INVESTIGATION ON MUSCULOSKELETAL DISORDERS AMONG OFFICE WORKERS IN PUTRAJAYA

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ABSTRACT

Majority of office workers are sedentary and generally work in sitting position for much of the day and it is common for office workers to sit for more than 30 minutes at a time. Due to the above routine and activities it may cause musculoskeletal stress on different body regions of seated workers and is a major factor in development of musculoskeletal disorders (MSDs). Therefore, the aim of the study is to identify level of MSDs risk and the prevalence MSDs among office workers and to observe the knowledge and behavior. A study was done among 60 workers by using questionnaire survey and Nordic Musculoskeletal Questionnaires (NMQ) and another 20 workers by using Rapid Upper Limb Assessment (RULA). Statistical analyses were performed using the Statistical Package for the Social Sciences software using Spearman Correlation and Chi-square tests. From the analysis, it was found that knowledge on proper posture demonstrated significant association with the MSDs symptoms (χ^2=0.014) and were identified as one of the factors that lead to MSDs. The results of the NMQ revealed that that shoulder, upper back, lower back and neck were the most prevalent problems reported by office workers. Repetition, awkward postures or long-term static postures are considered the principal physical work-related risk factors in relation to MSDs. There is no relationship between gender, age, education level and frequency of exercise with the symptoms of MSDs. However, age was found to have a positive correlation with the MSDs symptoms. Finally, the RULA final score was 4 (low risk) indicating that further investigation is needed and change of posture may be required. The wrist and trunk are the most significant impact of body region at sitting position. As a conclusion, MSDs can be prevented by multidisciplinary approach. This study also provide recommendation to reduce the risk of MSDs. The study highlighted that there is a need to further improve the work design and introduce a control measure as to to heighten the working conditions ergonomically and finally improve the work productivity in general.

Keywords: Musculoskeletal disorders, prolong sitting, office workers, risk factors, RULA

ABSTRAK

Majoriti pekerja pejabat tidak aktif dan umumnya bekerja dalam posisi duduk serta adalah kebiasaan bagi pekerja pejabat untuk duduk lebih dari 30 minit pada satu masa. Oleh kerana rutin dan aktiviti tersebut, ia boleh menyebabkan tekanan pada tubuh dan merupakan faktor utama dalam gangguan muskuloskeletal (MSD). Oleh yang demikian, tujuan kajian ini adalah untuk mengenal pasti tahap risiko MSD di kalangan pekerja pejabat dan menentukan tahap pengetahuan dan tingkah laku pekerja. Satu kajian dilakukan terhadap 60 orang pekerja pejabat dengan menggunakan borang soal selidik dan *Nordic Musculoskeletal Questionnaires* (NMQ) dan seterusnya di kalangan 20 orang pekerja dengan menggunakan *Rapid Upper Limb Assessment* (RULA). Analisis statistik telah dijalankan menggunakan perisian *Statistical Package for the Social Sciences* menggunakan ujian *Spearman Correlation* dan *Chi-square*. Dari analisis, didapati bahawa pengetahuan mengenai postur yang betul menunjukkan persamaan yang signifikan dengan gejala MSD (χ^2 = 0.014) dan telah dikenal pasti sebagai salah satu faktor yang membawa kepada MSD. Keputusan NMQ menunjukkan bahawa bahu, punggung atas, punggung bawah dan leher adalah masalah yang paling umum dilaporkan oleh pekerja pejabat. Pengulangan, postur janggal atau postur statik jangka panjang dianggap sebagai faktor risiko berkaitan fizikal yang berkaitan dengan MSD. Tiada hubungan antara jantina, umur, tahap pendidikan dan kekerapan senaman dengan gejala MSD. Walau bagaimanapun, usia didapati mempunyai hubungan positif dengan gejala MSD. Akhirnya, skor akhir RULA adalah 4 (risiko rendah) yang menunjukkan bahawa siasatan lanjut diperlukan dan perubahan postur mungkin diperlukan. Pergelangan tangan dan *trunk* mempunyai kesan yang paling ketara pada kedudukan duduk. Sebagai kesimpulannya, MSD boleh dicegah dengan pendekatan pelbagai disiplin. Kajian ini juga memberi cadangan bagi mengurangkan risiko MSD. Kajian ini menekankan bahawa terdapat keperluan untuk terus memperbaiki reka bentuk kerja dan memperkenalkan

langkah kawalan untuk memperbaiki keadaan kerja secara ergonomik dan akhirnya meningkatkan produktiviti kerja secara umum.

Keywords: Gangguan *Musculoskeletal*, posisi duduk, pekerja pejabat, faktor risiko, RULA

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MSDs	:	Musculoskeletal Disorders
RULA	:	Rapid Upper Limb Assessment
NMQ	:	Nordic Musculoskeletal Questionnaire

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CHAPTER 1: INTRODUCTION

1.1 Background

Modern workplace has shifted a nature of occupations from active to sedentary and promotes excessive sitting behavior among the office workers. Majority of office workers are sedentary and generally work in sitting position for much of the day and it is common for office workers to sit for more than 30 minutes at a time. The transaction from paper to computer work is one of the causes of this problem. This study was carried out to investigate Musculoskeletal Disorders (MSDs) risk due to prolong sitting among office workers in Putrajaya.

Sitting too much can be bad to health. Studies show a strong relationship between prolong sitting and Musculoskeletal Disorders (MSDs) among office workers. The prolong sitting behavior caused musculoskeletal stress on different body regions of seated workers. MSDs can lead to chronic pain and disability. This ultimately results in less health-related quality of life, such as pain in neck, back, shoulders and wrist, prolapsed intervertebral discs, upper limb repetitive strain injuries, exhaustion during working day, reduce job satisfaction and hypertension (Daneshmandi, Choobineh, Ghaem, & Karimi, 2017; Hallman et al., 2016; Ranasinghe et al., 2011; Thorp et al., 2012; Tremblay et al., 2010). In addition, some studies have shown that the association between sedentary occupations and obesity and the risk of developing some type of cancer, cardio-metabolic disease, diabetes mellitus type 2 and coronary artery disease (Thorp et al., 2012; Tremblay et al., 2010).

The Global Burden of Disease (GBD) study in 2016 found that MSDs were the second highest cases of global disability and lower back pain was the main contributor since 1990. The prevalence of MSDs varies by age and diagnosis (WHO, 2018). Meanwhile in Malaysia, it is reported by "Department of Occupational Safety and Health (DOSH)" that

MSDs is the highest reported occupational diseases compared to other occupational diseases and increasing yearly resulting in sickness absenteeism as well as loss of productivity (DOSH, 2018). In Malaysia, the Occupational Safety and Health Act 1994 (Act 514) aims to secure the safety, health and welfare of persons at work and for protecting others against risks to safety or health in connection with the activities of persons at work . Under this Act, employers, employees and self-employed are required to comply with certain standard on safety, health and welfare at work place (DOSH, 1994). A safety and health guideline on seated workers are also published by DOSH. This guideline suggests appropriate seating condition and advise on work station design and selection of seating. As the solution to the problem it is important to have ergonomic assessments on the workers. These people remain in sitting posture for about two-third of their working hours and their sitting periods last at least 30 minutes (A. A. Thorp et al., 2012).

MSDs are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nervous system and affected body regions such as neck, arm, upper body and lower body. They represent a wide range of disorder from mild to severe conditions. MSDs are caused or made worse by the work environment. For example, the problem with lower back part is often associated with lifting activities while the upper part of the body (fingers, wrists, elbows, arms, shoulders and neck) may be due to forceful, repetitive or prolonged exertions of the hands.

Job factors associated with MSDs are awkward posture, static and repetitive movements, temperature, and vibration (Batham & Yasobant, 2016; Padmanathan, Joseph, Omar, & Nawawi, 2016). Psychosocial factors such as poor and lack of communication during working times, isolated working environment, high demands for work performance, lack of work control, and low supervisory relations with employees are associated with the emergence of musculoskeletal complaints in workers (Amin, Nordin, Fatt, Noah, & Oxley, 2014; Taghinejad, Azadi, Suhrabi, & Sayedinia, 2016). While individual factors related to musculoskeletal disorders were sociodemographic (gender and age) and personal characteristics (anthropometry, education level, smoking status, alcohol consumption, exercise habits and years of work (Oha, Animägi, Pääsuke, Coggon, & Merisalu, 2014; Ranasinghe et al., 2011).

The musculoskeletal complain is common among computer office workers and can cause absenteeism from work, decrease productivity, poor quality of life and increased medical expenses (Gerr, Marcus, & Monteilh, 2004). This affects employee's general welfare and has adverse consequences for safety and health. Employers who provide a safe and conducive working environment are not only comply with legal requirement but also help to increase the work efficiency.

Based on observations and interviews with office workers, musculoskeletal complaints often occur at the neck, shoulder and arm. They sit for a long duration range of 4 to 5hours in that time in static position. These activities are the factors can cause MSDs complaints, which can have an impact on the work performance.

Data were collected by using questionnaire and Rapid Upper Limb Assessment (RULA). Data on socio demographic, socio economy, ergonomic knowledge and behavior were collected by using questionnaire. For MSDs symptoms, Nordic Musculoskeletal Questionnaire (NMQ) was carried out to assess symptoms and examine reported cases of MSD. Meanwhile body posture assessment using RULA is used to investigate on posture of respondents and to identify which body part is most affected at sitting position. RULA is used because it is more suitable to measure static postures with repetition of the same action and a better tool for upper body assessment. From the summary of RULA score, the control measure and mitigation plan can be proposed to eliminate or minimize the WMSDs risk.

As the total average workers age increase every year and with physical high demand, the MSD have significant impact to job performance. As physical work load demand maintains the same every year, senior or older workers may face difficulties to cope with the high work pace particularly for process which their body part is exposed to high repetitive workload. Therefore, it is significant to study the prevalence of sitting behavior and its effect among office workers in Putrajaya and recommend the solution.

1.2 Scope of the Study

This study involved government agencies in Putrajaya. To be included an office worker and use computer to complete their job tasks more than 3 hours daily. This study is interested in musculoskeletal disorder as a result of prolong sitting and computer use in completing daily office tasks by the workers. The objective is to access the ergonomics risk study for upper limb and lower limb of working postures caused by prolonged sitting.

1.3 Problem Statement

Office workers are part of a large group of occupations that generally work in a sitting position for much of the day. Some complaints the presence of minor head, shoulder, neck and lower back pain is common among office workers (Lis, Black, Korn, & Nordin, 2007; Ranasinghe et al., 2011). Workers are required to sit for static position and make them feel uncomfortable and painful. The prolonged sitting times among office workers could have effects on exhaustion during a working day, job satisfaction, hypertension and MSD symptoms in the shoulders, lower back, thighs, and knees of office workers (Daneshmandi et al., 2017). Besides that, it also involves repetitive use of upper body and arms. All of these are related to work relates musculoskeletal disorder (WMSDs). Without proper technics and incorrect body posture, it can develop a back-pain injury. To cope with this situation, knowledge together with safety behavior need to be increased by identifying ergonomic risks that present in the working environment and make recommendation on reducing the risk. This study is to identify level of MSDs and if there are a significant between prolong sitting and with MSDs complaints among office workers in Putrajaya.

1.4 Objective of the Study

The aim of the study is to identify ergonomic risks that present in the working environment and make recommendation on reducing the risk.

The objectives of this study are:

1) To observe the knowledge and behavior of the office workers regarding ergonomic risks in workplace;
2) To determine the prevalence of MSD among office workers;
3) To identify level of MSD risk among office workers; and
4) To suggest improvement and control measure to eliminate or minimize the MSDs risk.

1.5 Significant of Study

Previous studies show that there is a strong relationship between prolong sitting and the complaint and development of pain and injury of in upper body (Daneshmandi et al., 2017; Hallman et al., 2016; Ranasinghe et al., 2011; Thorp et al., 2012; Tremblay et al., 2010). Therefore, it is important to ensure all workers can perform their job under safe workplace environment, less absenteeism and perform work until at least until retirement age.

The results of this study are expected to help to determine factors contributing to MSD as well can increase knowledge and knowing the relationship of body posture when working against complaint of MSD. From this study result, it is expected to be an information/input for agency and can be applied to prevent musculoskeletal problem which can reduce the work productivity. Finally, it may help workers to understand more about ergonomic and perform their jobs more productively and comfortably.

1.6 Flow Chart of the Study

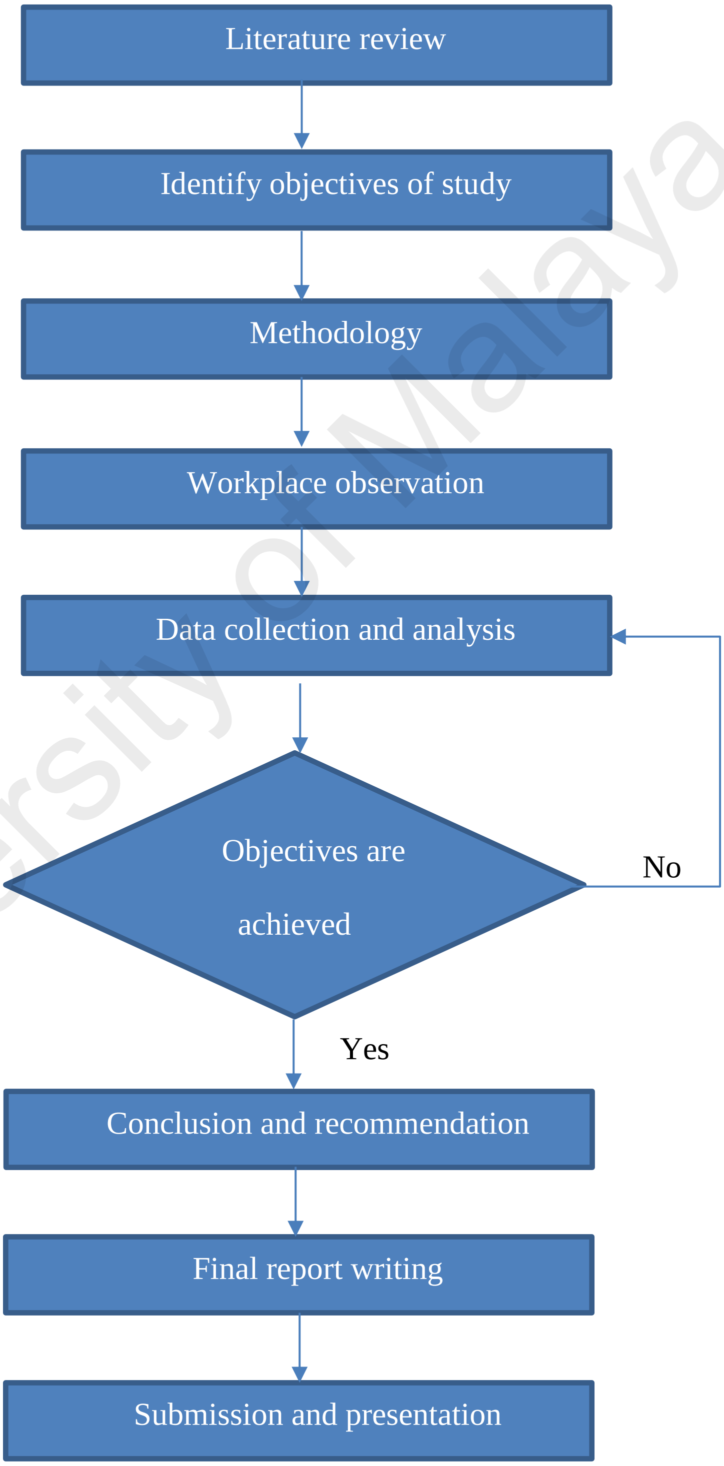


Figure 1.1 Flow Chart of the Study

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Prolonged sitting includes sitting in the workplace, during commuting and also during leisure time. Sedentary lifestyle behaviors include activities that tend to be done while sitting such as watching television, reading, working on computer or sitting in an automobile which require little to no energy expenditure.

