THE RELATIONSHIP BETWEEN MUSCULOSKELETAL DISORDERS AND MENTAL WORKLOAD AMONG FEMALE COMPUTER WORKERS AT SERVICES SECTOR IN SHAH ALAM

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FACULTY OF ENGINEERING

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RESEARCH REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SAFETY, HEALTH, AND ENVIRONMENT ENGINEERING

FACULTY OF ENGINEERING
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Name of Degree: Master's in Safety, Health, and Environment Engineering

Title of Research Report ("this Work"): The Relationship between Musculoskeletal Disorders and Mental Workload among Female Computer Workers at Services Sector in Shah Alam

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ABSTRACT

This study conducted to determine the relationship between musculoskeletal disorder and mental workload among female computer workers. This study conducted on sixty (60) female computer workers at services sector in Shah Alam. An assessment method to determine the ergonomic risk level for the workstation is using the ROSA tool. The questionnaire distributed is concerning the demographic data of respondents. The assessment of level musculoskeletal disorders was assessed using the Cornell Musculoskeletal Discomfort questionnaire. The mental workload level was evaluated using Carmen-Q and NASA-TLX. The level of mental health is assessed using DASS-21. The data were analyzed using SPSS version 20.0.

The level of ergonomic risk for workstation obtained is 5.54. 50% staff experience a severe level of musculoskeletal disorders with majority of the workers experience discomfort at the lower back (13.5%), neck (12.4%), and right shoulder (9.7%). For the hand region, the data showed respondents are experienced discomfort at area A (11.96%), area B right (9.96%), and at area E right (9.96%). NASA-TLX index showed that the subject assessed that Effort Demand is the highest segment with 64.08%, Temporal Demand (63.67%). DASS-21 showed that most subjects have mental stress issues, with a percentage of 81.7%. For the segment of DASS21 that symptomize, anxiety held at the highest rate followed by depression in the 2nd place, with 15% of the respondents felt mild.

Pearson Correlation statistically showed a significant correlation between the total score of: Weighted Workloads and total score for the MSDS body region, a few part of MSDS body region with a few segment under mental workload score, total score of Weighted Workload with MSDS right-hand, and MSDS hand left.

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ABSTRAK

Kajian ini dilaksanakan bagi mengenalpasti hubungan antara gangguan rangka otot dan beban kerja mental dikalangan pekerja komputer wanita. Kajian ini dijalankan ke atas enam puluh (60) pekerja komputer wanita di sektor perkhidmatan di Shah Alam. Kaedah penilaian bagi mengenalpasti tahap risiko ergonomik untuk stesen kerja adalah menggunakan kaedah ROSA. Soalan diagihkan mengambilkira demografik responden, penilaian tahap gangguan rangka otot menggunakan soalan kaji selidik *''Cornell Musculoskeletal Discomfort''*. Tahap beban kerja mental dinilai dengan kaedah Carmen-Q dan NASA-TLX. Tahap kesihatan mental dinilai menggunakan kaedah DASS21. Data analisa menggunakan SPSS versi 20.0.

Tahap risiko ergonomik untuk stesen kerja ialah 5.54. 50% pekerja mengalami gangguan rangka otot pada tahap yang teruk dan majoriti pekerja mengalami gangguan pada bahagian pinggang belakang (13.5%), leher (12.4%), dan bahu kanan (9.7%). Bagi bahagian tangan, data menunjukkan pekerja mengalami gangguan rangka otot pada bahagian A (11.96%), kawasan B kanan (9.96%), dan di bahagian E kanan (9.96%). Indeks NASA-TLX menunjukkan penilaian pada pekerja *''Effort Demand''* adalah segmen tertinggi dengan 64.08%, *''Temporal Demand''* (63.67%). DASS-21 menunjukkan majoriti pekerja mengalami isu tekanan mental dengan peratus 81.7%. Bagi segmen di bawah DASS-21 yang bergejala, anzieti yang tertinggi diikuti oleh kemurungan di tempat kedua dengan 15%.

'Pearson Correlation' secara statistik menunjukkan terdapat hubungan signifikan antara: jumlah markah bagi *''Weighted Workload''* dan markah bagi MSDS pada bahagian badan, beberapa bahagian MSDS bahagian badan dengan segmen di bawah markah beban kerja mental, jumlah markah *'' Weighted Workload''* dengan bahagian tangan kanan dan MSDS pada bahagian tangan kiri.

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LIST OF SYMBOLS AND ABBREVIATIONS

MSDS	:	Musculoskeletal Disorder
WRMSD		Malaysian Investment Development Authority
ROSA	:	Rapid Office Strain Assessment
OSH	:	Occupational Safety and Health
SOSCO	:	Social Security Organization
DOSH	:	Department of Safety and Health
FMA	:	Factory and Machine Act
OSHA	:	Occupational Safety and Health Act
NIOSH	:	National Institute of Occupational Safety and Health
CMDQ	:	Cornell Musculoskeletal Discomfort Questionnaire
NASA-TLX	:	The National Aeronautics and Space Administration - Task Load Index
WWL	:	Weighted Workload

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LIST OF APPENDICES

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CHAPTER 1: INTRODUCTION

1.1 Background of Study

Referred to (Punnett & Wegman, 2004) in a journal study on Work-Related musculoskeletal disorders: The epidemiologic Evidence and the Debate mention that Musculoskeletal Disorders terms refer to a wide range of inflammatory and degenerative condition that were effecting the muscle, tendons, ligament, joints, peripheral nerves and supporting blood vessel. The journal also stated that manual-intensive occupations are the activity that has extremity musculoskeletal disorders, the movement such as cleaning, delivery service, clerical work, industrial inspection, and computer workers. Refer to (Rempel, 1999b) a musculoskeletal discomfort is referred to injuries affecting the soft tissues of the neck, shoulder, elbow, hand, wrist, fingers, and include the nerves.

The computer workers' responsibilities have consequences regarding concentration in human-machine associations and exact quick-reaction processes in the processing system. These duties demand several mental functions, including continuous high concentration and focus, noticing, proper high vision, increased memory, planning, and decision making. In the ergonomic field, the mental workload is commonly accepted; no formal definition of workload exists. Much attention has been paid to physical workload, workplace factors, and workstations in creating these mental workloads and musculoskeletal disorders. However, only a few studies have reported relationship between psychological and physiological factors in workplaces (E. Darvishi, Maleki, Giahi, & Akbarzadeh, 2016).

This study examined the relationship among three factors, mental workload, mental stress, and MSDS, this study also examined the level of ergonomic risk of computer workstation

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among female workers at services sector in Shah Alam. These studies were reviewed via assessment method and questionnaire survey on sixty female computer workers (at Lembaga Zakat Selangor (MAIS)) whose job required extensive use of computers like call center operator, service counter, office work, and secretary work. The questionnaire was distributed and collected daily for twenty days.

With this research study, a healthy workplace will be recommended considering this two-aspect psychical and psychosocial and hopefully improve a better work environment and increase its production for the workplace.

1.2 Problem Statement

Computer workers deal with the high complexity of activity and work environment, interaction among machines, a design of workstation and equipment, data entry, environment of workplace, body posture, and job content (Matos & Arezes, 2015). This work has been related to some WRMSD risk factors and mental issues, especially in stress and mental workload. Working with complicated postures, prolonged static motion, non-neutral postures of the upper limb low, static load, or repetitive motion is the factor of increasing muscular activity in the upper back and shoulder (Ming, Narhi, & Siivola, 2004).

The computer workers' duties have particular implications regarding concentration in human-machine relationships. These duties demand several phycological functions, including high demand for attentiveness, perceiving, proper vision, memory, planning, and decision making.

Therefore, the mental workload can be categorized as one of the factors in creating MSDS. The correct understanding of mental workload and its effect on performance and individual health is vital in the workplace. Hence, this study aims to determine the level of musculoskeletal discomfort, the factor affecting it, and the correlation with the mental

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workload. These findings propose enhancement in the ergonomic environment among female computer workers in the services sectors.

1.3 Aim of the Study

This study aims to determine the relationship between musculoskeletal disorders and mental workload among female computer workers in the services sector in Shah Alam.

1.4 The objective of the study

Following are the objectives of the study:

i. To identify the level of musculoskeletal discomfort symptoms and ergonomic risk level on female computer workers.
ii. To determine the level of mental workload and the level of stress among female computer workers.
iii. To determine the relationship between musculoskeletal discomfort and mental workload on female computer workers
iv. To recommend an ergonomic work design for a healthy working condition for female computer workers' workstation.

1.5 Scope of the Study

To achieve the objectives, the scope of the project is limited to:

i. The workers involved in this study are permanent female computer workers.
ii. All respondents are working in normal office hours, 8 hours per day, and five days a week.
iii. Rapid Office Strain Assessment is observed only on the assessment of chair, monitor, computer peripheral, and phone.

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1.6 Report Outline

This report consists of 6 chapters, as follow:

Chapter 1- Introduction of female computer workers in the services sector as the background of this project. In this chapter, problem statements, research problems, objectives, and scope of research will be discussed.

Chapter 2- Literature review based on the current findings related to MSDS, ROSA, ergonomic workstation, mental workload, work stress among female computer workers.

Chapter 3- This chapter will discuss the project methodology used to complete this project, such as questionnaire, observation, and measurements.

