicable to wide range of office jobs. However, the existing research that applied this method was mainly focused to a limited range of office components and computer accessories such as seat pan, keyboards, mouse, monitor and telephone. In addition, further testing of reliability and validity of the observational method was less reported. This study was conducted to propose the new office ergonomic risk assessment (OFFERA) method to assess a wide range of office risk factors related to WMSDs, which include office components and office environment where this method covers both right and left side of the body part. The initial development of OFFERA method was divided into two stages, the development of OFFERA system components and psychometric properties of OFFERA method. In reliability testing, the results of inter and intra observer reliability recorded good (K=0.62-0.78) and very good (K=0.81-0.96) agreement among the observers. Meanwhile, in validity testing, the relationship of the final score of OFFERA to the musculoskeletal symptoms statistically shows a significant value for wrists/hands (χ^2=7.942; p=0.047), lower back (χ^2=13.478; p=0.000), knees (χ^2=7.001; p=0.008), and ankle/leg (χ^2=5.098; p=0.024). The usability testing shows that the OFFERA method was easy and quick to be used (mean 4.48 ± 0.821) and applicable for wide range of office working activities (mean 4.02 ± 0.952). Based on the results obtained, it can be concluded that the OFFERA method was found to be practically reliable and applicable for wide range of office work-related activities.

ABSTRAK

Kaedah pemerhatian kekal menjadi kaedah yang paling banyak digunakan untuk menaksir faktor risiko pendedahan terhadap *Work-Related Musculoskeletal Disorders (WMSDs)* yang berkaitan dengan kerja-kerja di pejabat kerana ianya merupakan kaedah yang murah dan dapat digunakan untuk kelompok kerja pejabat yang meluas. Namun, penyelidikan sedia ada yang menggunakan kaedah ini kebanyakkan menjurus kepada barangan pejabat dan aksesori komputer yang terhad seperti *seat pan*, papan kekunci, tetikus, monitor dan telefon. Tambahan pula, ujian mendalam mengenai kebolehpercayaan dan kesahan kaedah pemerhatian tidak banyak dilaporkan. Kajian ini dijalankan untuk mengusulkan kaedah yang baru iaitu *Office Ergonomic Risk Assessment* (OFFERA) untuk menaksir kelompok besar faktor risiko di pejabat yang berkaitan dengan WMSDs, termasuk komponen dan persekitaran pejabar, di mana kaedah ini merangkumi kedua-dua belah bahagian badan. Pembangunan awal kaedah OFFERA ini dibahagikan kepada dua peringkat, iaitu perkembangan sistem komponen OFFERA dan ciri psikometrik kaedah OFFERA. Dalam ujian kebolehpercayaan, keputusan kebolehpercayaan inter dan intra pemerhati menunjukkan persetujuan yang baik (K=0.62-0.78) dan sangat baik (K=0.81-0.96) dalam kalangan pemerhati. Manakala dalam ujian kesahan, hubungkait antara markah akhir OFFERA dengan simptom muskuloskeletal menunjukkan statistik yang jelas untuk lengan/tangan (χ^2=7.942; p=0.047), bawah belakang (χ^2=13.478; p=0.000), lutut (χ^2=7.001; p=0.008), and buku lali/kaki (χ^2=5.098; p=0.024). Ujian kebolehgunaan menunjukkan bahawa kaedah OFFERA mudah dan cepat untuk digunakan (min 4.48 ± 0.821), dan ianya boleh digunapakai untuk kelompok aktiviti kerja pejabat yang luas (min 4.02 ± 0.952). Berdasarkan keputusan yang dicapai, ia boleh disimpulkan bahawa kaedah OFFERA terbukti boleh dikatakan dipercayai dan boleh digunakan untuk kelompok kerja pejabat yang lebih luas.

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LIST OF SYMBOLS AND ABBREVIATIONS

p	-	Probability Level
χ	-	Chi-square test
K	-	Cohen Kappa Coefficient
X	-	Mean
%	-	Percentage
AEC	-	Appropriate Ergonomic Configuration
ANSI	-	American National Standards Institute
ART	-	Assessment of Repetitive Tasks
CCOHS	-	Canadian Centre of Occupational Health and Safety
CI	-	Confidence Interval
CTDs	-	Cumulative Trauma Disorders
ERFs	-	Ergonomic Risk Factors
MSDs	-	Musculoskeletal Disorders
NMDQ	-	Nordic musculoskeletal disorders questionnaire
OEA	-	Office Ergonomic Assessment
OFFERA	-	Office Ergonomic Risk Assessment
OR	-	Odd Ratio
OSHA	-	Occupational Safety and Health Administration
OWAS	-	Ovako Working Posture System
QEC	-	Quick Exposure Checklist
REBA	-	Rapid Entire Body Assessment
ROSA	-	Rapid Office Strain Assessment
RSI	-	Repetitive Strain Injury
RULA	-	Rapid Upper Limb Assessment
SD	-	Standard Deviation
SPSS	-	Statistical Package for Social Sciences
SOCSO	-	Social Security Organization