2.2 Definition

Sedentary behaviors typically are in the energy-expenditure range of 1.0 to 1.5 METs (multiples of the basal metabolic rate)(Ainsworth et al., 2000). There is a difference between individual who is sedentary and physically inactive. Being sedentary means the person sitting or lying down for a long period. In contrast with physically inactive which means the person not doing enough physical activity. Someone can do enough physical activity but still be considered sedentary if they spend most of their day sitting or lying in the workplace, at home, for traveling or during their free time (DOH Australia 2019).

While, moderate to active physical activity such as walking or running involved variety of body positions and movement and require an energy expenditure of 3 to 8 METs (Ainsworth et al., 2000). Prolonged sitting promotes a whole-body muscular inactive. A lack of whole-body muscle movement associated with prolonged sitting was linked to health problem according to previous studies (Daneshmandi et al., 2017; Faryza E, Murad MS, & S, 2015; Heneghan, Baker, Thomas, Falla, & Rushton, 2018).

2.3 Musculoskeletal System and Sitting Position

The musculoskeletal system plays a role in supporting posture and movement. When sitting, rotation occurs back of the pelvis which will cause even distribution in the curvature of the lumbar vertebrae or changes in shape on the bone (Figure 1). This event will increase pressure on the posterior disc intervertebral which will cause organ susceptibility on long-term damage (Gkikas, 2013).

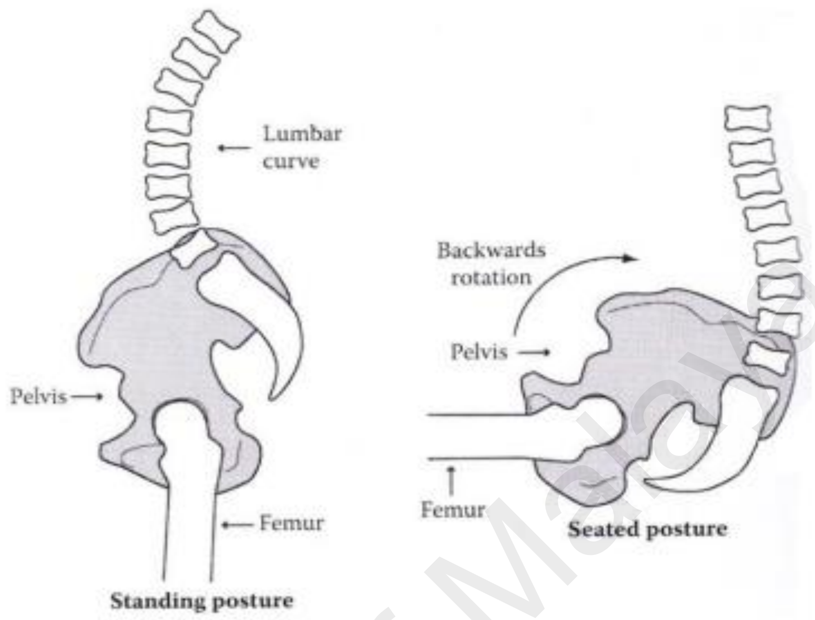


Figure 2.1 Pelvic Rotation in Sitting Position

2.4 Sitting Risk

Prolonged sitting can be bad to health. Sitting uses less energy than moving and standing. Prolonged sitting behavior have caused musculoskeletal stress on different body areas and is a major factor in development of MSDs (Daneshmandi et al., 2017; Hallman et al., 2016; Ranasinghe et al., 2011; Thorp et al., 2012; Tremblay et al., 2010). Prolonged sitting also seem to increase the risk of obesity and the risk of developing some type of cancer, cardio-metabolic disease, diabetes mellitus type 2 and coronary artery disease (Thorp et al., 2012; Tremblay et al., 2010).

Any extended sitting such as at a desk or in front of a screen can be harmful. Previous studies showed that significant association between MSD symptoms among office workers working in computer workstation (Abdol Rahman, Masood, & Hassan, 2017; Dinar A, Susilowati IH, Azwar A, Indriyani K, & M, 2018).

2.5 Guideline

A safety and health guideline on seated workers have been published by DOSH in 2002. This guideline recommended suitable seating conditions and advice on the design and selection of workstation (DOSH, 2002). Sitting in an uncomfortable and unsuitable chair can cause fatigue and tiredness which can affect the welfare of employees. The guideline provides advice and suggestion on the design and selection of seating to the employers and employees. Employers who provide suitable seating and a conducive working environment are not only complying with the legal responsibilities but also contributing to the efficiency of workforce. Figure 2.2 shows the general principle of selecting work seating. It is very important for each employee to know the correct sitting position and proper sitting posture to avoid injury while working and reduce the risk of MSDs (DOSH, 2002).

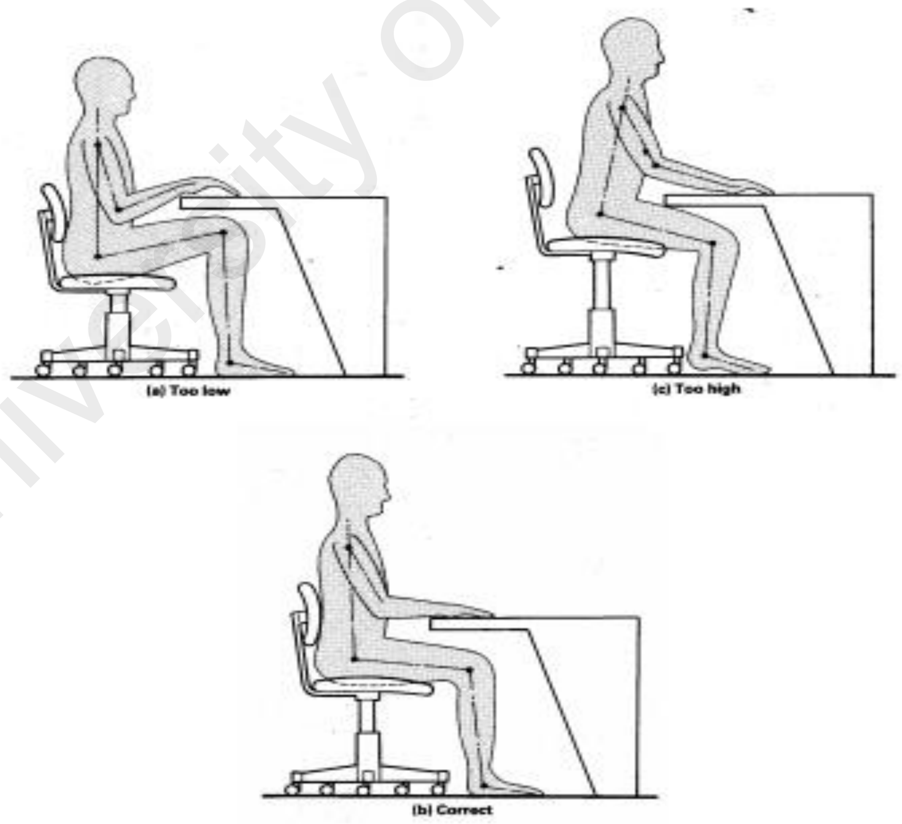


Figure 2.2 Guideline on Selection of Seating

In addition to the DOSH Guideline, the Ministry of Health of Malaysia (MOH) has also introduced a guideline on Light Exercise or X-Breaks while working among office workers in April 2019. This guideline is to ensure employees remain active, healthy and productive during working time. The guideline also provide suggestion on how to do the exercise with in a fifteen minutes break during work days (MOH, 2019).

2.6 Overview of Health and Safety Legislation in Malaysia

In Malaysia, Occupational Safety and Health Legislation was introduced in 1994. The Occupational Safety and Health Act 1994 (Act 514) aims to secure the safety, health and welfare of persons at work, for protecting others against risks to safety or health in connection with the activities of persons at work and also for awareness of safety and health among workers. This Act defines the employer's responsibility, manufacturers, self-employed and suppliers. Furthermore, this act provides for the appointment enforcement officers and the establishment of safety and health policy to protect the safety, health and welfare of the workers and others from the dangers inherent in the activities of the workplace. Under the Act, employers, employees and self-employed are required to meet certain standard on safety, health and welfare (DOSH, 1994). Section 15 of the Act, stipulates the duty of the employer to provide a safe and healthy workplace and to ensure the well-being of the employees.

In summary, employers should practice the workplace culture of quality such as prioritizing an open working environment, practicing dialogue and communication extensively, giving equal opportunities and ensuring problem solving. Occupational safety and health issues can be resolved by the Occupational Safety and Health Committee (OSH) established under Section 30. The ergonomic implementation of the workplace is in accordance with the requirement of Section 4 (c) of Act 514 to introduce the environment working in accordance with the physiological and psychological needs of the workers. The establishment of the National Occupational Safety and Health Institute (NIOSH) in 1992 has introduced ergonomic knowledge and applications at work to ensure a safe and comfortable workplace.

2.7 Musculoskeletal Disorders (MSDs)

2.7.1 Prevalence

The global prevalence of MSDs is 8.4% in 2014. It is recorded an increasing number in Disability-Adjusted Life Years (DALY) from 20.6 million in 1990 to 30.9 million in 2010 (Smith et al., 2014). In a survey conducted in Great Britain recorded that the incidence of MSDs is 35 % of the incidence of work related musculoskeletal disorders statistics (WRMSDs) in 2018, and it was revealed that MSDs accounted for 24% of the causes of absenteeism employment (HSE, 2018). Even in Malaysia, according to DOSH statistic, there are an increasing number of occupational diseases every year from 2005 to 2014. In 2017, it was reported that 146 cases out of 282 (51.8%) from Basic Occupational Health Services (BOH) survey by DOSH was MSDs related cases followed by other occupational diseases like “Noise Induced Hearing Loss (NIHL)”, skin disease and lung diseases (DOSH, 2018).

Most MSDs cases occur in the manufacturing sector or service industry. However MSDs can also occur in other jobs like office workers who spent much time working on computer, typing and perform repetitive movement in their jobs in a long period (Gerr et al., 2004; Grooten, Wernstedt, & Campo, 2011; Lalit, 2015; Punnett, 1999; Wiitavaara, Fahlström, & Djupsjöbacka, 2017). Work-related MSDs contribute to increase occupational diseases as well as economic and social burdens on employee and employer (Levy & Wegman, 2000). The presence of musculoskeletal complain is common as a cause off occupational illness leading to work absenteeism, less productivity, poor quality of life and increased medical expenses (Gerr et al., 2004). This affects the welfare of workers and also have a bad consequence for safety and health.

2.7.2 Risk Factors

MSDs are a disorder of the musculoskeletal system that causes symptoms such as pain due to damage to the nerves, and blood vessels in various part of body such (neck, shoulders, wrists, hips, knees and heels) (Cho, Cho, & Han, 2016). MSDs are caused by various factors that can also aggravate the disorder (Batham & Yasobant, 2016). Some studies show the relationship to occupational risk factors, psychosocial risk factors and individual risk factors in the development of MSDs.

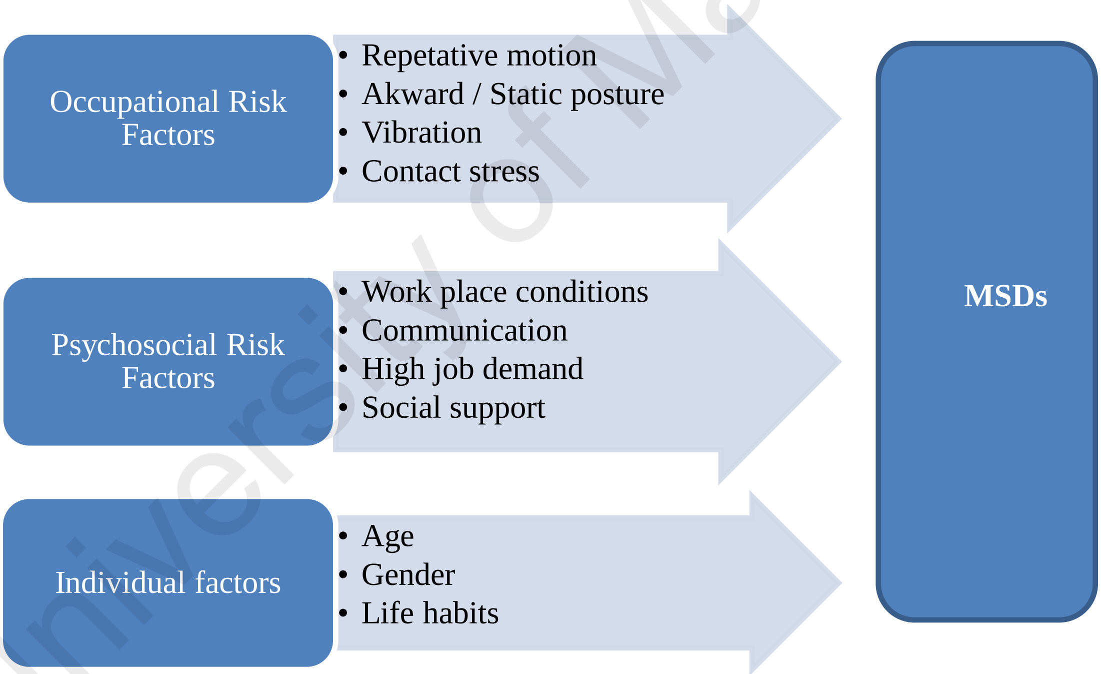


Figure 2.3 Risk Factors for MSDS

2.7.2.1 Occupational Risk Factors

Studies show that MSDs have significant association with occupational ergonomic stressors such as non-neutral postures, static posture, repetitive motion, heavy lifting, vibration, awkward posture, temperature, forceful exertions and contact stress (Batham & Yasobant, 2016; Padmanathan et al., 2016; Punnett, 2014). This is because the body performs the same task in the same way and the affected area will be the same. When the area is experiencing the same force every day, the area will be less efficient because of fatigue experience (Wiitavaara et al., 2017).

2.7.2.2 Psychosocial Risk Factors

In general, psychosocial risk factors are referred to individual perceptions of the working environment, such as working hours, working shift and organization style. The Health and Safety Executive, UK, identified categories of psychosocial risk factors in the workplace including job demands, decision latitude, social support, extrinsic effort, intrinsic effort, reward, role ambiguity, role conflict, job future ambiguity, verbal abuse, threat of harm/injury and work organization (hours worked, type of hours, travel time to work, shiftwork) (Devereux, Rydstedt, Kelly, Weston, & Buckle, 2004).