Chapter 4- All the results obtained from observation, questionnaire, and measurement will be discussed

Chapter 5- Proposal on ergonomic improvement will be discussed

Chapter 6- Conclusion and recommendation from the data analyzed and project objective with the recommendation was summarized

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CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Nowadays, it is hard to imagine that the service sector will operate without a computer. Computers have become a part of day-to-day life, whether at home or work. Over the past decade, effects and technology changes, especially computers, have become a crucial part of employment opportunities, job content, and work reward (Lowe, 1997). Since 1993, most workers have used a computer during their job duties, and both women and men become part of computer users in that era (WEINBERG, 2000). Every activity can be done more efficiently and effectively, starting from data collection, writing paperwork, and making any decision. Computers are becoming a cornerstone for every organization, especially in the service sector. (Andries, Smulders, & Dhondt, 2002) A study on computer activity among the European Union workers and its influence on the quality of work showed that computer activity in the office had increased rapidly between 1992 and 2000. In general, the study also stated that the use of a computer results in more qualified work and less physical movement. Still, those who work with a computer permanently clearly show more physical and psychosocial issues compared to those who use a computer part-time. The other study on a computer user in Europe shows that the proportion of workers using computers has increased from 40% to more than 60% over 20 years.

Furthermore, several countries in Europe have seen a significant increase in computer use event in low-skilled occupations (Menon, Salvatori, & Zwysen, 2018). The analysis of the study on data computer use by employees show in between 1984 and 1989, the percentage of workers who report using the computer at work increased by over 50 percent. From 24.6 to 37.4 percent of the workforce, female are more likely to use computers at work than men

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(Kruger, 1991). Therefore, because of the importance and the need of a computer for life, work, career, industry, economy, and the widespread use, the use of computer will affect human health physically, emotionally, and mentally. Many epidemiological studies show many complaints, especially in musculoskeletal discomfort among employees (Kaliniene, Ustinaviciene, Skemiene, Vaiciulis, & Vasilavicius, 2016).

2.2 Computer Work and Task Behavior

Job content, speed data entry, work environment like lighting, work station dimension, and equipment are a part of complex computer work activity (Matos & Arezes, 2015). This work has been related to some WRMSD risk factors and mental issues, especially in stress and mental workload. Working with non-natural posture, prolonged static movement sustained non-neutral postures of the upper limb low motionless load or repetitive work increased muscular activity in the upper back and shoulder. It's a part of computer workers' routine activities (Ming et al., 2004). (Ming et al., 2004) added that because of all the actors involved in computer workers, shoulder and neck pain become a common problem for those who use computers intensively. Computer workers are categorized as a sedentary job with constrained posture, restrictive, and excessively monitored (Norman, 2005). Performing this call center task and computer behavior using the telephone while simultaneously using display equipment and typing data continuously for 4-8 hours will lead to Musculoskeletal Disorder (MSD) and psychosocial and mental health problems. Computer users spent an average of 16.2 hours weekly on their machines, and in primary occupations average weekly hours range is around 8 and 9 hours (Inc., 1997). Computers workers are deal with their flat light-touch keyboard, and related peripheral technologies (Mouse, touch-pad, etc) have caused more common reporting of injuries and health problems.(S. A. Zakerian & Subramaniam, 2015).

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2.3 Female Workers in Computer Work Environment

A high level of computer use is reported among female workers. Over 37% of women used computers in their work compared with about 30% of men (Inc., 1997), and around 80% of them is clerk. Computer users spent an average of 16.2 hours, compared to the man, women spent slightly more hours using a computer (Inc., 1997). The demand for female workers in computer use is increased rapidly, starting in 1970, and the increased use of computers is because the job is acquiring computer skills (WEINBERG*, 1997).

2.4 Ergonomics

Ergonomics is explained as is the education of work design is based on the human biological sciences: anatomy, physiology, and psychology (SINGLETON, 1972). W.T Singleton also divided ergonomics into three components of ergonomics which are Anatomy covered for anthropometry and biomechanics, Physiology was covered for work physiology, and environmental physiology and meanwhile Psychology was covered skill psychology and occupational psychology. According to R.S Bridge, the implementation of ergonomics should make the system of work better by eliminating aspects such as Inefficiency, fatigue, accident, injuries, user difficulties and low morale and apathy (BRIDGE, 2009). The International Ergonomics Association defined ergonomics as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human wellbeing and overall system performance" (EIA2019). EIA also divides the ergonomics discipline into three categories: Physical ergonomics is concerned with human anatomical, anthropometric physiological, and biochemical. Mental ergonomics is concerned with cogitive processes, and Organizational ergonomics is concerned with sociotechnical optimization (EIA 2019). Thus, it can be concluded that ergonomics is a

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comprehensive study that was not approaching human physiology solely but psychological as well. Applying ergonomics at the workplace gives comfortable working conditions, increases the level of efficiency and work efficiency, reduces errors, raises productivity, reduces fatigue and stress, and improves work productivity and quality of life.

2.5 Ergonomics in Legislation Perspective in Malaysia

In Malaysia, the Malaysia government established two main Act that covers safety and health in the workplace. It is the Occupational Safety and Health Act 1994 and Factory and Machinery Act 1967. This act aims to prevent any illness, injuries, and accident that cause by the operation of work in the workplace. Regulations, guidelines, and industrial code of practice have been drawn up to support both Acts. Referring to the journal The Influence of ergonomics on Occupational Safety and Health (OSH) legislation in Malaysia (Sirat & Shaharoum, 2011), there is significant evidence of important ergonomics influences OSHA. Still, it is not having clearly stated in the Act; some parts of the Act refer to ergonomic and are detailed enough to merit acting. From the study on the implementation by the Malaysian government, that can be concluded, the government of Malaysia with the Department of Occupational Safety and Health has put much effort to ensure the safety and health of employers, employees, and others than employees are absent from any risk in terms of psychological and physiological.

Below is the summary of ergonomic mentioned in the Act, regulation, and guidelines available in Malaysia.

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TABLE 1: ACT, REGULATION, AND GUIDELINE IN MALAYSIA

Issue	The detail in the category (FMA/OSHA)	Act or regulation relevant to ergonomics
Objective of OSHA	Sec.4 OSHA 1994	The objective of OSH: - To promote an occupational environment for a person at work which is adapted to their physiological and psychological need
Safety and Health policy	Sec16 OSHA 1994	……...to prepare……a written statement of general policy with respect to the safety & health at work.
Medical Surveillance	Sec.28 OSHA 1994	By reason of changes in any process…. …there may be a risk if injury to the health of person employed in the process.
Function of SHO	Sec.15 OSHA	… Duty extends, include in particular: a) Provision and Maintenance of Plant b) Making Arrangement
Space (related to anthropometry	Reg.24 Safety, Health and Welfare Regulation 1970 under FMA 1967	1) …not less than four hundred cubic feet of space for each person employed therein, and in determining such space, all space more than fourteen feet above the level of the floor shall not be considered.

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Height at work room (related to anthropometry	Reg.24 Safety, Health and Welfare Regulation 1970 under FMA 1967	2) Every workroom shall not be less than 10feet in height measured from the floor to the lowest point of any cross beam
Work bench (related to work method problem)	Reg.31 Safety, Health and Welfare Regulation 1970 under FMA 1967	Every workbench or worktable shall be of a design construction and dimension suitable for persons employed so that the work can be carried out without undue strain.

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TABLE 2: MATRIX ON ERGONOMICS GUIDELINES AVAILABLE FOR OSH IN MALAYSIA

No	Guideline Ergonomics issue	Guideline on seating at work 2003	Guideline on standing at work 2002	Guideline on Occupational safety and health in the office1996	Guideline on working with VDU 2003	Guideline on registration of assessor, hygiene technician and occupational health doctor,	Guidelines on OSH in agriculture ure, 2006	Guideline on safety and health in logging operation, 2004	Guideline on safety and health in fishing and aquaculture operations,	Guideline on Occupational Health services, 2004
1	Temperature / heat stress	-	-	◘	○	-	●	-	○	-
2	Humidity	-	-	-	○	-	-	-	-	-
3	Ventilation	-	-	●	-	-	○	-	○	-
4	Vibration	-	-	-	-	-	○	○	-	-
5	Lighting/ illumination	-	-	◘	◘	-	○	○	○	-
6	Color	-	-	◘	-	-	○	-	-	-
7	Noise	-	-	-	◘	-	●	◘	○	○
8	Space	●	●	○	-	-	○	○	○	-
9	Manual handling		-	◘	-	-	●	●	-	-
10	Stress	○	◘	○	-	-	○	○	○	-

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11	Work bench height	◘	-	○	◘	-	○	○	-	-
12	Chair	●	-	○	◘	-	○	○	-	-
13	Screen placement		◘	◘	●	-	-	-	-	-
14	Posture and movement	●	●	◘	●	-	○	○	-	-

2.6 Work-Related Musculoskeletal Disorders (WRMSDs)

Referred to (Punnett & Wegman, 2004) in a journal study on Work-Related musculoskeletal disorders: The Epidemiological Evidence and the Debate mention that Musculoskeletal Disorders terms refer to a wide range of inflammatory and degenerative condition that are effecting the muscle, tendons, ligament, joints, peripheral nerves and supporting blood vessel. The journal also stated that a clerical work, postal service, cleaning, industrial inspection, and packaging is the activity that generates highly prevalent upper musculoskeletal disorder. Refer to (Rempel, 1999b) is refers to injuries affecting the soft tissues of the neck, shoulder, elbow, hand, wrist, fingers, and include the nerves.

Musculoskeletal disorders affect the human body system, such as muscles, tendons, ligaments, nerves, discs, blood vessels, etc. According to the Annual Report by SOCSO (Figure 1), the MSDS reported an increasing trend from 1995 to 2009. In eight (8) years, MSDs cases tremendously increase, and all parties, governments, and industries need to find a better solution to reduce the MSDS cases in Malaysia.