TO	-	Training Outcome
ULDs	-	Upper Limb Disorder
UTHM	-	Universiti Tun Hussein Onn Malaysia
VDU	-	Visual Display Unit
VDT	-	Visual Display Terminal
WMSDs	-	Work-related Musculoskeletal Disorders
WRULDs		Work-Related Upper Limb Disorders

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Work-related musculoskeletal disorders (WMSDs) are injuries or dysfunctions affecting the nerves, tendons, muscles, and joints that cause discomfort, pain, swelling, numbness, and fatigue among workers (Tittiranonda *et al.,* 1999; Piligian *et al.,* 2000; da Costa and Vieira, 2010). Work-related musculoskeletal disorders (WMSDs) are common health problems experienced by the workers and have long been a major cause of suffering in many countries (Benard, 1997; Kuorinko 1998; Chiasson *et al.,* 2012; Rahman *et al.*, 2012). WMSDs usually occur when the cumulative damage caused by the over exposure of the physical, individual, psychosocial, and organizational risk factors related to the workplace (Wahlstrom, 2005; Waersted *et al.,* 2010). Physical risk factors are the exposure to the physical demands while performing task including awkward posture, forceful exertions, repetitive actions, contact stress, prolonged sitting and standing, and prolonged task (Punnet & Wegman, 2004; da Costa & Vieira, 2010). Generally, musculoskeletal disorders are associated with an upper limb, head and neck and back posture (Gerr *et al.,* 2002; Jensen *et al.,* 2002; Korhonen *et al.,* 2003; Wahlstrom, 2005). Over the past few years, work-related musculoskeletal disorders (WMSDs) among office workers have increased mainly due to the frequent use of computer at workstations (Buckle & Devereux, 2002; Gerr *et al.,* 2004).

According to the statistics reported by Social Security Organization (SOCSO), musculoskeletal disorders (MSDs) are one of the most common occupational diseases in Malaysia at 15% compare to other diseases (SOCSO, 2006).

The prevalence of reported work-related musculoskeletal pain is seen to be on the rise in Malaysia. Malaysia Institute of Occupational Safety and Health Organization has recorded a ten-fold rise in cases of musculoskeletal pain, a total number of 194 cases in 2012, compared to only 16 cases in 2016 (NIOSH, 2012). Musculoskeletal disorders (MSDs) provide a risk to office workers and computer users where soft tissue injuries may affect the neck, shoulders, elbows, hands, wrists, and fingers. Moreover, there were two types of MSDs associated with computer users and office workers which include the carpal tunnel syndrome (CTs) and tendonitis (Tittiranonda *et al.,* 1999; Chiasson *et al.,* 2012). The main factors that lead to MSDs among office workers and computer users include prolonged static seating posture, awkward posture of the head, neck and upper limbs, repetitive movement of the wrist and fingers (Village *et al.,* 2005; Loghmani *et al.,* 2013; Sonne *et al.,* 2012), increasing of muscular activity at the upper back and shoulder, as well as the pressure due to heavy workload (Punnet & Wegman, 2004). Besides, computer users often faced health problems related to MSDs caused by the inappropriate posture and movement retained throughout a long period of working hours (Robertson *et al.,* 2009; Chaiklieng & Krusun, 2015; Matos & Pedro, 2015; Poochada & Chaiklieng, 2015). Most office components such as chairs, desks, keyboards, mouse and telephones exert certain risks to office workers (Amell & Kumar, 2000; Cook *et al.,* 2000; Ferreira & Saldiva, 2002). In fact, several studies suggested that the increased prevalence of muscle symptoms is associated with the frequently used of the computer mouse (Jensen *et al.,* 2002). In addition, problems associated with the eyes could also occur due to the worker's behaviour of focusing on the monitor for a long time. This consequently results in visual discomfort and symptoms such as eye strain, blurriness, dryness, and difficult to focus while using the monitor (Amick *et al.,* 2012; Robertson *et al.,* 2013).

Several ergonomic risk assessment tools have been developed to assess the working posture in order to assess the risk factors of WMSDs (Eyal *et al.,* 2012, Rahman and Mohamad, 2017). Ergonomic risk assessment tool has been used to analyse the ergonomic risk especially among employees working in an awkward posture, repetitive actions or forceful exertion (McAtamney and Corlett, 1993; Hignett and McAtamney, 2000; Sonne *et al.,* 2012). Seven ergonomic risk assessment tools have been widely used for WMSDs related to office workstation between the year 1992 until 2015 including Rapid Upper Limb Assessment (RULA)

(McAtamney and Corlett, 1993); Rapid Entire Body Assessment (REBA) (Hignett and McAtamney, 2000); Computer Workstation e-Tool (OSHA, 2003); Quick Exposure Checklist (QEC) (David *et al.*, 2008); Assessment of Repetition Tasks (ART) (Ferreira *et al.*, 2009); Office Ergonomic Assessment (OEA) (Robertson *et al.*, 2009); and Rapid Office Strain Assessment (ROSA) (Sonne *et al.*, 2012).