Some studies showed an effect of psychosocial risk factors for MSDs. (Sterud, Johannessen, & Tynes, 2014) reported that low support levels from management and high job demands have a significant relationship with neck/shoulder pain. The findings in line with study by (Chen, O'Leary, & Johnston, 2018) which suggested psychosocial risk factors like high job demands, job control, greater job satisfaction and long working hours were associated with neck pain in the more senior office workers.

2.7.2.3 Individual Risk Factors

Individual risk factors related to musculoskeletal disorders were sociodemographic (gender and age) and personal characteristics (anthropometry, education level, smoking status, alcohol consumption, exercise habits and years of work (Oha et al., 2014; Ranasinghe et al., 2011). According to (Chen et al., 2018) female office workers have a higher risk of having neck pain than men. Age affects a person’s chances for experience MSDs. Muscles have maximum strength when it reaches the age of 20-29 years, then after age reaching 60 years muscle strength will decrease the strength. Based on these factors and combined with an attitude that is not ergonomic will cause occurrence of MSDs.

2.7.3 Types of MSDs

There are various types of MSDs ranging from common to vary rare. Some of these disorders share the same symptoms as pain and inflammation in joint or muscle. However, some of them have own unique symptoms as well. MSDs can affect almost all tissues in human body (nerves, tendons, tendon, ligaments, joints and muscles) but the most often parts are arms and the upper and lower back.

Table 2.1 Types of MSDs

Disorders	**Descriptions**
Disorder of the arm	
Tendonitis	Tendonitis is inflammation of the tendon and difficulty moving affected joints. Causes as a result of repetitive motions of the wrist, elbow and shoulder and prolong load on shoulder
De Quervain's Tenosynovitis	De Quervain's Tenosynovitis is inflammation of the tendon on the side of the wrist at the base of the thumb. Most common cause is overuse through heavy or repetitive physical activities especially such repetitive thumb movement such as grasping, pinching, squeezing or wringing. movements. Symptoms that arise including pain, edema, numbness, tingling and difficulty move the thumb
Carpal Tunnel Syndrome (CTS)	CTS caused by compression of the median nerve at the wrist. Factors that cause CTS including pressure on the hand in a long time, repetitive movement such as typing on a computer keyboard. The symptoms arising usually like tingling, burning sensations and numbness in the hands and fingers in particular index finger and middle finger

Disorders	Descriptions
Trigger Finger	Trigger finger is a condition in which it is difficult to straighten fingers once bent. Trigger finger are caused by highly repetitive or forceful use of the finger and thumb
Disorder of the neck and shoulder	
Tension Neck Syndrome	This symptom occurs in neck when experiences tension in the muscles due to neck posture looking up for long period. This syndrome results stiffness in the neck muscles, muscle spasms, and pain which spreads to the neck

(OSHA3125, 2000; Stack T, Ostrom LT, & CA, 2016)

2.7.4 Effects

MSDs can be classified into several stages according to Oliveira and Browne (de Carvalho et al., 2009).

Table 2.2 Characterization of MSDs Stages

Stages according to Olivera	Stages according to Browne
Stage 1: Fatigue, discomfort, localized pain without irradiation which get worse when work and better with rest	Stage I: Pain during work, ceasing at night without sleep disturbance
Stage II: Persistent and more intense pain, associated with paresthesia and burning feeling. It gets worse with work and home activities and causes reduction in productivity	Stage II: Pain during work that persists at night and causes sleep disturbances
Stage III: Persistent, strong and irradiated pain which gets some relief of rest, associated to a decrease in muscular strength and movement control edema and paresthesia. This is reduction of productivity or incapacity for work	Stage III: Pain even at rest with sleep disturbance

Stages according to Olivera	Stages according to Browne
Stage IV: Strong and continual pain, with intense suffering and irradiation to all members. pain and continuous. It causes an incapacity for any work	

(de Carvalho et al., 2009)

2.8 Ergonomic

Ergonomics is a study of the relationship between the workers and the working environment. More specifically, ergonomics is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job (OSHA3125, 2000). Ergonomics consider to adjust the work system with human capabilities. In other words, ergonomics is the study of human relationships with the tools used, machinery or machines, work procedures and working environment (McCauley-Bush, 2012).

For example, employees working with computers, need to be sure their workplace is like a computer stand, the suitability of tables and chairs is appropriate to the ability of the worker. This is to avoid things like discomfort during work, mistakes in doing work that may result in decreased productivity and thereby avoid injury and accidents at work.

2.9 Ergonomic Assessment

Ergonomic assessments methods are used for determining risk factors and assessing the level of ergonomic risk in the work environment. (Tee et al., 2017) review on ergonomic assessment done by other researcher has suggested two most preferred methods by the researchers in ergonomic fields which are Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) . Ergonomic assessment of Work-Related Musculoskeletal Disorders (WMSDs) involves the assessment and investigation of body regions and occupational tasks.

Methods for assessing the work postures of workers through ergonomic analysis and workplace design are numerous. Assessment methods are different either in assessment stage or in the area of their assessed body and also the types of work they are working on. The most common methods are RULA, REBA, Ovako Working Posture Assessment System (OWAS), Loading of Upper Body Assessment (LUBA), New Ergonomic Posture Assessment (NERPA), Evaluación del Riesgo Individual (Individual Risk Assessment) (ERIN) and the National Institute of Occupational Safety and Health (NIOSH) lifting equation (Herzog & Buchmeister, 2015; Rodríguez, 2019; Yazdanirad et al., 2018). Therefore, it is important to know the differences of each assessment method and decide which one would be the best for assessing the organization.

2.9.1 Rapid Upper Limb Assessment (RULA)

RULA was a survey method developed by Dr. Lynn McAtamney and Dr. Nigel Corlett in 1993 (McAtamney & Nigel Corlett, 1993). RULA evaluates the risk factors like posture, force, repetition and movement of several body parts which include upper arm, lower arm, wrist, neck, trunk and legs by using RULA employee assessment worksheet (Hedge, 2000). This method considers force/load and biomechanical while performing job tasks. Diagrams of body postures are used and evaluated by using scoring tables. From the tables, data on risk levels can be obtained.

RULA is use in ergonomics investigations of workplaces where work-related upper limb disorders are reported. A scoring methods is used to get a final RULA score and action list which indicates the MSDs risk and action level (McAtamney & Nigel Corlett, 1993). A low RULA score does not guarantee that the workplace is free of ergonomic hazards, and a high score does not assure that a severe problem exists. Therefore, further investigations are needed to determine the cause of this problem and corrective action to be done immediately to reduce the risk of MSDs among workers.

RULA was developed to:

1. Assessing and screening the risk of work-related upper limb disorder of a selected working group;
2. Identify the most affected body region due to the work process;
3. Provide a final score that can help determining the level of action to take.

RULA Analysis Method involves developing a postural analysis system. The development of RULA methods needs three stages which are:

(1) Stage 1: Recording working postures

(2) Stage 2: Group the body part posture scores

(3) Stage 3: Final score and action list

In RULA method, analysis of body is divided into 2 Parts (Part A and Part B). Part A consists of upper arm, lower arm and wrist whereas Part B consists of neck, trunk, and legs. A scoring system is used based on the posture analysis of each body part. Score 1 indicates the most neutral posture as an example arms by the sides, wrists in neutral position, elbows in approximately 90° flexion (McAtamney & Nigel Corlett, 1993). While score 4 shows the worst position (Massaccesi et al., 2003). Figure 2.3 shows the example of RULA worksheet used in the assessment.

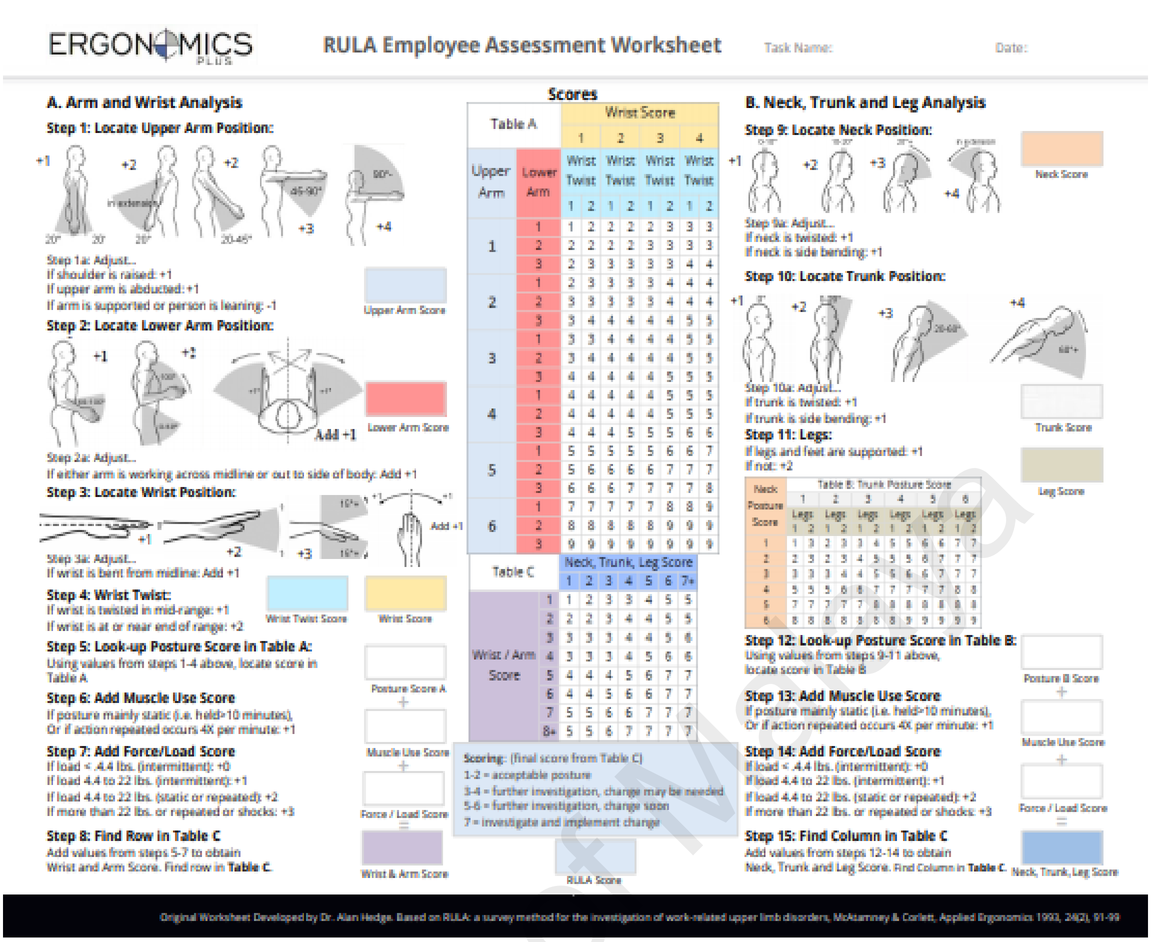


Figure 2.4 RULA Assessment Worksheet

From the RULA final score, the level of MSD risk can be determined whether there is a high risk of injury or not. In addition, the level of intervention that needs to be done can also be determined.

Table 2.3 RULA Final Score and Level of MSDs Risk

Score	Level of MSD Risk
1-2	Negligible risk, no action required
3-4	Low risk, change may be needed
5-6	Medium risk, further investigation, change soon
7	Very high risk, implement change now

2.9.2 Nordic Musculoskeletal Questionnaires (NMQ)

Nordic Musculoskeletal Questionnaires (NMQ) is a standard questionnaire for the analysis of musculoskeletal symptoms. The questions are multiple-choice questions and can be either self-administered or used in interviews (Kuorinka et al., 1987). It is used to access a general level of discomfort of body parts. It consists of 28 questions structured in two parts. The first part, refers to symptoms during the past 12 months in 9 parts of the body (neck, shoulders, elbows, wrists/hands, upper back, lower back, hip/thighs, knees, and ankles/feet). While, the second part, refers to symptoms throughout 7 days beforehand and disabling attack (López-Aragón, López-Liria, Callejon-Ferre, & Gómez-Galán, 2017).

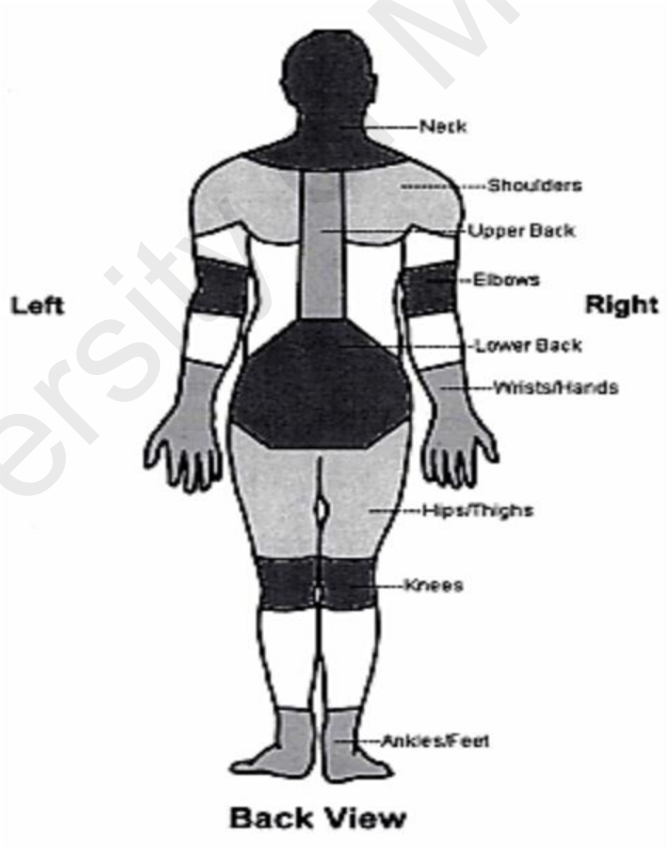


Figure 2.5 Nordic Body Map

CHAPTER 3: METHODOLOGY

3.1 Introduction

This study was carried out among office workers to identify level of MSD symptoms, to determine the significant between sitting behavior and the risk of MSDs and to observe the knowledge and behavior of the office workers regarding ergonomic risks in workplace.

The RULA and Questionnaires which consist of NQM were used in this study to identify and to assess the WMSDs among participants. Observation and photos of sitting office workers have been taken for RULA analysis in order to identify the individual body part that are exposed to developing a postural risk while doing their daily tasks.

3.2 Study Participating and Sampling

This study involved government agencies in Putrajaya. To be included an office worker and use computer to complete their job tasks more than 3 hours daily. All participants were asked whether have prior medical records or previous history of musculoskeletal injuries and only participants with no injuries were included in this study.

Sixty office workers were randomly selected for data collection by using questionnaire and twenty were involved to be the participants for the RULA assessment. The subjects were randomly chosen from agencies in Putrajaya.