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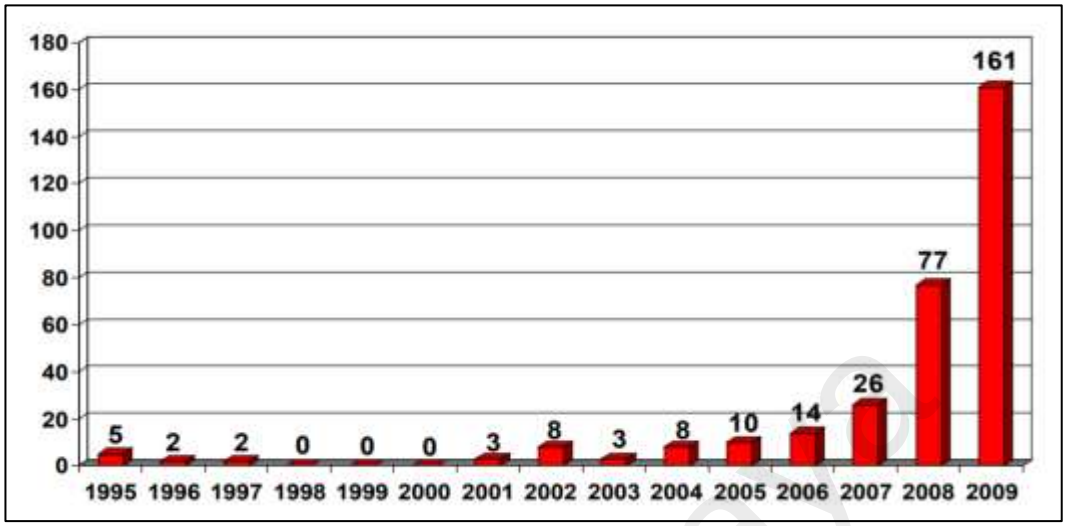
FIGURE 1: MSD CASES TREND FROM 1995 TO 2009



2.7 Work-related Musculoskeletal Disorders among Computer Workers

In Malaysia, the impact of work-related musculoskeletal disorders on quality of life have been documented for different occupational groups and industry. Office workers in Malaysia are one of the high-risk occupations that can be affected by MSDs. The regular use of computers and simultaneously answering a phone call with prolonged static movement, an awkward posture of the neck, and repetitive movement are the key operation of computer activity. This movement and task can lead to the many risks of ergonomics issues such as musculoskeletal disorder and mental workload. The increasing popularity and use of computers and computer peripheral technologies (mouse, touchpads, etc.) have caused more common reporting health problems, especially musculoskeletal disorder issues. The study by (Anghel, Talpos-Niculescu, & Lungeanu, 2007) found that pain and injury or MSDS are consequences of the working process. Workers tend to apply wrong postures like prolonging static movement, awkward posture, and repetitive movement during works. (Shikdar & Al-Kindi, 2007) identifies that the employees are used a computer for long hours, prolonged movement in the same posture, and inadequate rest breaks can lead to ergonomic issues and work-related health symptoms. (Matos & Arezes, 2015), conducted evaluation of office

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workplaces with Rapid Office Strain Assessment indicates that the sitting posture at the computer that workers implemented throughout the workday and its dealings with the workplace environment can cause muscle stress in the shoulder and neck area. A study of work-related complaints of Arm, Neck, and Shoulder (CANS) among office workers in Selangor and Kuala Lumpur done by (Faryza, Murad, & Anwar, 2015) reported that 53% of the workers have pain in the neck region and 53% at the shoulder region. All the workers' complaints are associated with workstation, body posture, break time, and social support. A study by (Noraziera & Norzaida, 2018) shows a similar finding that musculoskeletal issues' prevalence is the high level of risk among the office workers were use a computer workstation during work hours. WRMSD is registered as a common ergonomics issue on call center operators and was found to have a high prevalence among computer users. (Odebiyi, Akanle, Akinbo, & Balogun, 2016), refer to (Poochada & Chaiklieng, 2015), a study conducted among 216 call center workers in Khon Kaen province in Thailand shows that most call center operators were at a high-risk level WRMSD development. The same results study conducted by (Miller & Hendrickse, 2016) stated that most workers using a computer as a working platform indicated that they had experienced aches, pain, and discomfort in various parts of the body such as the neck, shoulder, and lower back. WRMSD has a serious impact on the call center's daily job activities. There were discomfort in the neck, low back, and knees that prevented most call center operators from performing their daily work. (Imtiazhossain, Muniandy, Nasiruzzaman, & AsifmahbubKarim, 2018) Musculoskeletal difficulties are why the employee turnover rate is high among call center operators in Klang Valley. An in-depth review studied by (Wahlstrom, 2005) on Ergonomic, Musculoskeletal Disorders, and Computer Work found that the perceived muscular tension is developed by computer work activity that involved physical, psychosocial, and organization factors. The intervention on MSDS issues among computer workers should be carried out directly through

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physical, work organizational, and psychosocial factors. Therefore, from the studies mentioned above, the work activities involving computers as a routine activity are more likely prone to experience musculoskeletal disorder issues. Musculoskeletal disorders among computer workers still become a health issue among employers to gain the productivity of workers. The neck, shoulder, and lower back body region are more likely to experience computer workers' pain and discomfort. For example, the intervention workstation, re-arranging workspaces, adjusting furniture and accessories, and changing computing work habits can reduce musculoskeletal discomfort and increase environmental satisfaction(Robertson, 2007).

2.8 Mental workload Among Computer Workers

Mental workload is a popular topic for ergonomics, phycology, and organizational behavior-related studies. The mental workload is an exact synonym in ergonomic and human factors fields and is widely used and represents an essential topic. The mental workload can be useful for self-performance and can be harmful, workers can thrive under high MWL, or workers' performance can drop if the demand becomes too low or too high. Mental workload also could affect the individuals who are interacting with computers and other devices while navigation complex interfaces that might impose high cognitive demand (Alsuraykh, Wilson, Tennent, & Sharples, 2019)

Mental workload and stress also can be categorized under one of ergonomics risk factors. Too much workload, an inappropriate working environment, working with awkward posture, unhealthy lifestyle, and sedentary behavior was several factors that can lead call center operators to get mental workload and stress. The study on A self-analysis of the NASA TLX Workload Measure (Noyes & Bruneau, 2007) mentioned that the computer-based would demonstrate a significantly higher mental workload compare to paper-based forms. In the

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ergonomic field, the mental workload is commonly accepted; no formal definition of workload exists. Still, the category of workload can be described as a mental construct that reflects the mental strain resulting from performing a task under specific environmental and operational conditions, coupled with the operator's capability to respond to those demands (Cain, 2007). Mental workload may be due to time pressure, procedural uncertainty, outcome uncertainty, task difficulty, procedure requirements, task data quality, conflicting demands, and desired outcomes (Cook & Salvendy, 1998). A study shows psychosocial work factors can also affect musculoskeletal discomfort and work stress (S. A. Zakerian & Subramaniam, 2015). An operator's workload level can affect task performance. This effect can be caused by either excessive or reduced mental workload (Cao, Chintamani, Pandya, & Ellis, 2009). The primary reasons employees are getting stress in their routine lifestyle are non-stop mobile calling, duty to interact with the customer, and complete the target. The threat of intensity makes the employees stressed and depressed. (Dollard, Dormann, Boyd, Winefield, & Winefield, 2003; Heidarimoghadam et al., 2019). (Makhbul, Abdullah, & Senik, 2013) conducted a study on Ergonomics and Stress at Workplace: Engineering Contributions to Social Sciences found that ergonomically design workstations are proven to be a sign to help organizations minimize work stress outcome. According to (Khalid, 2013), employees receive customer calls, increasing their exhaustion level that increases their stress level. (Khalid, 2013) also found that stress can have various harmful consequences leading to physiological and psychological disorders. A high amount of work to be done within time is one reason why employees working with a computer are mentally under pressure, and this can lead to work-related stress, which not only feeling but can cause functional changes in the body (Reinhold, Pille, Tuulik, Tuulik, & tint, 2014). Finding on the study to find out the relationship between Mental Workload, Burnout, and Job performance indicated that there

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was a statically significant relationship were found between job performance and burnout (Akca & Küçükoğlu, 2020).

2.9 Ergonomics Risk Assessment Tools

2.9.1 Cornell Musculoskeletal Discomfort Questionnaire

Questionnaires are widely used to assess musculoskeletal symptoms as self-administered, cost-effective, and practical data collection tools. Using questionnaires in data collection allows one to record the location, frequency, severity, and work performance outcomes of musculoskeletal symptoms such as pain or discomfort. The Cornell Musculoskeletal Discomfort Questionnaire (CMQD) is a data collection tool developed in the Human Factors and Ergonomics Laboratory a Cornell University to assess musculoskeletal symptoms. CMDQ addressee the frequency of severity and work interference of MSD across 20 body parts. (Erdinc, Hot, & Ozkaya, 2011).