1.2 Problem Statement

The pen-and-paper based observational method is a one of the existing method for assessing the exposure to the risk factors associated with WMSDs related to office works. This method is less expensive to be carried out and is more practical to be used in a wide range of workplaces so that the postural assessment can be made without disrupting the workers (Li and Buckle, 1999; David *et al.*, 2005; Burdorf, 2010). It is necessary to assess a wide range of office risk factors candidate including administrative assistant, accountant, and research assistant.

However, the existing tools only covered limited range of office components and computer accessories among computer users or office workers, including the office components (seat pan height, seat pan depth, backrest, armrest, desk depth, desk height, monitor, keyboard, mouse, telephone, document holder, keyboard wrist rest, and mouse wrist rest) and office environment (lighting, temperature, and noise). ROSA tool was also lacking in parameters to assess the office workstation such as work area (desk) and the environment (lighting, temperature, and noise) (Sonne *et al.*, 2012). As an example, RULA and REBA tools were used to assess the worker's interaction with a computer in the office. Nevertheless, the ergonomic risks among office workers cannot be properly identified using RULA or REBA since the assessment tool was not specific for office environment (McAtamney and Corlett, 1993; Hignett and McAtamney, 2000).

In addition, the most important part in developing a tool is to validate the exposure assessment techniques. However, a few of the existing observational methods did not assess their reliability and validity there are (Computer Workstation e-tool, Office Ergonomic Assessment (OEA), Ergonomic Checklist for Computer (VDT)). Based on the reliability and validity previously studied, only four tools were found to have examined both testing which are RULA, REBA, QEC, and ROSA.

The lacking of validity and reliability leads to poor performance of exposure assessment tool (David, 2005; Burdorf, 2010; Takala *et al.*, 2010). Besides, the existing methods did not cover the right and the left side of the body part. Most of the methods can only assess the right and left side region separately where there was no methods available to combine these scores or data (Takala *et al.*, 2010).

Therefore, this research aims to develop a new type of office ergonomic risk assessment tool that covers the wide range of risk factors among office work which include office components and office environment associated with WMSDs and covers both right and left side of the body part. Other than that, this research also establishes the reliability and validity of the tool during the development process.

1.3 Objective of the study

The main objectives of this study are:

i. To develop a new office ergonomic risk assessment (OFFERA) method in assessing the risk factors of work-related musculoskeletal disorders (WMSDs) related to office works.
ii. To evaluate the inter and intra observer reliability of OFFERA method.
iii. To establish the concurrent validity analysis of OFFERA method.

1.4 Scope of the study

The scopes of this study are:

i. Pen-and-paper based observational method was used to develop OFFERA method.
ii. OFFERA method focused on the sitting computing work only (not assessed for standing computer work).
iii. The risk factors of OFFERA method covered office components (seat pan height, seat pan depth, backrest, armrest, desk height, working area, monitor position, monitor distance/screen distance, keyboard, mouse position, mouse size, telephone position, document holder, keyboard wrist rest, and mouse wrist rest) and environment (lighting, temperature, and noise).

iv. OFFERA method assessed for computing works only, not for other jobs such as photocopying, document binding, etc.

v. OFFERA method assessed physical factors only (individual and psychosocial are excluded)

vi. OFFERA method covered both right and left side of the body part.

vii. The selection items of the risk factor were based on the strength of association (Odd Ratio (OR) and 95% Confident Interval (CI) value)

viii. The development of a scoring system for OFFERA method using the summation score of weighted item scores.

ix. Inter and intra observer reliability was used to assess the reliability testing of OFFERA method.

x. The training for inter and intra observer reliability was conducted by non-expert (undergraduate student of Mechanical Engineering from UTHM)

xi. Three different jobs including administrative counter, accountant, and a research assistant have been assessed using OFFERA method in order to determine the reliability

xii. Cohen's Kappa coefficient was used to assess the level of agreement for inter- and intra- observer reliability using 18 items of the OFFERA risk factors.

xiii. Concurrent validity was used to assess the validity testing's of the OFFERA method.

xiv. The sample size for validity testing is 108 selected among office workers.

1.5 Significance of the study

The proposed method for this study contributed to the new knowledge of method in the ergonomic risk assessment tools. This is because; the lack in well-designed existing techniques is a primary issue for epidemiological studies on work-related musculoskeletal disorders (WMSDs) among office workers (Burdorf, 2010; Takala *et al.,* 2010). Previous studies show that no tools have been developed to cover all of the office risk factors of WMSDs and to carry out the reliability and validity studies during the development process of the tool.

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