3.3 Research Flow

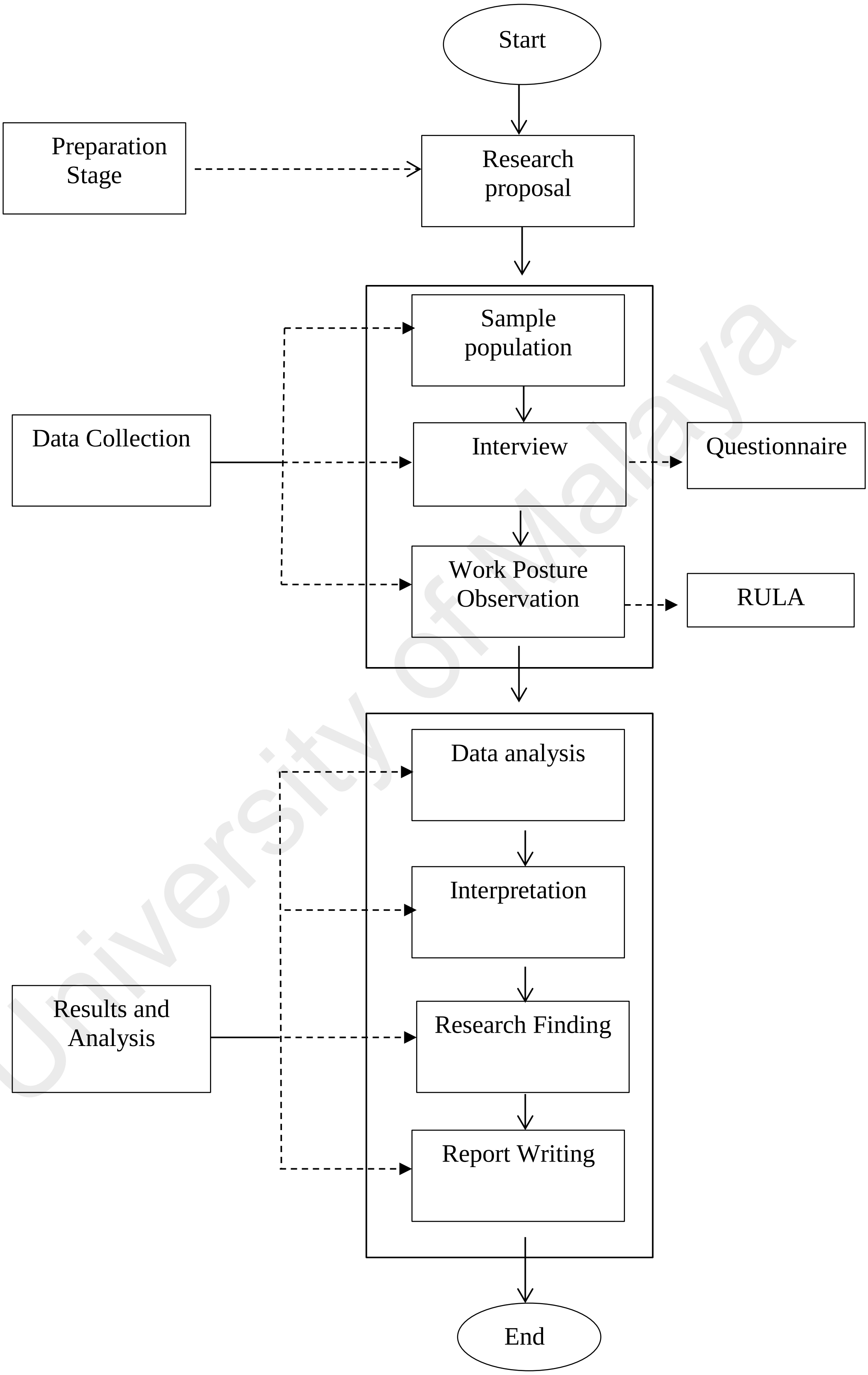


Figure 3.1 Research Flow

3.4 Data Collection

The study was done in 2 phases:

i. Data collection by using questionnaire

ii. Ergonomic Assessment

3.5 Data collection by using questionnaire

The observation was done during working hour and interview session to participants. Data were collected from each participant. The questions are forced choice variants and use in interviews. The main objective of this interview is to understand if any of the workers have encountered with any health problems or discomfort by using NQM and to access level of knowledge and behavior of the participants regarding ergonomics. The questionnaire form was randomly issued to a total of sixty office workers. The questionnaire contained two parts:

Part 1

1. Socio demographic and socio economy (age, weight, height, education level, working hours per day, frequency of exercise, duration of time sitting at work)
2. Ergonomics Knowledge Test (body position, distance, risk factor for MSD, proper posture, intervention)
3. Behavior Questions (regular break during works, nature posture, body posture)

Part 2

Nordic Musculoskeletal Questionnaire (NMQ) and Nordic Body Map.

This standard questionnaire, detects symptoms in different body regions. It consists of multiple-choice questions, structured in two parts. The first part, refers to symptoms in 9 parts of the body (neck, shoulders, elbows, wrists/hands, upper back, lower back, hip/thighs, knees, and ankles/feet) during the last 12 months. While, the second part, refers to symptoms throughout 7 days beforehand and disabling attack (López-Aragón et al., 2017).

3.6 Ergonomic Assessment

3.6.1 Rapid Upper Limb Assessment (RULA)

RULA is used in ergonomics assessment of workplace focused on upper limb of the body. In this study, a RULA worksheet is used to evaluate body posture, force/load and movement of the participants. Participant's photos were taken during the survey session while they were performed their tasks (Figure 3.2) and used to access postural working angels for RULA analysis.

Figure 3.2 Posture Observation by Using RULA Method

3.6.2 Posture Analysis Using RULA Method

RULA Analysis Method involves step by step results and important steps of coding and process analysis to fill up RULA assessment worksheet. The participants were interviewed to understanding their job tasks and demands. Then, their posture and movement during working were recorded and observed and scored based RULA worksheet. Selection of the postures evaluated is based on the posture sustained for the longest period of time.

Picture of participants working in sitting position was taken during the session. From the picture, frame classification was done to recognize and identified the most awkward body posture. Then the assessment using RULA analysis as performed to check the RULA score for the selected frame. Each score postures for segment A (neck, trunk and leg) and segment B (arm and wrist) was calculated and if there is force/load used by the workers while performing the task, the additional score is added. The Final score was then calculated and confirmed the action level.

The development of RULA methods needs three stages which are:

1. Recording working postures

Observe the task and select the posture for assessment. Photos of participants while they were performed their daily tasks and the critical posture to be evaluate were taken.

2. Scoring the body regions

a) Score the postures

Body parts are divided into Part A and Part B. Part A (arm and wrist analysis) consists step 1 – 4 and Part B (neck trunk and leg analysis) consists step 9 – 11. Score 1 indicates the most neutral posture and increasing scores shows the worst position. Step 5 is sum for step 1 - 4 for group posture A and Step 12 is sum for posture score for group posture B by using values from steps 9 – 11.

b) Processing the score

The completes score for Arm and Wrist Posture is the sum of Table A, muscle and Force/Load score. The value is written in Step 8. While the completed score for neck, trunk and leg posture is sum of Table B, muscle and Force/ Load Score. The value is than written in Step 15.

3. Finalize the RULA Final score and action list

a) Final RULA score

The final RULA score is read from Table C by completing score for Part A and Part B. Figure 3.3 defines how final RULA score is obtained. The final score range is 1 to 7 which shows posture from good to worst respectively.

b) Confirm the action level

RULA score indicates the level of MSD risk and action level with respect of the urgency for control measures. The degree level of risk severity provides a guide for further actions.

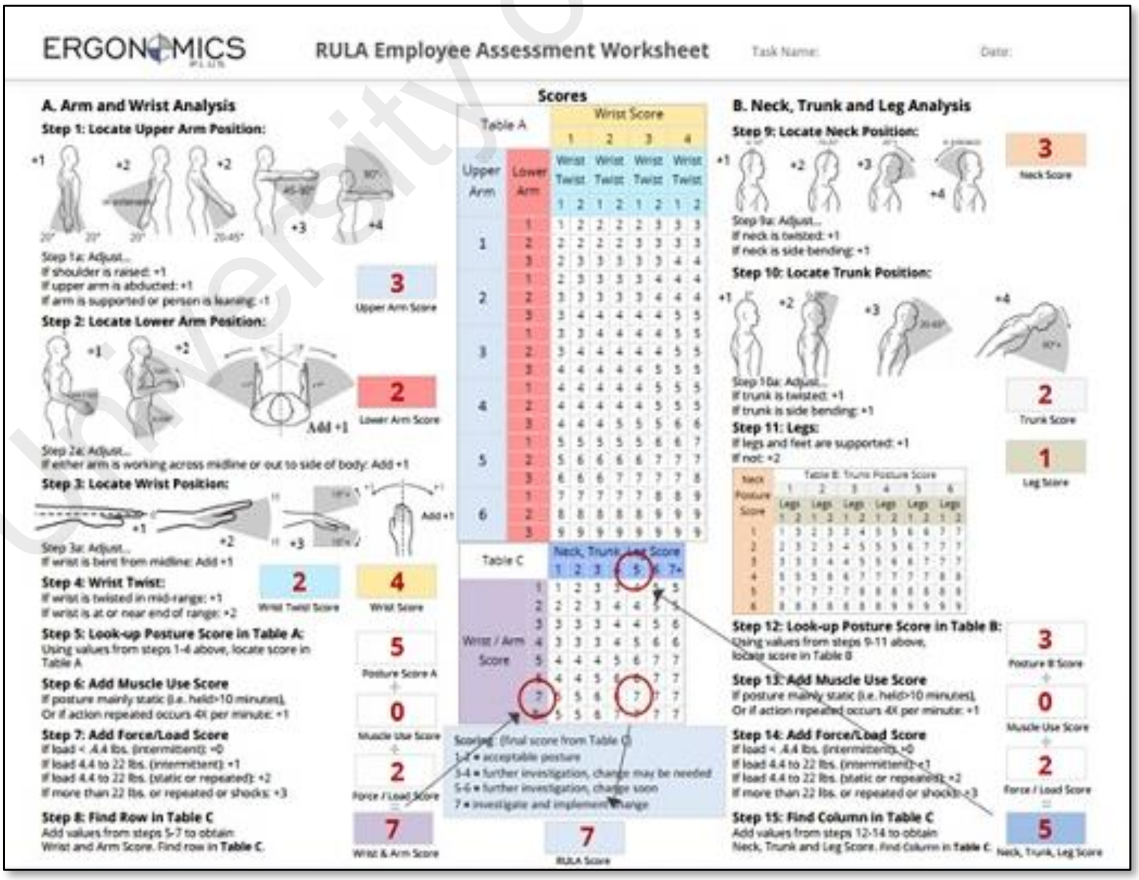


Figure 3.3 RULA Assessment Calculation

Workload assessment by using RULA method is carried out to investigate on the underlying ergonomic impact of prolong sitting. Then to recognize which body part is exposed to relatively high workloads. From the RULA score summary (Figure 3.3) it will identify some risk preventions, mitigation plan and control measure to eliminate or minimize the MSDs risk. As the total average workers age increase every year and with physical high demand, the MSDs have significant impact to job performance.

3.7 Framework Concept

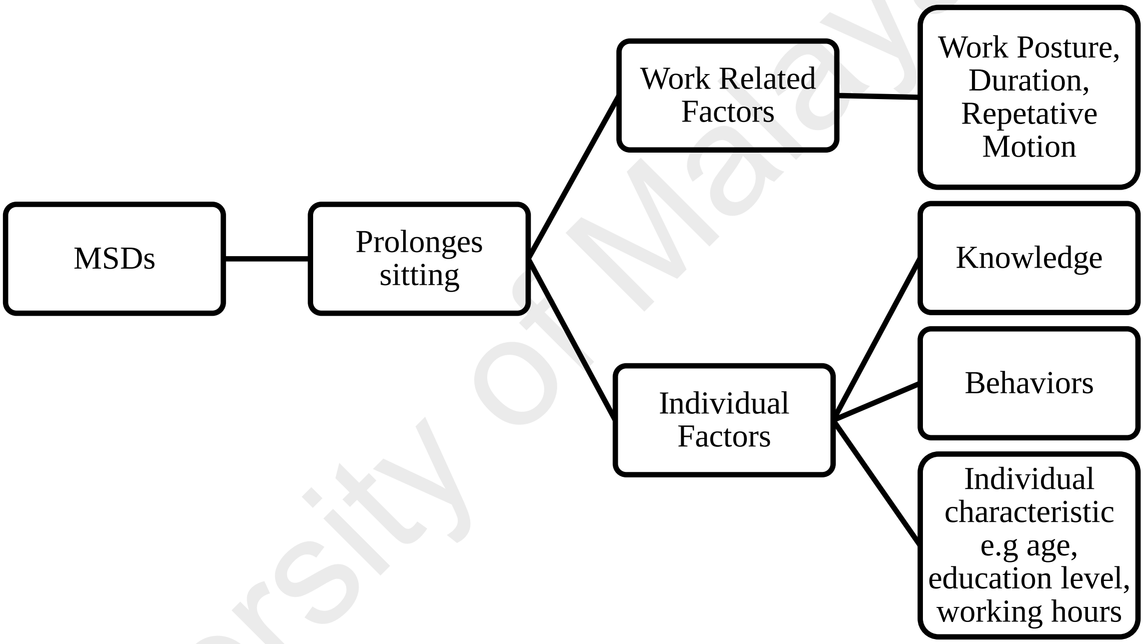


Figure 3.4 Risk Factors Related to MSDs

3.8 Analysis and Reporting

This study aims to observe the knowledge and behavior of the office workers regarding ergonomic risks in workplace, to investigate posture at prolong sitting and to determine the significant between sitting behavior and the risk of MSDs among office workers. The data obtained was analyzed by statistical analysis using Statistical Package for the Social Science (SPSS) version 25 to determine the association between variables.

Data obtained from the survey were processed through this step as following:

i. Coding

To translate research data into codes for analysis purposes

ii. Data Entry

Key in into the computer system by using Statistical Package for the Social Science (SPSS) program version 25.

iii. Cleaning

Re-check the data entered to avoid mistake

iv. Output

Results analyzed by using statistical test program.

Data analysis used:

i. Univariate analysis

This analysis is used to determine the frequency distribution of variables. In this study it determines the value of mean (mean), standard deviation, minimum value and the maximum value for the dependent variable and independent variable such as sociodemographic factor and MSDs complaints among office workers.

ii. Bivariate analysis

The purpose of this analysis is to see the relationship and the degree of the relationship between the variable. A chi-square test and Spearman Correlation was performed to examine the relationship of socio demographic factors and MSDs complaints. Requirements for the chi-square test in this study is a cell that has an expected value of less than 5 no more than 20%, with a confidence degree of 95% and alpha (α) 5%. If the value of $\chi \leq 0.05$ means that there is a meaningful relationship status, and if the value $\chi > 0.05$ means there is no relationship statistically significant.

CHAPTER 4: RESULTS

4.1 Introduction

Results was obtained from questionnaire analysis and RULA postural analysis. Results from questionnaire survey was used to access knowledge level and behavior on ergonomic in workplace. This finding reflects the awareness of the workers in ergonomic and correct sitting posture. The investigation was done further by using RULA method. Results from RULA were used to identify risk level and propose recommendation on working sitting posture.

4.2 Results of Questionnaire Analysis

Sixty (60) office workers from government offices were selected for the study. To be included, an office worker that use computers to complete their job tasks for at least two hours per day and did not have prior medical records or previous history of musculoskeletal injuries.

The questionnaire contained two parts which are Part 1 and Part 2. Part 1 include sociodemographic factors, knowledge on ergonomic and behavior questions while Part 2 consists of questionnaire from Nordic Musculoskeletal (NMQ) and Nordic Body Map. The questionnaire was used to obtain more information on demographic information of the participants, knowledge and behavioral and will be compared to the symptom of MSDs in NMQ.