2.9.2 Rapid Office Strain Assessment

The intensive use of computers in the office, especially in the service sector, contributed to the appearance of many risks with work-related musculoskeletal disorders (WMSD) such as prolong sitting motion, awkward posture, increasing of muscle use, contact stress with the central body part, especially in an area that involving the tendon. The Rapid Office Strain Assessment (ROSA) is a tool that purposely identifies the risk of an ergonomic cause by always dealing with computer and computer peripherals. ROSA form was designed to quantify the risk associated with computer activity and establish an action level to change based on worker discomfort reports. Computer use risk factors were identified in previous research and standards on office design for a chair, monitor, telephone, keyboard, and mouse. The risk factors were diagrammed and coded as increasing scores from 1 to 3, ROSA final scores ranged in magnitude from 1 to 10, with each successive score presenting an increased

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risk factor. (Sonne, Villalta, & Andrews, 2012). ROSA had been designed for the assessment of office workers. It can help identify factors relating to computer job discomfort, and from ROSA, four risk levels were low, medium, high, and very high. The definition and score were low-risk levels in each risk level - score 1-2 points, medium risk level = score 3-4 points, high-risk level = score 5-7 points, and very high-risk level = score 8-10 points. Referring to some study from (Matos & Arezes, 2015) study on thirty-eight office workplaces shows that workers' interaction with the office task and the adopted sitting posture at the computer throughout the day have effects at a muscular level, mainly for cervical area and shoulders. Thus, the ergonomic risk level among female service sector workers who extensively use a computer can be measured using ROSA assessment tools to identify the ergonomic risk level. A study done by (Rempel, 1999b) has stated that industrial present in the operations of VDT and alphanumeric keyboards, including repetitive motion sustained static neck, shoulder, and hand postures is one of the ergonomic risk factors.

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2.10 Mental Workload Assessment Tools

2.10.1 NASA Task Load Index (TLX)

The six dimensions used by NASA TASK Load Index are mental demand, mental workload, physical demand, performance demand, effort, temporal demand, and frustration (Rubio, Diaz, Martin, & Puente, 2004). Table 3 shows the definition of NASA-TLX dimensions.

TABLE 3: DEFINITION OF NASA-TLX DIMENSIONS

TITLE	ENDPOINTS	DESCRIPTION
MENTAL DEMAND	Low/high	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering. Looking. Searching. Etc)? was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	Low/high	How much physical activity was required (e.g.: pushing, pulling, turning, controlling, activating. Etc)? was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	Low/high	How much time pressure did you feel due to the rate or pace at which the task or task elements

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		occurred? Was the pace slow and leisurely or rapid and frantic?
PERFORMANCE	Low/high	How successfully do you think you were in accomplishing the goals of the task set by the experimenter? How satisfied were you with your performance in accomplishing these goals?
EFFORT	Low/high	How hard did you have to work (mentally and physically) to accomplish your level of performance
FRUSTRATION LEVEL	Low/high	How insecure, discouraged, irritated, stressed, and annoyed versus secure, gratified, content, relaxed, and complacent did you feel during the task?

The NASA TLX has been used in a variety of fields. It has been used in studies involving the evaluation of visual and/or auditory displays, vocal and/or manual inputs devices, and virtual/augmented vision(Cao et al., 2009). Studies have explored the Relationship between NASA TLX ratings and other performance factors such as fatigue, stress, trust, experience, and situational awareness (Cao et al., 2009).

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2.10.2 CARMEN-Q Mental Workload

Carmen-Q was used for the purpose of subjective evaluation of mental workload level. This questionnaire can assess four mental workload segments: Cognitive, temporal, and emotional/ health and performance demands. Carmen Q is a paper-and-pencil questionnaire designed to assess mental workload in a simple, valid, and reliable way and consists of 29 items. The items response format is a Likert Frequency scale of four alternatives in which 0 means never, one rarely, two often, and three always. All items have been stated so that a higher score indicates a more high mental load. (Rubio-Valdehita, Lopez-Nunez, Lopez-Higes, & Diaz-Ramiro, 2017). In this study, exploratory factor analysis and Cronbach's Alpha method were used to determine this version's reliability. The value of reliability is Cognitive Demand 0.86, Emotional Demand 0.86, Temporal Demand 0.78, and performance demand is 0.78 and was considered statically relatively high (Taber, 2017).

2.11 The Relationship between Musculoskeletal Discomfort and Mental Workload and Work Stress

Over the years, computer-based technology has increased work intensity and created stressful and unhealthy working conditions, inadvertently leading to an increase in Musculoskeletal Discomfort and mental issues. Some study shows that computer users experienced musculoskeletal discomfort and psychological stress. A review by (S. A. Zakerian & Subramaniam, 2015) is supported the direct relationship between psychosocial work factors, work stress, and musculoskeletal pain. According (Habibi, Taheri, & Hasanzadeh, 2015), a study on the relationship between mental workload and musculoskeletal disorders found significant relationships, especially in low back pain and frustration. With the increasing numbers of workers who use a computer for work, especially among office workers, there is a high risk of MSDs and mental health. There is a significant relationship between

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psychosocial factors, work stress, and musculoskeletal discomfort (S. A. Zakerian & Subramaniam, 2015). A journal from Occupational Health and Epidemiology Journal indicated a considerably high correlation between mental workload, occupational fatigue, and Musculoskeletal discomfort (Haghshenas et al., 2018). (Issever, Ozdilli, Altunkaynak, Onen, & Disci, 2008) In their study, one of the factors of depression among office workers is issues relating to musculoskeletal disorders.

Based on the analysis above, it can conclude that there is a correlation between musculoskeletal discomfort and mental workload but in various occupational fields. The healthy workplace recommendation considering these two-aspect psychical and psychosocial can perhaps improve a better work environment and increase the organization's production.

2.12 Summary

Traditional ergonomic risk factors such as awkward posture, repetitive movement, and contact stress have been hypothesized as a factor that can contribute to work-related musculoskeletal disorder among female computer workers. Nevertheless, a recent study shows that psychosocial factors contribute to ergonomic risk issues among computer workers. Most of the previous studies found a correlation between musculoskeletal disorder and mental workload in computer workers. Hence, the mental workload should evaluate as a risk factor in creating the MSDs and mitigate and control the issues on MSDs appropriately. It is necessary to have comprehensive action control involving the work environment's arrangement, job task load, management of work schedule, and workstation adjustment of computer workers.

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CHAPTER 3: METHODOLOGY

3.1 Introduction

In this chapter, the methodology of the project will discuss. Both qualitative and quantitative approaches will utilize. There is a brief explanation of the critical research question, the research design, sampling, data collection method, and data analysis method. This research will cover the five aspects of the findings:

- The level of ergonomic risk.
- The level of the musculoskeletal discomfort,
- The level of mental workload,
- The level of mental health,
- And the identification of the relationship between musculoskeletal discomfort and mental workload.

This research assessment will use some of the tools. The chosen tools will refer to the objective study, the task's suitability, and the literature review findings. Observation of the work area of female computer workers will be conducted to identify the method's usefulness. After completing observation at the focus area, the Rapid Office Strain Assessment (ROSA) will find the ergonomic risk level on workstation design. The (ROSA) tool will measure female computer workers' ergonomic risk level during their task and determine the critical area that needs to mitigate to accomplish this study's objective.

After the ergonomic level risk is identified, the questionnaire will be distributed to the specific samples. The questionnaire will include sample demographic information, mental workload, mental health, and musculoskeletal disorder. This questionnaire aims to identify the mental workload level, mental health level, and musculoskeletal disorder prevalence.

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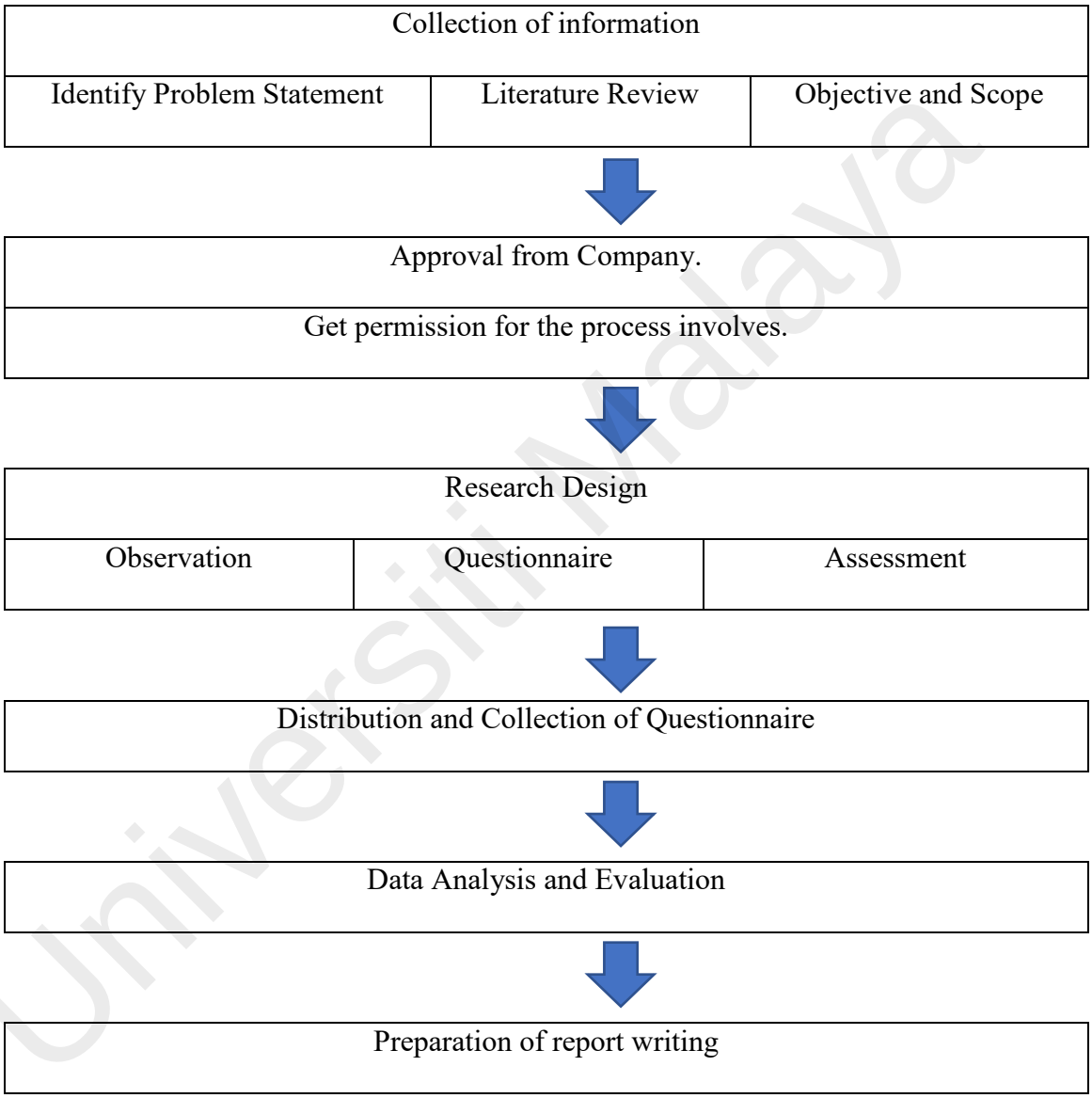
This questionnaire's data is crucial to determine the relationship between musculoskeletal disorder and mental workload among female computer workers. Below flow chart is simplified to achieve the purposed of the research:

FIGURE 2: METHODOLOGY FLOW CHART



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3.2 Study Sampling

The subject sampling consists of sixty female computer workers representing workers in each team to conduct ROSA. Survey questionnaire distributed to sixty female computer workers at services sector in Shah Alam. All the computer workers working as permanent workers and work for 8 hours of routine work office hours, five days a week, and computer work as their primary task during working hours.

3.3 Study Ethics

The study was done in a services Sector Company located at Shah Alam. Permission was applied through the Head of Department Strategic and Corporate to conduct related to ergonomic and mental health.

3.4 Research Design

In this project, three methods have been used: observation, distribution of the questionnaire, and data collection analysis.

3.5 Observation

The observation is conducted during the workstation of selected computer works to determine female computer workers' activity during their task. With the head of the department's permission, the ROSA assessment activity was conducted among selected female computer workers for 8 hours of work office.

3.6 Rapid Office Strain Assessment (ROSA)

Rapid Office Strain Assessment is a method of assessment designed to quickly quantify the risk associated with computer work, establish an action level based on the final score, and determine if an office workplace requires additional intervention and assessment (Sonne et al., 2012). This method is based on the CSA standards for Office ergonomics (CSA-Z412),

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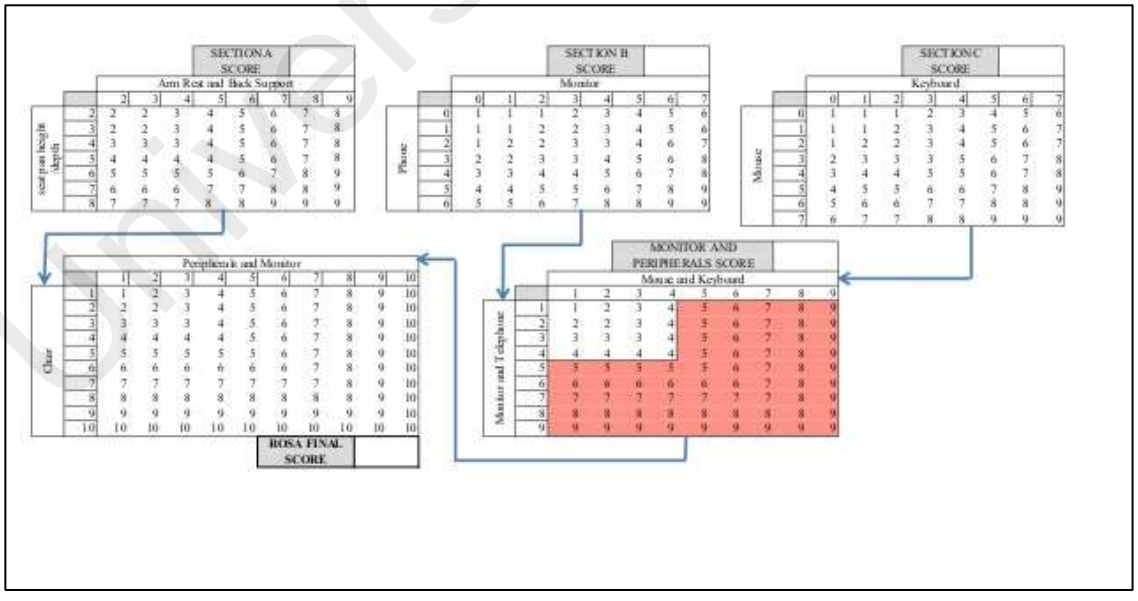
and the musculoskeletal risk factors are identified through extensive research specific to office and computer work (Matos & Arezes, 2015).ROSA method is an observation method that can identify ergonomic risk factors and has good reliability for assessing MSDS (Haghshenas et al., 2018). ROSA tool is divided into several subsections like a chair, monitor and telephone, and mouse and keyboard. These subsections emphasize the risk factors of each component of the office workplace and weigh risk scores. The scoring charts are represented in each subsection and by matching two office subsections against each other in other to get the complete score for that area. Each subsection's details were seat pan height and seat pan depth, back rest and arms support for chair section, monitor, telephone, keyboard and mouse for monitor and computer peripheral section. According to the scores obtained section and putting them in the final table, ROSA final score is determined, which is in the range of 0 to 10. Scores of 0 to 3 represent low risk rate, 3 to 5 is area of notification, and scores more than 5 need ergonomic intervention (Sartang & Habibi, 2015a).

FIGURE 3: ROSA ASSESSMENT SCORE



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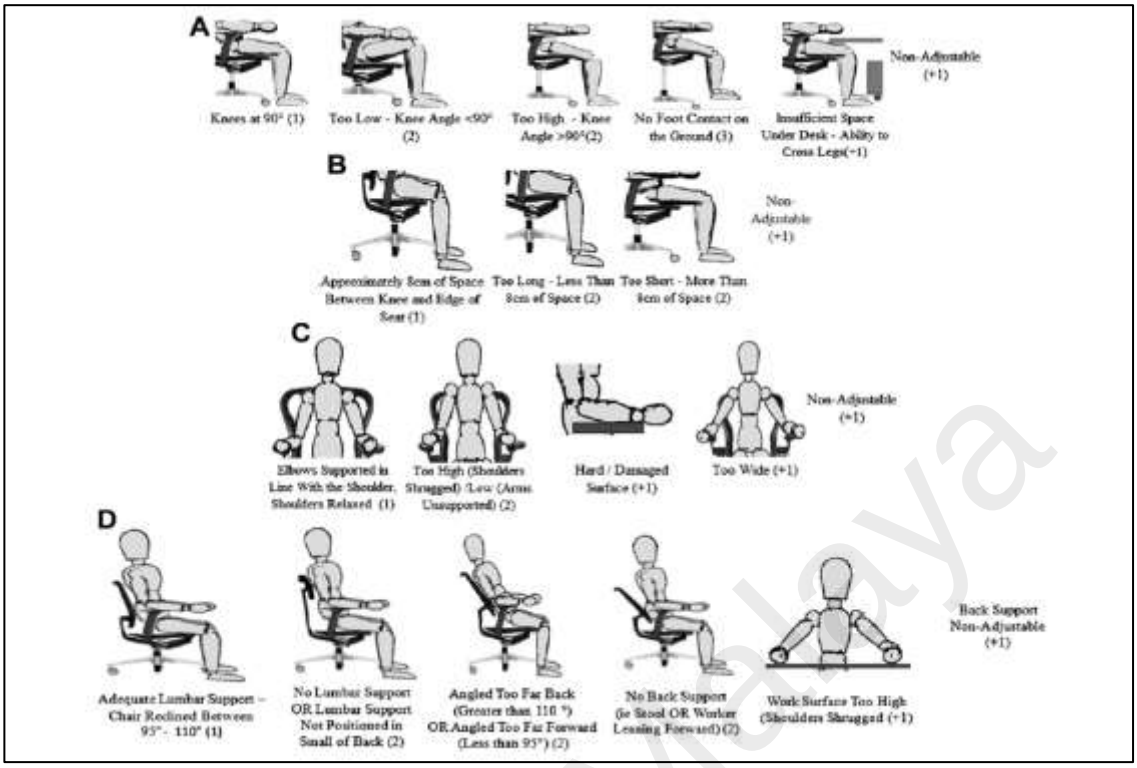

3.7 Questionnaire

In this study, Carmen Q, Nasa TLX, and Comparison Card Nasa TLX were utilized to determine the employees' mental workload. In contrast, DASS 21 was used to measure and categorized the level of mental health of respondents. The tools, including the demographic data, were distributed by physical form and email due to the Covid-19 outbreak. Sixty (60) sets of questionnaires were distributed to all respondents in all departments in Lembaga Zakat Selangor at Shah Alam. A brief introduction about this project and how to fill the form has been given through physical and online mediums. This is to ensure all respondents able to provide the correct response to answer all questions. These questionnaires were filled in at the workplace. The respondents wrote the demographic information age, gender, race, height, weight, marital status, education level, occupation, position, working hours, and working experience.