4.2.1 Sociodemographic Factors

Sociodemographic data was obtained from questionnaire. Table 4.1 summarizes the personal details of the participants.

Table 4.1 Demographic information of the participants

Sociodemographic factors					Mean	SD
Age (years)					35.73	5.78
Weight (kg)					65.98	10.51
Height (cm)					163.55	8.69
Job tenure					10.15	5.58
Working hours per day					8.52	0.75
Sociodemographic factors					**No.**	**%**
Sex	Male				21	35%
	Female				39	65%
Sociodemographic factors	**Male**		**Female**		**Total**	
	No.	**(%)**	**No.**	**(%)**	**No.**	**(%)**
Age category						
19-30	1	4.8	9	23.1	10	16.7%
31-40	16	76.2	26	66.7	42	70%
41-50	3	14.3	3	7.6	6	10%
51 and above	1	4.7	1	2.6	2	3.3%
Total	21	100	39	100	60	100.0%
Education level						
Secondary education	3	14.3	3	7.7	6	10%
Diploma	0	0	11	28.2	11	18.3%
Degree	14	66.7	22	56.4	36	60%
Master and above	4	19	3	7.7	7	11.7%
Total	21	100	39	100	60	100%

From the table, the mean age of the participants was 35.73 ± 5.78 years (range 23 -52 years). While the mean for weight and height was 65.98 ± 10.51 and 163.55 ± 8.69 respectively. For the job tenure in their current working position, the mean was 10.15 ± 5.58 years. Most of the participant's working hours per day was 8.52 ± 0.75 in average. It is also showed that 65% of the participants were female and 35% were male.

A majority (70%) of the study population was aged between 31-40 years followed by age group of 19-30 (16.7%), and age group of 41 -50 (10%). The least are the age more than 51 years old (3.3%). The results of education level of the participants showed that the majority 36 (60%) of the participants had studying until degree level, followed by 11 (18.3%) subjects with diploma graduates, 7 (11.7%) subjects were postgraduates and above and lastly 6 (10%) subjects were secondary education.

In the following Table 4.2, the distribution of subjects has been arranged according to time spent sitting per workday. The relevant scores and the percentage of workers has been shown accordingly. Finally, the result is plotted in the Figure 4.1.

Table 4.2 Distribution according to the duration of sitting per workday

Duration	Male		Female		Total	
	No.	%	No.	%	No.	%
1-3 hours	0	0.0	1	2.6	**1**	**1.7**
4-6 hours	5	23.8	13	33.3	**18**	**30.0**
More than 6 hours	16	76.2	25	64.1	**41**	**68.3**
Total	21	100.0	39	100.0	**60**	**100.0**

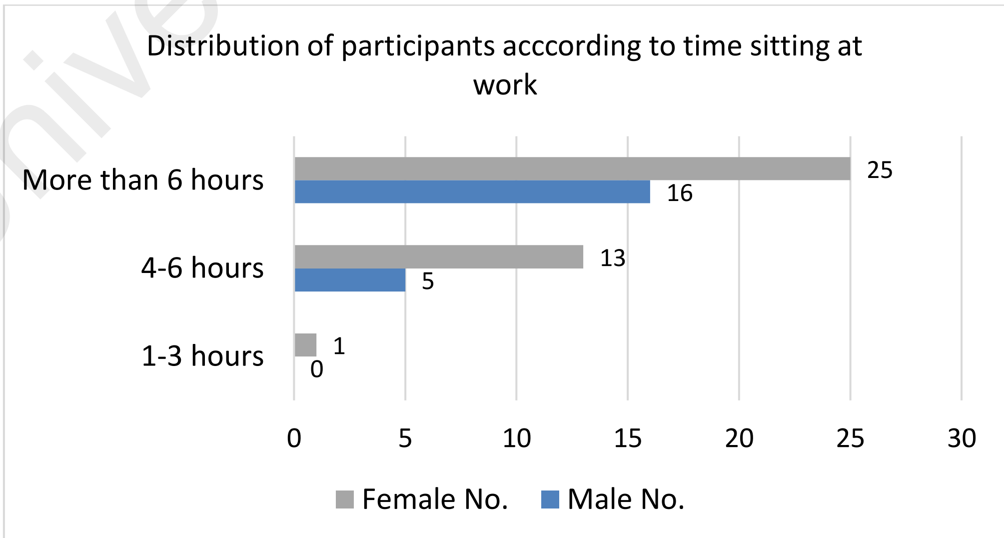


Figure 4.1 Distribution of participants according to time sitting at work

From the results, it showed that majority of the subjects 41 (68.3%) sitting for more than 6 hours per workday followed by 18 (30%) for 4-6 hours and only 1 (1.7%) less than 3 hour. Among the male’s, majority of subjects sit more than 6 hours per workday 16 (76.2%) followed by 5 (23.8%) for 4 – 6 hours and no person sit less than 3 hours. Among the female’s, majority of subjects 25 (64.1%) for 3-6 hour followed by 76 (27.73%) sit more than 6 hours per workday, 13 (33.3%) for 4 – 6 hours and 1 (2.6%) for less than 3 hours. The following results have been arranged according to hours of exercise per week.

Table 4.3 Distribution of participants according to hours of exercise per week

Duration	Male		Female		Total	
	No.	%	No.	%	No.	%
Seldom or never	2	9.5	9	23.1	**11**	**18.3**
2 – 4 times a month	8	38.1	17	43.6	**25**	**41.7**
Weekly	8	38.1	11	28.2	**19**	**31.7**
Daily	3	14.3	2	5.1	**5**	**8.3**
Total	21	100.0	39	100.0	**60**	**100.0**

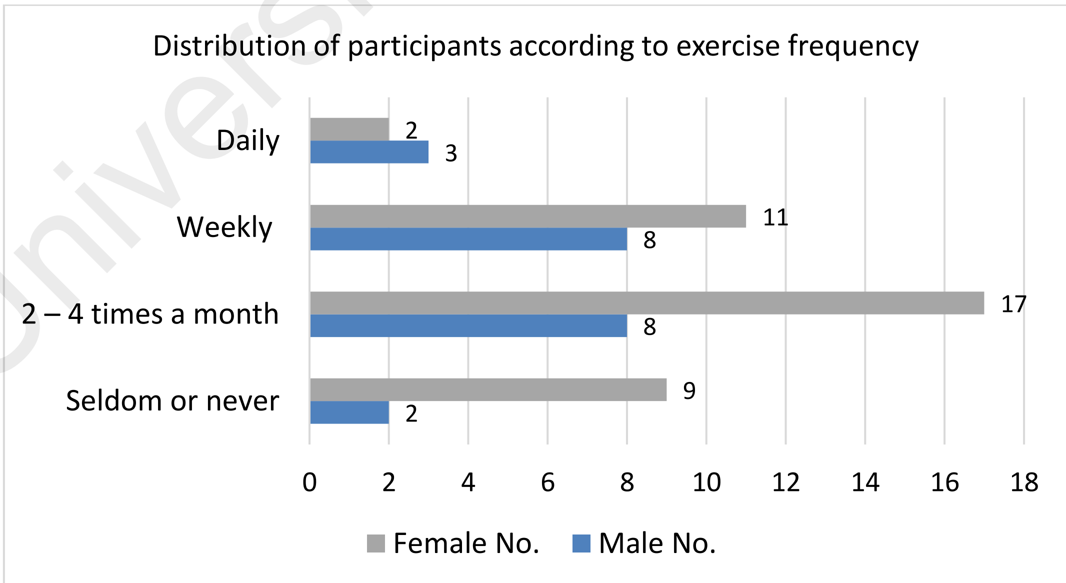


Figure 4.2 Distribution of participants according to exercise frequency

From the above table, it has been found that majority 25 (41.7%) of the subjects exercise 2 - 4 times a month, followed by second highest 19 (31.7%) of the subjects, the next category was seldom or never exercise 11 (18.3%) and subject with the category daily was the least with 5 (8.3%). Among the male's majority of subjects' exercise for 2 -4 times monthly and weekly 8 (38.1%) followed by daily 3 (14.3%) and 2 (9.5%) for seldom or never. Among the female's majority of subjects' exercise for 2-4 times a month 17 (43.6%) followed by 76 (27.73%) for weekly, 44 (16.05%) for 6-9 hours and 38 (13.86%) for more than 9 hours.

4.2.2 Ergonomic Knowledge Questions

The questionnaire composed of a few sections of knowledge on ergonomics. The questions related on understanding of ergonomic, good postures, seating posture, musculoskeletal disorders and its risk factors, working postures, workstation and finally control measures.

Figure 4.3 showed data on ergonomic knowledge segment answered by participants. The responses were presented by percentage of the subjects who answered correctly. The correct answer (yes) reflected the participants are aware and have adequate knowledge about ergonomic and most probably will take some precautions and make changes to avoid the MSDs risk. Meanwhile the wrong answer (no) demonstrated that the participants have less awareness and knowledge on ergonomics.

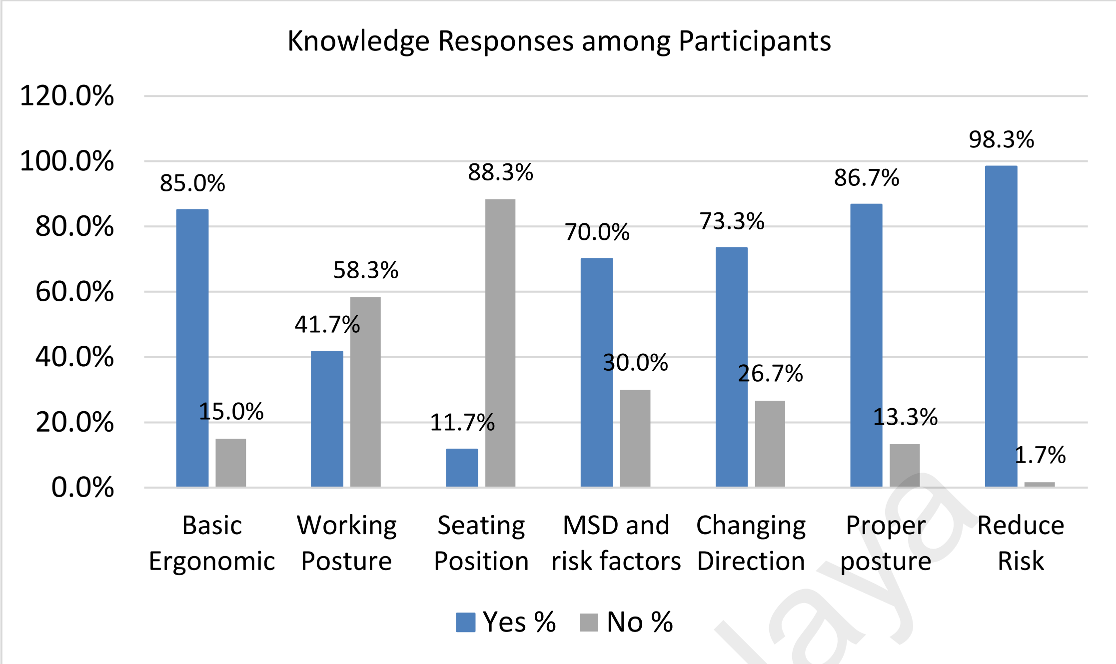


Figure 4.3 Ergonomic knowledge responses among participants

Ergonomic knowledge responses among participants were presented in Figure 4.3. The results showed that majority of the subjects were aware of how to control the risk of MSDs (98.3% correct responses), proper posture (86.7% correct responses) and basic ergonomics (85.0% correct responses). The following data on changing body direction (73.3%), risk of MSD (70.0%) and body position (41.7%) also showed higher percentage on correct responses compared to the wrong responses. The higher percentage of correct answer can be indicated that the subjects were aware of ergonomic knowledge. The only data which show the unaware of ergonomics knowledge was knowledge on sitting position that showed only 11.7 % of respondents answer the correct answer.

Table 4.4 showed the association between the ergonomic knowledge and the MSDs symptoms. Ergonomic knowledge data was compared to the MSDs symptom in NMQ to find the association between the knowledge and the prevalence of MSDs among office workers. From the finding, some interventions and control measures can be planned such as a serial of training.

Table 4.4 Association between ergonomic knowledge and the symptom of MSDs

Sections (Knowledge About)	Musculoskeletal Symptoms		No Musculoskeletal Symptoms		Total		χ²-Value	r_s-value
	No.	%	No.	%	No.	%		
Basic ergonomics								
Yes	14	23.3	37	61.7	51	85	3.223	**0.232**
No	0	0	9	15.0	9	15		
Working body position								
Yes	5	8.3	20	33.4	25	41.7	0.266	-0.067
No	9	15	26	43.3	35	58.3		
Sitting position								
Yes	2	3.3	5	8.4	7	11.7	0.122	**0.045**
No	12	20	41	68.3	53	88.3		
MSDs and risk								
Yes	9	15.0	33	55.0	42	70.0	0.284	-0.069
No	5	8.3	13	21.7	18	30.0		
Changing direction								
Yes	12	20.0	32	53.3	44	73.3	1.431	**0.154**
No	2	3.3	14	23.4	16	26.7		
Proper posture								
Yes	12	20.0	40	66.7	52	86.7	**0.014**	-0.015
No	2	3.3	6	10	8	13.3		
Reduce risk of MSD								
Yes	14	23.3	45	75	59	98.3	0.310	0.072
No	0	0	1	1.7	1	1.7		

Note: $\chi^2<0.05$; $-1\leq r_s$ -value ≥ 1 Spearman correlation

From the table above it has been statistically found that knowledge on proper posture demonstrated significant association with the MSDs symptoms ($\chi^2=0.014$). Analysis by using Spearman Correlation showed a weak correlation between basic ergonomics and changing direction with MSDS symptoms and a very weak correlation between sitting position and reduce risk knowledge.

4.2.3 Behavioral Questions

As presented in Table 4.5, the behavioral responses were asked to identify responses on behavioral during work day among office workers. The questions asked in Likert scale on how often in a typical 8 hours work day, the respondents act on different body posture while performing jobs and regular stretch break.

Table 4.5 Behavioral responses among participants

Behavioral in 8 hours work day	Always		Sometime		Rarely		Never	
	No	%	No	%	No	%	No	%
Rapid pace	16	19.5	38	46.3	6	63.3	0	0
Feet position	9	11	39	47.6	10	12.2	2	2.4
Back support	28	34.1	20	24.4	8	9.8	4	4.9
Shoulder level	14	17.1	34	41.5	12	14.6	0	0
Elbow position	19	23.2	32	39	8	9.8	1	1.2
Wrist posture	14	17.1	37	45.1	9	11	0	0
Upper body posture	16	19.5	24	29.3	20	24.4	0	0
Break and exercise	15	18.3	36	43.9	9	11	0	0

From the table, majority of the participants response to "sometime" in every question about the behavioral except for back support question where majority responded at always 28(34.1%). This can demonstrate that the subject's behavior was not in good or correct behavioral at all time when sitting.

4.2.4 Nordic Musculoskeletal Questionnaire (NMQ)

Results of NMQ are summarized in Table 4.6. The results present the prevalence of musculoskeletal symptoms in various parts of the body among the participants. From these finding, the most affected area of the body can be identified.

Table 4.6 Distribution of the participants according to the NMQ

Body Regions		Previous 12 months		Previous 7 days		Disabling attack	
		No.	%	No.	%	No.	%
Neck	No	33	55	41	68	51	85
	Yes	27	45	19	32	9	15
Shoulders	No	14	23	27	45	40	67
	Yes	46	77	33	55	20	33
Elbows	No	52	87	55	92	57	95
	Yes	8	13	5	8	3	5
Wrists/hands	No	46	77	55	92	58	97
	Yes	14	23	5	8	2	3
Upper back	No	23	38	30	50	41	68
	Yes	37	62	30	50	19	32
Lower back	No	22	37	34	57	47	78
	Yes	38	63	26	43	13	22
Hips/Thighs	No	45	75	54	90	57	95
	Yes	15	25	6	10	3	5
Knees	No	46	77	54	90	54	90
	Yes	14	23	6	10	6	10
Ankles/Feet	No	46	77	55	92	55	92
	Yes	14	23	5	8	5	8

The results revealed that shoulder 46 (77%), lower back 38 (63%), upper back 37 (62%) and neck 27 (45%) were the most prevalent problems reported by office workers in the past 12 months. While, MSDs symptoms occurring during the previous 7 days showed a similar finding as the past 12 months where shoulders showed the highest number 33 (55%) followed by upper back 30 (50%) and lower back 26 (43%). The disabling attack of MSDs were found on shoulder 20 (33%), upper back 19 (32%) and lower back 13 (22%) respectively.

4.2.5 Sociodemographic Factors and NMQ

Sociodemographic data from questionnaire was compared to the response in NMQ to investigate which body regions that most commonly affected by MSDs. Table 4.7 summarizes the finding of the analysis.

Table 4.7 Association between Sociodemographic Factors and NMQ

Factors	Standardized Nordic Questionnaire				χ^2-Value	r_s-value
	Musculoskeletal Symptoms		No Musculoskeletal Symptoms			
	No.	%	No.	%		
Sex						
Male	6	10	15	25	0.496	-0.091
Female	8	13.3	31	51.7		
Age category						
19-30	3	5	7	11.7	1.278	**0.045**
31-40	9	15	33	55		
41-50	2	3.3	4	6.7		
51 and above	0	0	2	3.3		
Education level						
Secondary education	2	3.3	4	6.7	0.631	-0.005
Diploma	2	3.3	9	15		
Degree	8	13.3	28	46.7		
Master and above	2	3.3	5	8.3		
Time spent sitting per day						
1-3 hours	1	1.6	0	0	3.759	-0.015
4-6 hours	3	5	15	25		
More than 6 hours	10	16.7	31	51.7		
Exercise frequency						
Seldom or never	1	1.6	10	16.7	6.479	-0.302
2-4 times a month	4	6.7	21	35		
Weekly	6	10	13	21.7		
Daily	3	5	2	3.3		

Note: χ^2<0.05 ; $-1 \leq r_s$ -value ≥ 1 Spearman correlation

As seen in Table 4.7, MSDs symptoms are more common among female 8 (13.3), 31-40-year age group 9 (15%), time spent sitting at work per day in group more than 6 hours 10 (16.7%) exercise weekly 6 (10%). The relationships between the risk factors and MSD complaints are sex (r_s = -0.091; χ^2= 0.496), age category (r_s = 0.045; χ^2= 1.278), education level (r_s = -0.005; χ^2= 0.631), time spent sitting per day at work (r_s = -0.015; χ^2= 3.759) and frequency of exercise (r_s = -0.302; χ^2= 6.479). This finding suggests that age have a positive weak correlation with the prevalence of MSDs.

4.3 Ergonomic Assessment

Since the finding from questionnaire shows a weak correlation and significant in knowledge, behavior and sociodemographic risk factors, further investigation on ergonomic assessment was done to identify which body parts have the most affected by sitting position.

4.4 Results of Postural Analysis by Using RULA Method

A total of 20 workers were assessed by using RULA method. The age of the workers ranged from 25 to 38 years.

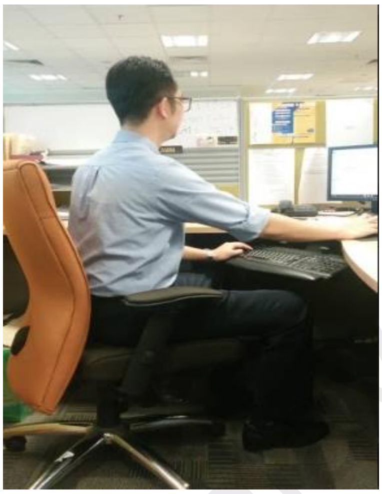
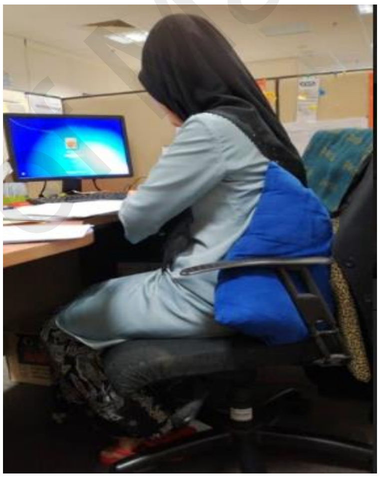
Table 4.8 Risk Level Among Participants

Risk level	**7: Very high risk**	**5-6: Medium risk**	**3-4: Low risk**	**1-2: Negligible risk**	**Total**
Number of workers	0	9	7	4	20

RULA score shows that no workers are exposed to "Very High Risk" and the highest number of respondents are in "Medium Risk" (9) group.

Table 4.9 shows body postures which were selected through the observation for RULA analysis.

Table 4.9 Postural Analysis by Using RULA Method

No	Risk Level	Score A	Score B	RULA Score	Picture	Body area at risk
1	Negligible risk	2	1	2		Upper arm
2	Low	3	3	3		Upper arm, Lower arm, Neck, Trunk
3	Medium	5	4	5		Upper arm, Lower arm, Wrist, Neck, Trunk, Shoulder

From the table above, upper arm and neck area are the most affected and exposed to MSD for sitting position. By seeing the results of these two table, Table 4.8 and Table 4.9, the medium risk scored the highest number of the respondents and the posture in medium risk score is not in comfortable zone. This RULA score indicates that some worker's sitting position need further investigation and implement change and control measure. However, the improvement will be more effective if we investigate further on each body region and identify the affected body parts and posture which will allow people to explore better control measures. In order to identify which body parts are affeted, the mean score of each body region is compared to maximum MSD score of RULA method.

4.4.1 RULA Score for Arm and Wrist (Part A)

Table 4.10 shows the result of RULA mean scores of arm and wrist. Figure 4.1 presents the mean score distribution of each body region compared to the maximum posture score of RULA method.

Table 4.10 RULA score for Part A

RULA Score	Upper arm	Lower arm	Wrist	Add Load
Mean	2.45	2.30	3.10	0.10
%	40.83%	76.67%	77.50%	3.33%
Score Max	6	3	4	3
Std Dev	0.60	0.73	1.12	0.31

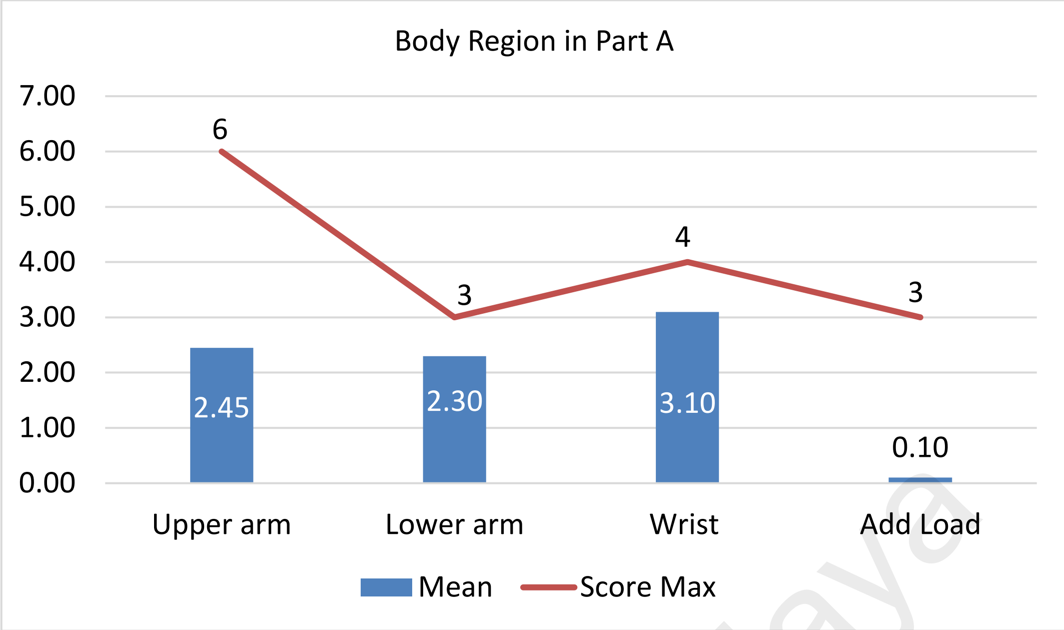


Figure 4.4 RULA score for Part A

According to Table 4.10, the mean for wrist position is equal to 3.10 (77.50%) %) which is apparently significant if compared to the maximum score of 4. This result shows that the wrist position is the not in natural posture and at risk of MSD. Most of the workers work in wrist position bent from midline and in extension while doing their job. Meanwhile the mean of lower arm is 2.13 (42.67%) and this result demonstrated the lower arm flexion angle was stated at 0° to 60° until 100° throughout to performing of the job task. Upper arm mean score was 2.45(40.83%) compared to the maximum score 6 as the arm was raised from 20° to 45° throughout performing the job task. And for the load / force, is demonstrated that additional load handle by workers while performs the job is below 4.4 lbs.

Final arm and wrist position scores are assessed by adding muscle usage score and muscle force/load score with initial arms and wrists position score obtained from RULA worksheet. Higher arms and wrist values increase the final score of RULA. Table 4.11 shows the final arm and wrist posture score. Accordingly, the result was plotted in the Figure 4.5 below.

Table 4.11 Final arm and wrist posture score of workers

Final Arm and Wrist Posture Score	Number of workers	%
2	4	20%
3	2	10%
4	4	20%
5	7	35%
6	3	15%

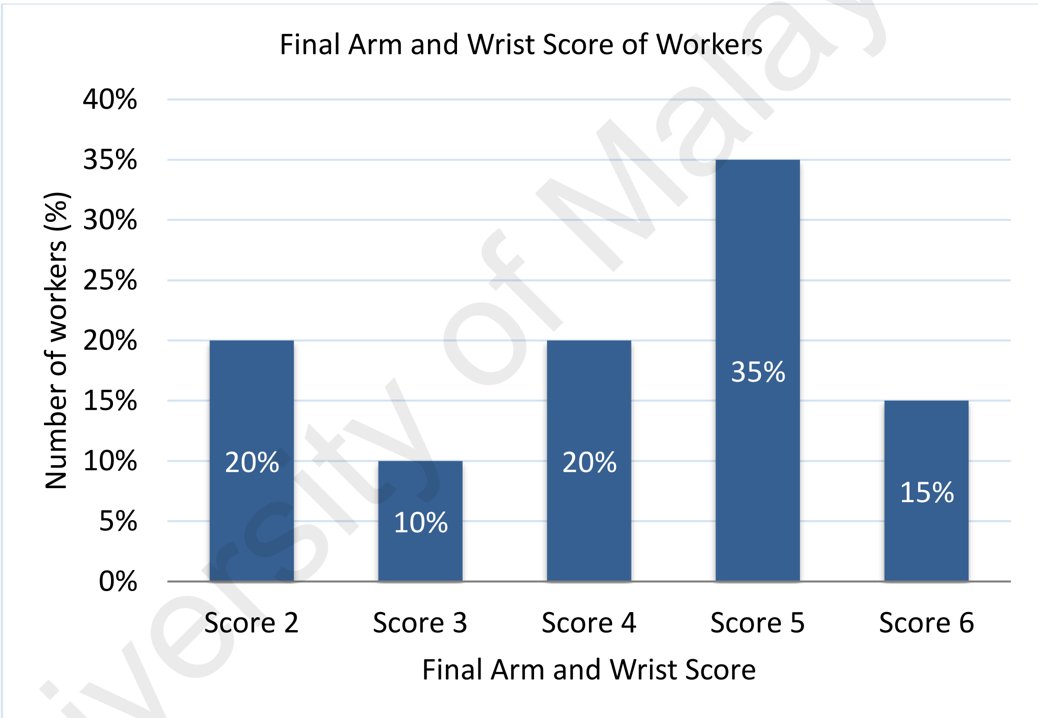


Figure 4.5 Final arm and wrist posture score of workers

It has been shown from the Figure 4.5 that the final arm and wrist position score is 5 (35%) which indicates relatively good condition of final arm and wrist posture. The score for 20% workers is 2 and 4, for 10% workers score is 3. However, for 15% workers the score is 6 which indicate bad work posture. No workers have been found with score of 7, 8 and 9.

4.4.2 RULA Score for Neck Trunk and Leg (Part B)

Table 4.12 shows the result of the mean scores for neck, trunk and leg analysis. Figure 4.6 presents the chat of the mean score distribution of each body region compared to the maximum posture score of RULA method in Part B.

Table 4.12 RULA score for Part B

RULA Score	Neck	Trunk	Leg	Add Load
Mean	2.33	2.40	1.00	0.13
%	38.89%	40.00%	50.00%	4.44%
Score Max	6	6	2	3
Std Deviation	0.82	0.99	0.00	0.35

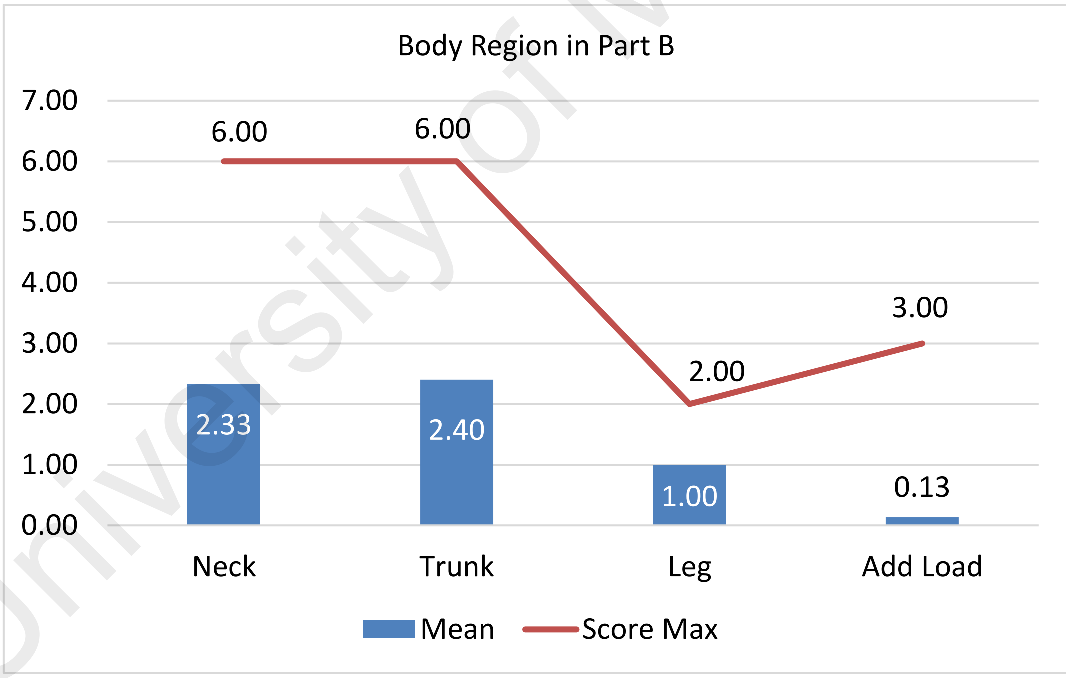


Figure 4.6 RULA scores for Part B

From the table 4.12, the mean for leg is equal to 1.00 (50.00%) compared to maximum score 2. This indicated that legs and feet are supported while working. This also indicate that the position of the legs and feet in the observation was in sitting position and balanced. While there is slightly significant for the neck and trunk position with the mean

2.33 (38.89%) and 2.40 (40.00%) respectively. These results show that the neck and the trunk position of the workers were in 10º – 20º while performing tasks. And for the load / force, is demonstrated that additional load handle by workers while performing the job is below than 4.4 lbs.