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3.8 Carmen-Q Mental Workload Assessment Tool

Carmen-Q was used for subjective evaluation of mental workload level. This questionnaire can assess four mental workload segments: Cognitive, temporal, and emotional/ health and performance demands. Carmen Q is a paper-and-pencil questionnaire designed to assess mental workload in a simple, valid, and reliable way and consists of 29 items. The items response format is a Likert Frequency scale of four alternatives in which 0 means never, one rarely, two often, and three always. All items have been stated so that a higher score indicates a higher mental load. (Rubio-Valdehita et al., 2017). In this study, exploratory factor analysis and Cronbach's Alpha method were used to determine this version's reliability. The value of reliability is Cognitive Demand 0.86, Emotional Demand 0.86, Temporal Demand 0.78, and performance demand is 0.78 and was considered statically fairly high (Taber, 2017).

3.9 NASA-TLX

NASA-TLX is a multi-dimensional scale designed to obtain workload from one or more operators while performing a task. This method analyzes the mental workload faced by workers who must perform various activities in their work by six indicators. NASA Task Load Index consists of six subscales representing somewhat independent cluster variables: Mental, Physical, temporal demand, frustration, effort, and performance (Hart, Center, & Moffett Field, 2006). After three years of extensive research on the physical and mental activities in various evaluation degrees, this tool was suggested, which provides a self-evaluation model to estimate mental workload through six scales (Habibi et al., 2015). Steps measurements using NASA-TLX is as follows:

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3.9.1 Weighting

NASA-TLX questionnaires given in pairwise comparisons, from this questionnaire counted the tally of each indicator that felt most influential. The amount of tally becomes weight for each indicator of mental load. The following table compares NASA TLX indicators.

3.9.2 Provision Rating

In this section, the respondents are asked to rate the six mental workload indicators. The rating given is subjective, depending on the mental workload felt by the respondent. The score is between 0 to 100. To attain a NASA-TLX mental load score, each multiplied indicator's weights and rating are then summed and divided by 15 (The number of pairwise comparisons).

3.9.3 Product value calculation steps

Obtained by multiplying the rating by the fact weight for each descriptor. Thus yielded 6 product values for six indicators (MD, PD, TD, OP, EF, and FR).

3.9.4 Workload Calculated Weight (WWL)

Sum all weighted workload of product.

3.9.5 Calculated WWL Score

Calculate the average weighted workload.

3.9.6 Score Interpretation

The score interpretation based on calculated WWL is low (0-9), medium (10-29), Rather high (30-49), High (50-79), very high (80-100).

The score calculation using comparison scorecard use as a weigh that will influence the total of Weight Workload Score are referred to (Hart & Staveland, 1988a) on the Development of NASA-TLX: Result of Empirical and Theoretical Research and (Sugarindra, Suryoputro, &

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Permana, 2017) in Mental Workload Measurement in Operator Control Room Using NASA-TLX.

3.10 DASS-21

Depression Anxiety Stress-Scale (DASS) is a well-established tool applied among clinical and non-clinical samples of adults to assess the perceived severity of symptoms associated with depression, anxiety, and stress (Lovibond & Lovibond, 1995). It is a self-report questionnaire with twenty-one (21) questions consisting of seven (7) items per subscale, which are depression, anxiety, and stress. The original DASS-21 by Lovibond has forty-two (42) questions were published in the year 1995, which was later simplified to twenty-one (21) questions.

Antony et al. revealed that DASS's consistency is observed in DASS-21, and the concurrent validity of both DASS and DASS-21 is in the acceptable to excellent scale range (Antony et al., 1998). Many researchers conducted numerous studies to validate DASS's reliability, and validity (Beaufort et al., 2017; Dreyer et al., 2019; Kaur et al., 2014; Oei et al., 2013) reported that DASS produces distinct characteristics of depression, physical arousal, and psychological irritation.

TABLE 4: DASS 21: SYMPTOM SCORE

Class	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely Severe	28+	20+	34

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3.11 Cornel Musculoskeletal Discomfort Questionnaire

CMDQ was used to investigate the prevalence of MSDS. The questionnaire is a data collection tool for musculoskeletal discomfort data designed by Professor Alen Hedge in 1999. This questionnaire has been designed in three stages of discomfort frequency, discomfort severity, and the effect on work capacity in the latest working week. It has a map of the body of 12 parts and including six areas for the hand, which analyzes 32 sections of the body.

Respondents will indicate the frequency of discomfort on an ordinal scale from 0 (none) to 4 (several times daily) and severity of discomfort from 1 (slightly uncomfortable) to 3 (very uncomfortable). A pain level of at least moderately uncomfortable" was selected as a severity threshold for determining prevalence and frequency. The level at which the discomfort interfered with work was scored from 0 (no interference) to 2 (Substantial interference). Total discomfort score was calculated by using the following formula: Frequency x discomfort x interference = discomfort score.

TABLE 5 CORNELL QUESTIONNAIRE SCORING METHOD

Frequency Score	Discomfort Score	Interference Score
Never = **0** 1-2 times/week = **1.5** 3-4 times/week =**3.5** Every day = **5** Several times every day = **10**	Slightly Uncomfortable = **1** Moderately Uncomfortable = **2** Very Uncomfortable = **3**	Not at All = **1** Slightly interfered = **2** Substantially interfered = **3**

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3.12 Statically Analysis

All data collected was keyed in Microsoft Excel (2017) and was analyzed using IBM Statistical Product and Service Solutions (SPSS) version 20.0. Descriptive statistics of demographic data, ROSA, MSDS, NASA-TLX, DASS-21, and CarMen-Q, were analyzed by considering the mean, frequency, standard deviation, and correlation. $P < 0.05$ (two-tailed) was considered significant. Pearson correlation was used to identify the Relationship between MSDS, NASA-TLX, Carmen-Q, and DASS-21 scores, with a 95% confidence interval (CI). Bar chart and data tabulation were also presented to present the data.

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CHAPTER 4: RESULTS & DISCUSSION

4.1 Introduction

This chapter discusses the results generated through the structured questionnaire. The data was accumulated to answer the following research questions:

Question 1: What is the ergonomic risk of female computer workers' workstation at the services sector in Shah Alam.

Question 2: What is the level of musculoskeletal discomfort among female computer workers

Question 3: What is the level of musculoskeletal discomfort among female computer workers based on their working station ergonomic level?

Question 4: What are the level of mental workload and mental stress among female computer workers?

Question 5: Is there any significant relationship between mental workload, mental stress, and musculoskeletal discomfort?

This chapter will thoroughly elaborate on the research's findings and outcomes through graphical and tabulation of data. In this chapter, the result will discuss in four consecutive parts. First, report of the demographic data of 60 employees. The second, the analysis level of ergonomic risk factor, level of musculoskeletal discomfort, analysis of the relationship between the level of ergonomic risk and level of musculoskeletal discomfort. The third part, the mental workload level, results from mental health categorized by depression, anxiety, and stress scale, the relationship between mental workload and mental stress. And the final part of this chapter discusses the relationship between two different mental workload tools:

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Carmen-Q and NASA TLX, the Relationship between ROSA and Cornell MSDS, and the relationship between musculoskeletal discomfort, mental workload, and mental stress scale by using SPSS through the Pearson correlation approach.

4.2 Reliability Analysis for Questionnaire

The reliability test for the questionnaire, Cronbach's Alpha are utilized. Cronbach's Alpha is the most common measure of internal reliability. It is mostly used to determine the reliability scale, especially multiple Likert Questions in a survey. Cronbach's Alpha has been described as one of the most important research statistics(Taber, 2017). Using a study from (Gliem & Gliem, 2003) the scale of Cronbach's Alpha that will used is >0.0-Exellent, >0.8-good, >0.7-acceptable, >0.6-Questionable, >0.5-Poor and >0.5-Unacceeptable. The Table 6,7,8, and 9 Shows Cronbach Alpha Coefficient values of the Cornell Musculoskeletal Discomfort, NASA-TLX, Carmen-Q, and DASS21 questionnaire.

TABLE 6: THE RELIABILITY ANALYSIS FOR CORNELL MUSCULOSKELETAL DISCOMFORT SEDENTARY AND HAND QUESTIONNAIRE.

Variable	Item	Score	Result
Musculoskeletal Discomfort (Sedentary & hand) body region	(Frequency Score) 17	0.934	Excellent
	(Discomfort Score) 17	0.963	Excellent
	(Interfered Score) 17	0.963	Excellent

TABLE 7: THE RELIABILITY ANALYSIS FOR MENTAL WORKLOAD NASA-TLX QUESTIONNAIRE.

Variable	Item	Score	Result
NASA-TLX	(Mental Demand) 1	0.775	Acceptable
	(Physical Demand) 1		

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	(Temporal Demand) 1		
	(Performance Demand) 1		
	(Effort Demand) 1		
	(Frustration) 1		

TABLE 8: THE RELIABILITY ANALYSIS FOR MENTAL WORKLOAD CARMEN-Q QUESTIONNAIRE.

Variable	Item	Score	Result
Carmen Q	Cognitive Demand 10	0.868	Good
	Temporal Demand 7	0.863	Good
	Emotional Demand 7	0.781	Acceptable
	Performance demand 5	0.787	Acceptable

TABLE 9: THE RELIABILITY ANALYSIS FOR THE DASS21 QUESTIONNAIRE

Variable	Item	Score	Result
Dass 21	Stress 7	0.845	Good
	Anxiety - 7	0.758	Acceptable
	Depression 7	0.838	Good

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4.2.1 Result & Discussion

The result of reliability analysis using Cronbach's Alpha shows that for the MSDS questionnaire, the score is between 0.934 to 0.963, which indicated an excellent result. The reliability test for the NASA-TLX questionnaire for seven items shows 0.775 scores, which indicate an acceptable result. The questionnaire regarding mental workload Carmen-Q indicates a score between 0.868 and 0.78 with good and acceptable results. For the last questionnaire. The DASS21 questionnaire indicates a score of 0.845 for stress questionnaire in category good, Anxiety with score 0.758 with result acceptable and Depression 0.838 with result Good. Cronbach's Alpha score shows all the questionnaires score are above 0.70, showing all questionnaire is internal consistency appropriate values according to standard recommendations and as a sufficient level of reliability follow common practice in science education (Taber, 2017).

4.3 Descriptive Analysis of Employees' Demographic Data

TABLE 10: DESCRIPTIVE ANALYSIS OF EMPLOYEES' DEMOGRAPHIC DATA

Variable		Frequency	Percent
	Number Respondents	60	100.0
Marital Status	Married	38	63.3
	Never Married	22	36.7
Education level	SPM	5	8.3
	Diploma	24	40.0
	Degree	31	51.7

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Position	Administrative Assistant	7	11.7
	Executive	11	18.3
	Office Secretary	12	20.0
	Call Operator	14	23.3
	Customer Service	14	23.3
	Head of Department	2	3.3
BMI	Underweight	6	10.0
	Normal Weight	24	40.0
	Overweight	16	26.7
	Obesity_Class_1	10	16.7
	Obersity_Class_2	3	5.0
	Obesity_Class_3	1	1.7
Working Experience	1-5	17	28.3
	6-10	17	28.3
	11-15	17	28.3
	16-20	6	10.0
	21 and above	3	5.0

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In this study, 60 female computer workers have participated. The percentage of married couples represents 63%, and 36.7% are still single. According to (Shettar & Sherkhane, 2017)), working women are mainly at more risk of developing MSDs since they are involved in household activities, childcare, and office work. The highest education level among participants with education level with Degree level represents 31 workers (51.7%) followed by Diploma level with twenty-four workers (40%) and SPM level with five workers (8.3%).

For years of working experience as computer workers with the organization study segment, the data indicated that seventeen workers (28.3%) have working experience between 1-5 years from sixty female workers. Seventeen workers (28.3%) have work experienced in the range between 6-10 years. Seventeen workers (28.3%) have work experience with 11-15 years. Six workers (10%) have experienced 16-20 years, and three workers (5%) have working experience for 21 years and above.

The Body Mass Index data indicated that 24 workers out of 60 workers (40%) have average weight, followed by 16 workers (26.7%) categorized as overweight. Ten workers (16.7%) are classified as obese Class 1, 6 workers (10%) have underweight, three workers (5%) are categorized as obese Class 2, and only a worker (1.7%) have categorized as obese class 3.

The data determined that Call Operator and Customer Services position with both sides represent 23.3% are involved with this survey from the demographic data. Followed by an Office Secretary position with 12 workers (20%), Executive 11 workers (18.3%), an administrative assistant with seven workers (11.7%), and only 2 Head of the department (3.3%) are involved with this survey.

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4.4 Ergonomics Risk Level Assessment (Rapid Office Strain Assessment)

Rapid Office Strain Assessment is presented to report each workstation's ergonomic risk level. Direct observation and data records are made. During the site visit, the researcher observed that workers are mostly sitting in an open space office with routine office tasks (reading of documents, writing on paper, computer work, answering the telephone). The workplaces are equipped with a desk, chair, computer (monitor, keyboard, and mouse), and phone. The score for each workstation ergonomic risk assessment is presented in Tables 11, 12, 13, 14, and 15.

4.4.1 Office Workstation

FIGURE 4: OFFICE WORKSTATION

TABLE 11: ROSA SCORE FOR OFFICE WORKSTATION

Section: Office workstation	ROSA Scores		
	N	Mean	SD
Chair Score	20	4.4	1.3
Mouse and Keyboard score	20	5.1	0.3
Monitor and telephone score	20	4.3	0.8
ROSA final score	20	5.3	0.5

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After the table analysis, it is showed that the mean chair score is 4.4, the mouse and keyboard score is 5.1, the monitor and telephone score is 4.3, and the mean ROSA final score was 5.3 (0.4). That means that the workplaces presented musculoskeletal discomfort risk and required ergonomic intervention, especially in Mouse and Keyboard.

4.4.2 Secretary workstation

FIGURE 5: SECRETARY WORKSTATION

TABLE 12: ROSA SCORE FOR SECRETARY WORKSTATION

Section: Secretary workstation	ROSA Scores		
	N	Mean	SD
Chair Score	12	4.8	1.4
Mouse and Keyboard score	12	5.1	0.3
Monitor and telephone score	12	4.2	0.7
ROSA final score	12	5.17	0.4

After analyzing the table, it is verified that the total ROSA score was 5.17 (0.4), which means that the workplaces presented musculoskeletal discomfort risk and that requires ergonomic intervention.

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4.4.3 Call Center Workstation

FIGURE 6: CALL CENTER WORKSTATION

TABLE 13: ROSA SCORE FOR CALL CENTER WORKSTATION

Section: Call Center Workstation	ROSA Scores		
	N	Mean	SD
Chair Score	14	3.2	0.4
Mouse and Keyboard score	14	4.9	0.2
Monitor and telephone score	14	3.0	0.2
ROSA final score	14	4.9	0.2

After the table's analysis, it is verified that the total ROSA score was 4.9 (0.4), which means that the workplaces presented musculoskeletal discomfort risk and that requires notification of the area, especially in mouse and keyboard.

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4.4.4 Customer service workstation

FIGURE 7: CUSTOMER SERVICE WORKSTATION

TABLE 14: ROSA SCORE FOR COUNTER SERVICES WORKSTATION

Section: Counter Services Workstation	ROSA Scores		
	N	Mean	SD
Chair Score	14	7.5	1.0
Mouse and Keyboard score	14	5.0	0.0
Monitor and telephone score	14	4.0	0.0
ROSA final score	14	6.7	0.7

After the table's analysis, it is verified that the total ROSA score was 6.7 (0.7), which means that the workplaces presented musculoskeletal discomfort risk and that requires ergonomic intervention.

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4.4.5 All workstation

TABLE 15: TOTAL ROSA SCORE FOR ALL COMPUTER WORKSTATION

Section: Computer Workstation	ROSA Scores		
	N	Mean	SD
Chair Score	60	4.9	1.9
Mouse and Keyboard score	60	3.9	0.7
Monitor and telephone score	60	5.0	0.3
ROSA final score	60	5.54	0.8

The mean ROSA final score was 5.54 (0.8), which means that the workplaces presented musculoskeletal discomfort risk, and that requires ergonomic intervention and modification can be necessary.

4.4.6 Discussion

Based on the analysis, it is highlighted the total ROSA score for all workstations is above the acceptable level score of 6.7. It can be concluded that all workstations for computer workers must do an ergonomic intervention. The most critical part is the chair, mouse, and keyboard.

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4.5 Cornell Discomfort Questionnaire