Table 4.13 shows the final neck, trunk and leg posture scores with the relative percentages of the workers for each and every score. The result was then plotted in the Figure 4.7 below.

Table 4.13 Final neck, trunk and leg posture score of workers

Final Neck, Trunk and Leg Posture Score	Number of workers	%
1	3	15%
2	4	20%
3	5	25%
4	5	25%
5	3	15%

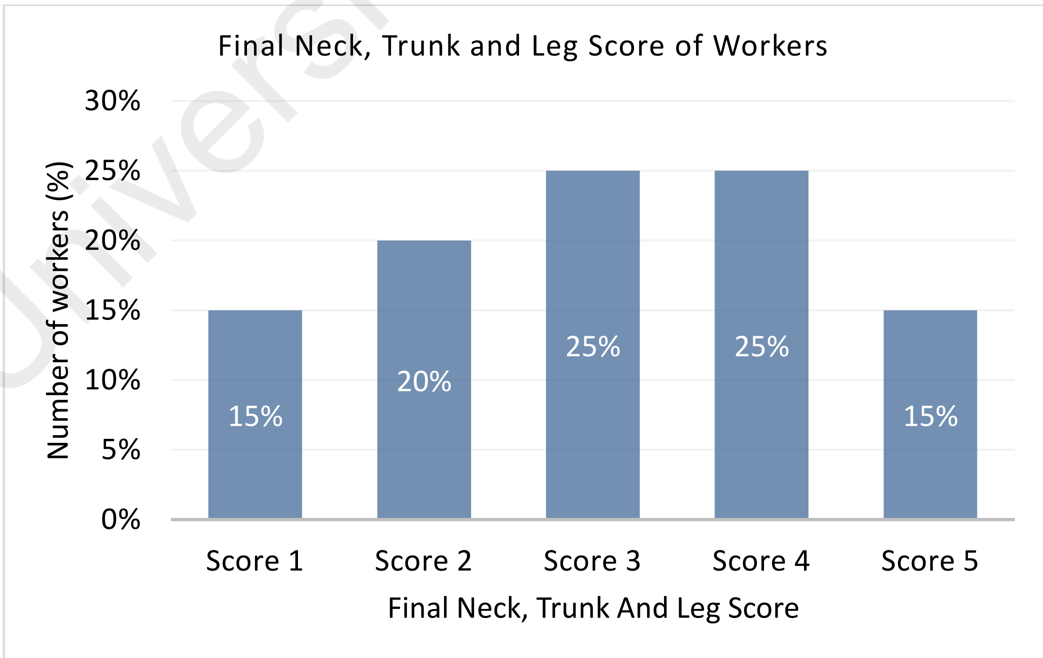


Figure 4.7 Final neck trunk and leg posture score of workers

From Figure 4.7, no workers have been found with score of 6, 8 and 9. The final neck, trunk and leg posture score of workers is 4 (25%) and 5 (25%) which indicates good condition of final neck, trunk and leg posture. The score for 15% workers is 1 and 5 respectively. The score for majority of the workers is 2 to 4 (70%) which indicates relatively good condition of neck, trunk and leg posture.

4.4.3 Evaluation of RULA Final Score

The final scores of Part A and Part B were tabulated in Table C of the RULA worksheet and final score of RULA has been evaluated by the intersecting value of these two scores. In the following Table 4.14, the RULA final score of 20 workers has been arranged to their relevant scores and the percentage of workers accordingly.

Table 4.14 Final RULA Scores

Final RULA Score	Number of workers	%
2	4	20%
3	4	20%
4	3	15%
5	6	30%
6	3	15%

Table 4.14 shows the final RULA score for 4 workers is 2 and 3 respectively, for 3 workers the score is 4 and for 6, respectively and the highest number of workers were in score 5. These results indicate that most of the workers are in medium risk and need further investigation and implement change.

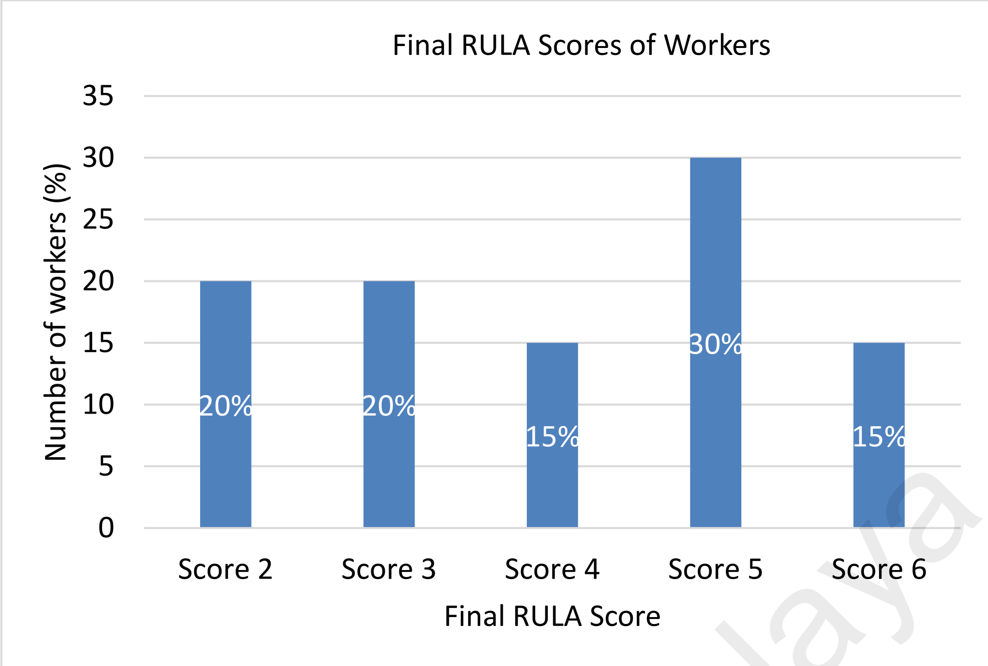


Figure 4.8 Final RULA score of workers

From Figure 4.8 it showed that 20% of respondents posture score 2 and valid according to the standard of RULA. Further investigation or change may be required for 45% (20% and 15%) workers because their RULA final score is 3 and 4. Lastly further investigation or implement change is required for 45% (30% and 15%) workers as they have the score of 5 or 6.

Table 4.15 indicated that the mean of RULA final score is equal to 4.0 showing that the workers' postures have to further investigate or change may be required and control measure to be made soon.

Table 4.15 Final RULA Score

Final RULA Score	Score A	Score B	RULA Score
Mean	4.10	3.10	4.00
%	51.25%	44.29%	57.14%
Score Max	8	7	7
Std Deviation	1.33	1.33	1.41

The most effect body posture for Part A is wrist position. Due to the nature of working conditions, workers wrist score was stated at 4.10 as the wrist position is bent from the midline or moved towards 15º above and 15º below the midline of the wrist. From the observation, most of the wrists were twisted in mid-range while performing tasks.

The mean result for final RULA score was 4. The result ranging from score 2 to score 6. No workers were found with score 1, 7 and 8.

In summary, based on the RULA final score analysis, it is clearly shown that there is a low risk exposure level caused by working in sitting position. Further investigation and implementing change on working posture are needed in order to reduce or eliminate MSD risk. By comparing the mean score of each body region, wrist and trunk are the most significant impact of body region at sitting position.

CHAPTER 5: DISCUSSION

5.1 Introduction

The aim of the study is to identify ergonomic risks that present in the working environment and make recommendation on reducing the risk. The study is to access the level knowledge and behavior of the office workers regarding ergonomic risks in workplace and to determine the prevalence of MSDs among office workers by using NMQ. This study also aims to identify level of MSDs risk among office workers by using RULA method in terms of RULA final score, and finally suggest improvement and control measure to eliminate or minimize the MSDs risk.

5.2 Questionnaire Analysis

The main objective of this questionnaire survey is to understand if any of the workers have encountered with any health problems or discomfort by using NQM and to investigate the knowledge and behavior of the participants regarding ergonomics. Data on socio demographic and socio economy was collected from the participants other than ergonomic knowledge and behavioral.

5.2.1 Knowledge on Ergonomics

The study showed that the participants were aware and have a knowledge of ergonomics. Analysis on the knowledge segments (postures, seating, musculoskeletal disorders and its risk factors, working postures, seating position, workstation and finally rest breaks and exercises) revealed that percentage of MSDs symptoms reduce when the participants have a knowledge on ergonomic. The level of ergonomics awareness reported in this study are contrast with previous studies in India and Kuala Selangor where in this study it was found that the respondents with no MSDs symptoms have high level of ergonomic awareness was high and they implement correct posture when sitting (Faryza E et al., 2015; Sherif Sirajudeen & Saad Mohamed Siddik, 2017). In the previous study among office workers in Kuala Selangor, majority of participants have low level of computer ergonomic awareness and did not have the know-how in implementing correct posture. A weak association was found between pain complaint in upper arm and wrist region with levels of ergonomic knowledge (Faryza E et al., 2015).

However, the finding of this study in line with the research finding by Ephraim-Emmanuel et al., 2019 where respondents which a good knowledge of musculoskeletal system disorders' prevention at work know how to prevent these work-related disorders (Ephraim-Emmanuel, Ogbomade, Idumesaro, & Ugwoke, 2019).

The differences between the finding of this study and the previous study can be explained that when the awareness and knowledge level is high, the workers are more aware regarding good posture and practice working in a correct posture. Other than that, the level of education in socio demographic data show that majority of the participants studied until degree level, this can reflect that the respondents have high knowledge on ergonomic and good posture. This study highlighted the necessity of ergonomic training regarding healthy postures and the measures to reduce the risk of musculoskeletal disorders.

The results showed a significant correlation between proper posture and the MSDs symptoms χ^2=0.014, and a weak positive correlation between knowledge on basic ergonomic and changing direction with MSDs symptoms (r_s=0.232, r_s= 0.154) respectively. This finding supports the previous results that ergonomic knowledge has association with the prevalence of MSDs among participants. This finding also indicate that levels of ergonomic knowledge were identified as the factors that lead to MSDs. Therefore, further investigation needs to be done. The ergonomic knowledge questionnaire used in this study is lacking in validity and reliability for Malaysian population. Future research could be done by recruiting office workers from all over

Malaysia including Peninsular Malaysia, Sabah and Sarawak as a true representation of the Malaysian population, because there is very limited data available on the prevalence of MSDs in Malaysia

5.2.2 Behavioral Attitude

Analysis on results on behavior responses among participants showed that majority of the participants responses to “sometime” in every question about the behavioral. This can demonstrate that the subject’s behavior was not in good or correct behavioral at all time when sitting. The subjects were not forced to do a good sitting postural such as music sound to frequent break and the workstation are designed to all populations. This will relate with the level of ergonomics knowledge. By improving knowledge, the behavior and attitude toward correct sitting behavior may be practiced. However, this finding is similar with the finding on previous study on attitude and practices of preventing on WMSDs among doctor in hospital. The study finding showed the practice of ergonomic principle was not satisfactory. Occurrence of WSMDs among participants was significantly associated with the practice of ergonomic principles to prevent the occurrence of these disorders (Ephraim-Emmanuel et al., 2019).

Since, there was no particular and specific safety and health program conducted at the work place during the past 12 months, the workers were not updated and less aware on ergonomic practices in work place. Therefore, safety and health program in regards of ergonomics should be done regularly to provide safety and health awareness and increase knowledge to workers in the form of in-house trainings, seminars, campaigns and awareness programs.

This study has revealed that there are opportunities to access the knowledge, behavior and practices (KAP) in safety and health in regards of ergonomic in Malaysia in the future. Therefore, the following field can be implemented for future studies:

1. Develop training modules and look for KAP impact before and after receiving training;

2. Cohort study on KAP after and before implementing intervention;

3. Current study can be extended to the large number of populations in Malaysia.

5.2.3 Socio demographic risk factors

From the study, it was found that the participants worked in a sitting position for more than 6 hours during an 8-hour working day. It was also revealed that the majority of participants exercise 2 – 4 times a month. The result was than analyzed with the prevalence of MSD and support the finding from other study that sitting time significantly correlate with the symptoms of MSDs (Daneshmandi et al., 2017). It indicated that prolonged sitting affected shoulders, lower back, thighs, and knees of office workers. Repetition, awkward postures and static postures for a long time were considered as the main risk factors.

Sociodemographic data from questionnaire were compared to the NMQ to investigate which body regions are that most commonly affected by MSDs. The results of the NMQ revealed that that shoulder (77%), upper back (37%) and lower back (63%) and neck (45%) were the most prevalent problems reported by office workers. This is consistent with a study among Iranian office workers that found neck, lower back and shoulder symptoms were the most prevalent problem among the office workers (Daneshmandi et al., 2017; Kaliniene, Ustinaviciene, Skemiene, Vaiciulis, & Vasilavicius, 2016). In this study, it was found that the percentage of respondents who experienced MSDs was 46 (76.7%), while the percentage of those who did not experience MSDs was 14 (23.3%). These results indicate that MSDs do not occur as acute complaints but rather accumulate continuously and/or slowly over a long period of time (Dinar A et al., 2018).

Association between prevalence of MSDs and socio demographic factors was investigated and it showed that there was no significant finding. It demonstrated that there is no association between gender, age, education level, duration of time sitting at work and frequency of exercise education level with the symptoms of MSDs. In addition, with respect to the age factor, a previous study found that there was no relationship between age and MSD complaints (Collins & O'Sullivan, 2015; Dinar A et al., 2018; Merisalu, Oha, Freimann, & Sirk, 2011). In this study approximately 87% of the respondents were 19-40 years old and therefore still productive. This condition can influence the workers' physical activities and life habits. However, the finding on exercise was contrasted with the finding exercise activities reduced the risk of MSDs (Descarreaux, Normand, Laurencelle, & Dugas, 2002; Rainville, Hartigan, Jouve, & Martinez, 2004). This can be explained by the sample size was small.

From the results, age have a positive weak correlation with the prevalence of MSDs (r_s = 0.045) These results indicate that age significantly and simultaneously influence the occurrence of MSD complaints.

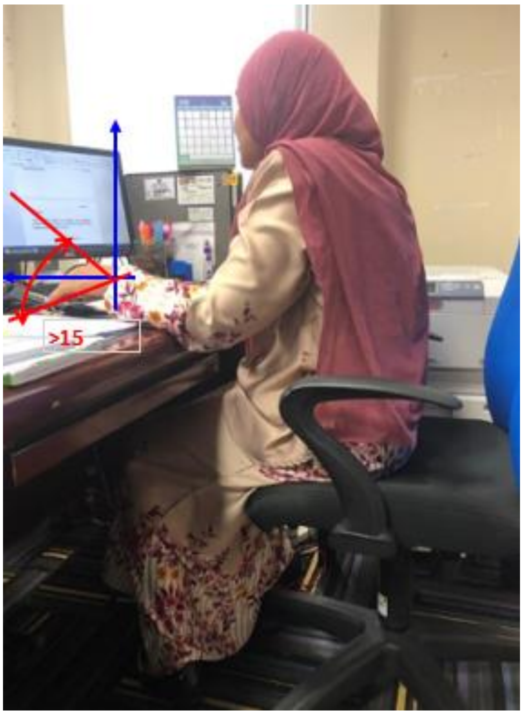
The results analysis from questionnaire showed a weak correlation and significant in knowledge, behavior and sociodemographic risk factors, therefore further investigation on ergonomic assessment by using RULA methods was done to identify which body part was the most affected by sitting position.

5.3 Body Posture Analysis by Using RULA

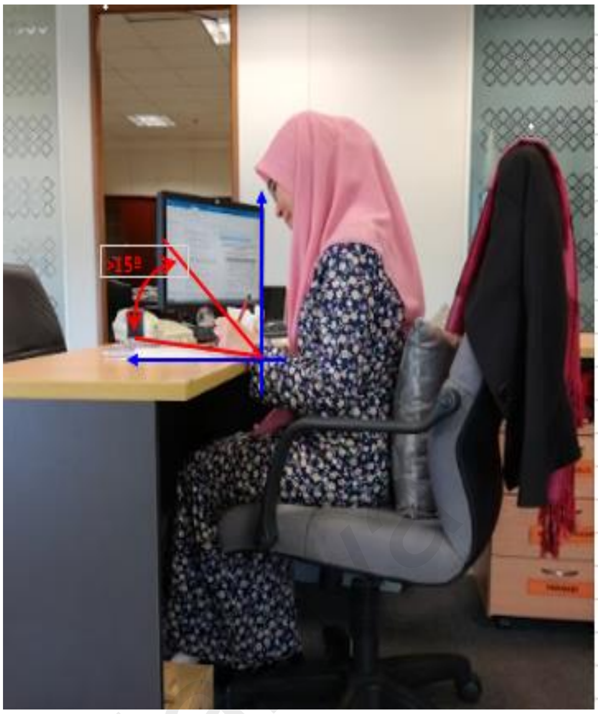
An investigation of ergonomic risk factor of upper body posture while sitting was conducted in this study. The study target is to determine which body regions are exposed to WSMD by using RULA tools. RULA scored show a result of body posture analysis for upper body limb when performing task. Furthermore, the final RULA score will determine the action level needed.

The results of the study from RULA score shows that 9 (45%) workers out of 20 workers are working under unnatural body posture particularly in their wrist and trunk region. No workers found to scored 1 in RULA final score. The result highlighted, that wrist scored the highest risk of body part according RULA. The mean for wrist score was stated at 3.10 (77.50%) %) which is apparently significant if compared to the maximum score of 4. This result shows that the wrist position is not in correct posture and at risk of MSD. Most of the workers work in wrist position bent from midline and in extension while doing their job.

From the observation, the workers wrist position is bent from the midline and moved 15º above and 15º below from midline of the wrist. Most of the wrist position showed twisted in mid-range while performing tasks (Lueder, 1996) This finding is in line with other study where the mean score of RULA was high in wrist among office workers (Kaliniene et al., 2016).



Monitor is high > 200. The keyboard is too high. Hand position when typing is > 15 º



Hand position when writing is > 15 º

Figure 5.1 Wrist Awkward Position

The wrist is being used mainly when working with computer. Wrist position and wrist score were assessed by considering the upward or downward position from midline, degree of bending and the twist of the wrist (Lueder, 1996). In this study, most of the workers performed their task at about chest height and the exposure levels for shoulder/arm are moderate compared to wrist. The wrist flexion is > 15º and from the survey majority of the workers were using computer more than 3 hours daily while performing tasks. When using computer for more than 3 hours and extremely use the wrist the workers were getting tired throughout the job task, and the upper body of workers getting forward as time goes by and will affect the trunk posture.

Another body part that has significant risk of Part A body region lower arm. The RULA score is 2.13 (42.67%) compared to maximum score 3. This result demonstrates the lower arm flexion angle was stated at 0º to 60º until 100º throughout to performing of the job task. The reason for this can be related to the repeated activity in body region, long-term involvement of static works, inadequate rest, and awkward postures during work with computers (Habibi, Mohammadi, & Sartang, 2016). (Kaliniene et al., 2016) found that 20% -30 % of computer workers complaints pain in arm, wrist, and hand.

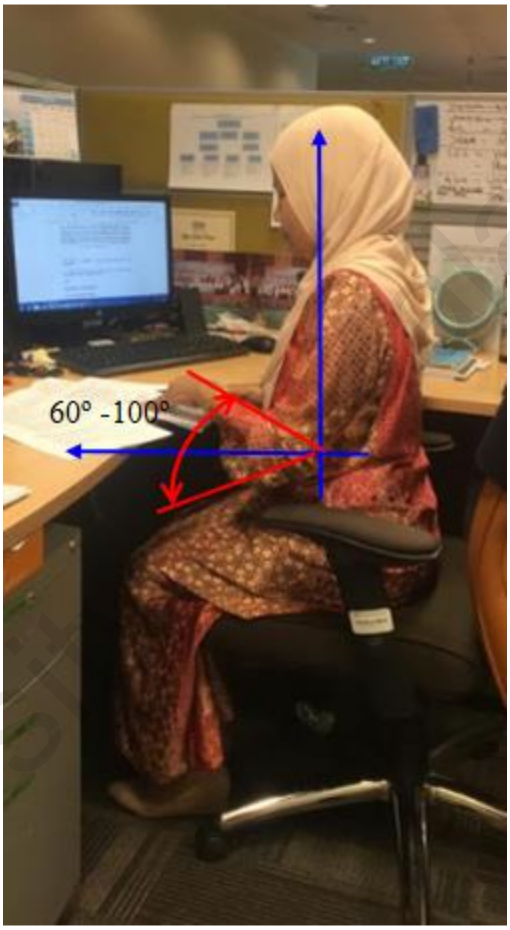


Figure 5.2 Lower Arm Awkward Position

The score for majority of the workers (70%) is 2 to 4 which indicates relatively good condition of neck, trunk and leg posture (Part B). This finding was contras with the previous studies where a high prevalence of MS pain in body parts such as shoulders, upper back, and low back among office workers were found. Neck pain is in the most affected position with the prevalence ranging from 19 % to 70 % in the population of office workers (Davudian-Talab, Azari, Badfar, Shafeei, & Derakhshan, 2017; Kaliniene et al., 2016). This can be explained by some respondents that use some back support or lumbar roll that can help posture of sitting while working. Most of the workstations can be adjusted the chair height so the workers can sit up close to their work and tilt it up.

From the table 5.1 , priority is given to most effective body region for control measure to be taken and implemented change. Expected final RULA score after control measure taken is to reduce from the risk level from low to lower risk.

Table 5.1 Final RULA Score

FINAL RULA SCORE	SCORE A	SCORE B	RULA SCORE
Mean	4.10	3.10	4.00
%	51.25%	44.29%	57.14%
Most Effected Body Region	Wrist	Trunk, Neck, Leg	

In summary, based on the result from RULA analysis, it is showed that the mean RULA final score of 20 workers was 4 indicating that further investigation is needed and change of posture may be required. There was a low risk exposure level caused by working in sitting position. By comparing the mean score of each body region, wrist and trunk are the most significant impact of body region at sitting position. During work, workers subconsciously have tendency to accept and adapt to unsatisfactory sitting working conditions. Higher RULA score indicates the working posture is at higher risk of getting MSDS. While, lower RULA score indicates the higher validity of work posture and lower risk of getting MSDs. Workers may not realize that their body is under stress until they feel pain and even, they may not understand the exact causes. Therefore, further investigation is needed to reconfirm and reevaluate this finding. Some other methods of analysis may be used to compare the reliability of the results. Some other methods that might be used is a checklist of body posture by ROSA (Rapid Office Strain Assessment) or Maastricht Upper Extremity Questionnaire (MUEQ).

5.4 Control Measure and Improvement for Sitting Position and Workstation

A guideline on occupational safety and health for seating at work by DOSH has been published that recommend suitable seating conditions and advice on the design and selection of seating (DOSH, 2002). The guideline provides advice and suggestion on the design and selection of seating to the employers and employees.

Based on the guideline, the work station needs to redesign to avoid strain and damage to any part of the body especially the back. While working, workers subconsciously have tendency to accept and adapt to unsatisfactory standing working conditions.

Other improvement that can be done is by doing prevention based from Hazard Identification, Risk Assessment and Risk Control (HIRARC). There are a few methods of hazard control method that can be used to improve the working environment and condition. First hierarchy of control used is to eliminate the risk body posture. By eliminating the risk body posture, the risk of getting MSDs can be reduced subsequently. The reduction can be done in closed monitoring by a safety and health team for a period of time as a task force. Secondly, through substitution of doing the same work in a less hazardous. Some work process can be change such as the change from computer use to laptop use which can adjust by the workers according to their body height and reach. Then through the engineering control method such as redesign the workstation or changing the chair used by the workers. Proper design of the workstation decreases the effort required of the worker to maintain a working position. The workstation should be fully adjustable as well as fit the worker's body size and shape. Then, administrative control method also might be useful to control the hazard risk. It can be done by introduce frequent break (light exercise) policy at work. Continue supervision and training on safe work procedure also is one of the methods that can be used to reduce and eliminate the risk at workplace. Last but not least, is to provide personal protective equipment (PPE) to workers. In this situation, the PPE can be used is lumbar support to help workers to sit in comfortable and better position.

5.5 Work Practices

Training is essential to increase awareness on MSDS and healthy postures. Besides that, regular training can develop a positive attitude towards the importance of ergonomic and correct sitting posture to the workers. Previous study showed a significant improvement in workstation habits after a controlled trial was conducted before and after received training and the neck showed the highest reduction compared to other body parts (Mahmud, Kenny, Md Zein, & Hassan, 2011).

Training should be given to workers engaged in works involving repetitive tasks. Management should emphasize the importance of rest periods during work time and make practice to do a short break between tasks to relax body muscles. This practice can be done by introducing an intervention computer program to pause for a few minutes automatically after 2 hours usage and play a slow music to encourage workers to do exercise at the workstation itself.

CHAPTER 6: CONCLUSION

6.1 Introduction

An investigation of ergonomic risk factors of upper body posture and level of MSD risk among office workers while sitting was conducted in this study. The study aims to determine the risk factor, knowledge level and behavior among the office workers and the association with MSDs symptoms. Further, ergonomic assessment was done to determine which body regions are exposed to WMSD risk by using RULA method. RULA score offered a result of body posture scores for neck, trunk, leg, arm, wrist and force/load factor when performing the task. Furthermore, the final RULA score of analysis also provided the action level needed for either workstation or work method improvement.

6.2 Conclusion

The results highlighted based on the result from questionnaire and RULA assessment. Sociodemographic data from questionnaire were compared to the NQM to investigate which body regions that most commonly affected by MSDs. The results of the analysis highlighted the prevalence of MSD among office workers. The results of the NMQ revealed that shoulder, upper back, lower back and neck were the most prevalent problems reported by office workers. Repetition, awkward postures or long-term static postures are considered the principal physical work-related risk factors in relation to MSDs. The age factor was found to have a correlation with the prevalence of MSDs. It was also found there is no relationship between gender, age education level and frequency of exercise with the symptoms of MSDs

In addition, another significant finding is the majority of the subject were aware of ergonomics knowledge. Analysis on the knowledge about postures, seating, musculoskeletal disorders and its risk factors, working postures, seating position, workstation and finally rest breaks and exercises revealed that percentage of MSDs symptoms reduce when the participants have a knowledge of awareness on ergonomic.

However, results on behavior responses among participants showed that majority of the participants responses to “sometime” in every question about the behavioral which indicated the subject’s behavior was not in good or correct behavioral at all time when sitting.

RULA analysis highlighted that the mean RULA final score was 4 (low risk) indicating that further investigation is needed and change of posture may be required. The most contributing factor for RULA score is coming from wrist, lower arm and trunk position. For effective control measure to be taken, these three-body regions must be taken into consideration before implementing any changes and/ or improvement. To conclude, the study has highlighted the significant findings on the relation of ergonomics risk factors and MSD among sedentary office workers. Thus, it is timely for organization to have corrective plan measures and correct working practices to reduce ergonomics risk factors and further improve workers productivity.

6.3 Recommendation

The guiding principle in workplace design is to fit the workplace to the worker. Evaluation of the workplace can identify the source or sources of WMSD. From the study, we found that further control measure and change is needed to improve the working conditions at sitting position. The following fundamental of ergonomics by (Mojtaba Valinejad Shoubi, 2013) described good and correct working practices and can be followed adapted as a work practices:

1. Work in natural posture - Neutral postures are postures where the body is aligned and balanced while either sitting, putting minimal stress on the body and keeping

joints aligned. Neutral postures minimize the stress applied to muscles, tendons, nerves and bones and allows for maximum control and force production.

2. Work in the Comfort Zone
3. Allow for Movement and Stretching - The musculoskeletal system is often referred to as the human body's movement system, and it is designed to move.
4. Reduce Excessive Force - Excessive force prior to workload can create a potential WMSD risk and exposed muscles for fatigue and injury.
5. Reduce Excessive Motions - A job is considered highly repetitive if the process cycle time is half minute or less.
6. Minimize Contact Stress - According to OSHA, contact stress results from continuous contact or rubbing between hard or sharp objects/surfaces and sensitive body tissue, such as soft tissue of the fingers, palms, thighs and feet.
7. Keep Everything in Easy Reach – Parts and components in workplace area should be put in easy reach conditions with easy body movement. In many ways, this principle is redundant with posture, but it helps to evaluate a task from this specific perspective.
8. Maintain a Comfortable Environment – Adequate lighting and away from any hazards. Comply with health and safety legislation.

This study has revealed that there are opportunities to access the knowledge, behavior and practices (KAP) in safety and health in regards of ergonomic in Malaysia in the future. Therefore, the following field can be implemented for future studies:

1. Develop training modules and look for KAP impact before and after receiving training;
2. Cohort study on KAP after and before implementing intervention;
3. Current study can be extended to the large number of populations in Malaysia.

6.4 Significant of the Finding

Lastly, this study provides surface information and as a platform to further investigate WMSD risk at sitting position. Therefore, for future study is it recommended that a proper ergonomic workstation with deeper analysis should be taken place. Below are significance of the findings of this studies:

1. Provide and determine level of ergonomics risk exposure for workers during sitting.
2. Provide information in evaluating better workstation based on ergonomics principles.
3. Provide ideas and partial solutions for control measure to reduce the WMSD.

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