4.5.1 Cornell Musculoskeletal Discomfort Questionnaire (sedentary)

FIGURE 8: MUSCULOSKELETAL SEDENTARY BODY PART

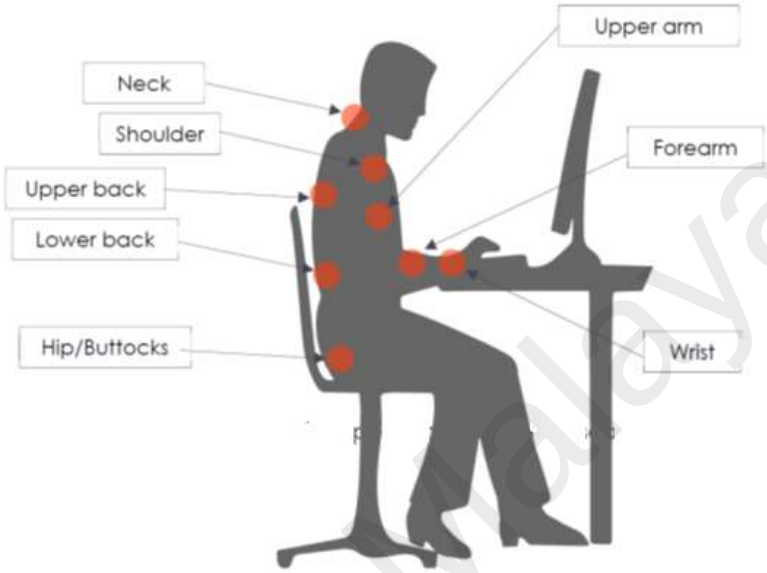

FIGURE 9: AVERAGE PERCENTAGE OF THE PREVALENCE MUSCULOSKELETAL DISCOMFORT FOR ALL BODY REGION

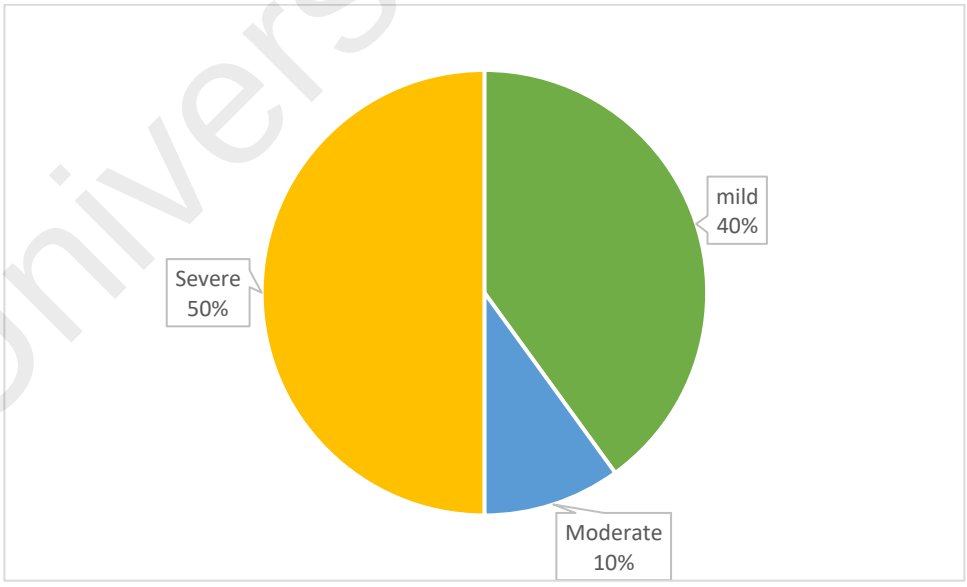

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TABLE 16: TOTAL SCORE MUSCULOSKELETAL DISCOMFORT SEDENTARY

Body parts referred to the questionnaire	Frequency	Discomfort	Interfered	Discomfort Score	Percentage
Neck	154.50	89.00	91.00	1251295.5	12.4
Shoulder Right	136.50	89.00	80.00	971880	9.7
Shoulder Left	125.50	92.00	82.00	946772	9.4
Upper Back	113.50	88.00	88.00	878944	8.7
UpperArm_R	74.00	70.00	72.00	372960	3.7
UpperArm_L	72.50	76.00	76.00	418760	4.2
LowerBack	152.50	97.00	92.00	1360910	13.5
ForeArm_R	37.50	71.00	71.00	189037.5	1.9
ForeArm_L	39.00	70.00	71.00	193830	1.9
Wrist_R	103.50	81.00	79.00	662296.5	6.6
Wrist_L	64.50	73.00	72.00	339012	3.4
HipButtocks	98.00	80.00	77.00	603680	6.0
Thigh_R	60.50	72.00	71.00	309276	3.1
Thigh_L	43.50	73.00	72.00	228636	2.3
Knee_R	62.00	75.00	73.00	339450	3.4
Knee_L	59.50	73.00	73.00	317075.5	3.1
LowerLeg_R	70.50	78.00	73.00	401427	4.0
LowerLeg_L	55.00	73.00	71.00	285065	2.8

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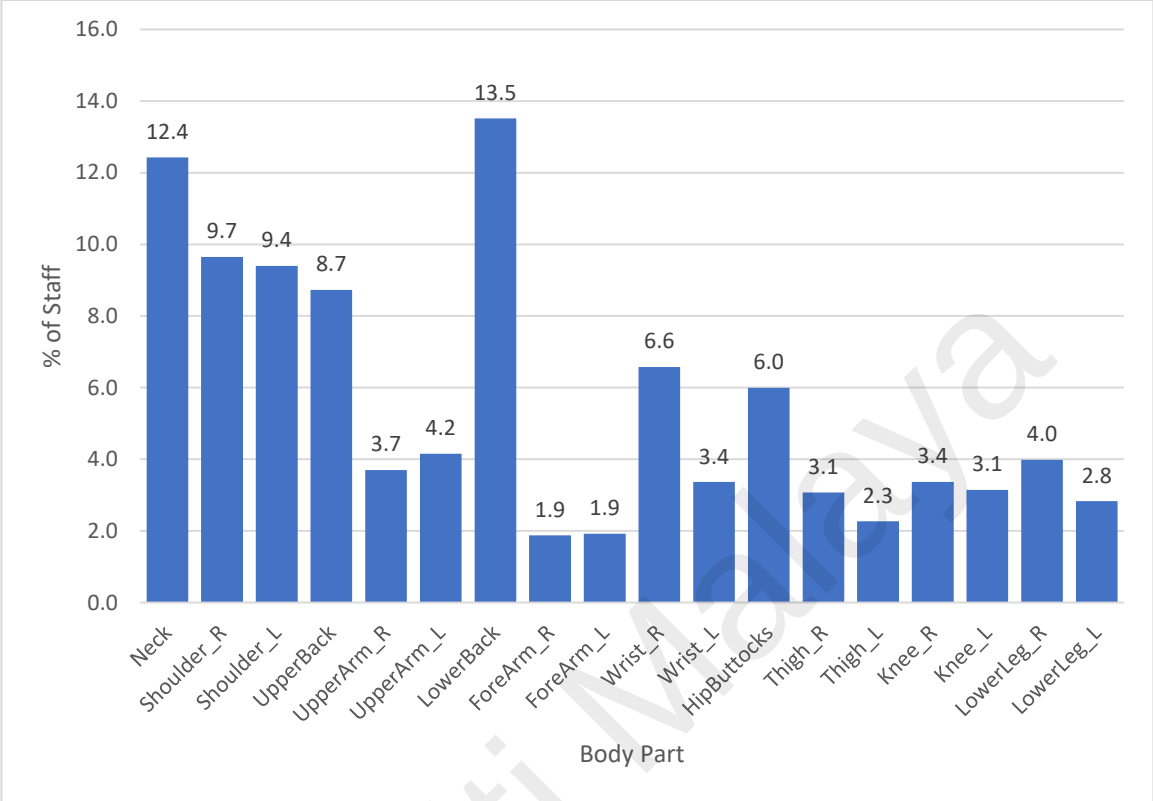
FIGURE 10: DISTRIBUTION OF EXISTING PAIN AND DISCOMFORT IN DIFFERENT AREAS OF THE BODY IN STUDY PARTICIPANTS.



4.5.1.1 Result

According to the total discomfort score of CMDQ (table 4.7), the majority of participants in this study felt discomfort mostly in the lower back (13.5%), neck (12.4%), right shoulder (9.7%), and left shoulder (9.4%). In comparison, it was less pronounced in the forearm right (1.9%), and forearm left (1.9%), and left tight (2.3%). The lower back and the neck were anatomical areas with the highest prevalence of symptoms for computer workers.

The self-reported prevalence of MSD questionnaire results (figure 9) shows that most of the staff had severe discomfort levels with 50%, followed by mild discomfort levels with 40% and moderate 10%.

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4.5.1.2 Discussion

The Cornell Musculoskeletal Discomfort Questionnaire result determined that most of the participants in this study felt low back pain as much as 13.5%. The result is similar to the research done by (Shettar & Sherkhane, 2017) that found the most discomfort area in the body region among working women is lower back pain. A study from (CHEE & RAMPAL, 2004) also mentioned that the highest prevalence among women workers in Peninsular Malaysia was a pain in the lower limbs, neck, and shoulders. The study has supported research by (Sartang & Habibi, 2015b) that mentions the highest prevalence of musculoskeletal disorders among computer users in Isfahan was in the area back region significantly higher among women.

As discussed above and the previous study, the result can conclude that the MSDS issue, especially on lower back pain, neck, and shoulders occurred may be due to the gender background

The 2nd majority of participants who felt MSDs discomfort are in area neck pain; the result is in line with a study form (CHEE & RAMPAL, 2004; Sartang & Habibi, 2015b) mentioned computer workers felt discomfort most in the neck area. The condition is mostly due to prolonged sitting and the low monitor level that required workers to bend their necks to get a clear vision from the monitor. The situation is also because most of the workers are used the desk instead of using the forearm support because the keyboard level is highest than the arm support.

From the chair assessment, most of the workers who are using office workstations and secretary workstations had the chair height with the knees approximately 90 degrees and pan depth at about approximately more than 3inch. For the armrest features, it observed that many

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workers do not utilize it, and it is the arms supported on the desk that often cause elevation of shoulders and, consequently, the increase of tension in the neck muscles.

As for the lumbar support, some workers did not present the lumbar spine supported in the chair. Almost all workers didn't know how to utilize any equipment, such as a pillow, to support their lumbar. All workers were more than four hours in static posture for the time sitting, so the score was assigned is high. Prolong sitting with static motion can causing some problems to the workers, especially in lower back pain. Regarding the chair condition and how the workers apply it, the result mentioned most workers felt discomfort in area lower back, neck, and shoulder is in line with the research cited in a study by (S. A. Zakerian & Subramaniam, 2015)

The score assigned to the monitor is related to the head's positioning for all workstation type about the same. Workers are often with a shallow screen, forcing a neck to bend forward, and all workplaces do not present the documents support, which causes the workers to rotate the neck to analyze the papers places on the desk. As for the phone, most workstations except the call center workstation did not have available headsets. The condition forces workers to often hold the phone between their head and shoulder, causing tension in the neck region while using the phone. All workstations except call center operators have used the phone below two hours averagely.

The mouse analysis score found that many workers often do not put the mouse aligned with the shoulder, forcing the shoulder in abduction, and it was found to be associated with neck and shoulder discomfort. In another situation, most workers are not using wrist rest while using a mouse, forcing the wrist region to place prolong on the desk and tend to cause non-natural wrist and forearm postures. The condition can increase the risk of wrist pain and Carpal Tunnel Syndrome(Odell & Johnson, 2015). For time-related to working use a mouse,

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almost all the workers are using a mouse is above that four hours. Intensive mouse use for long periods is significantly related to Musculoskeletal Discomfort(Al-Hashem & Khalid, 2008).

4.5.2 Cornell Musculoskeletal Discomfort Questionnaire (Hand)

FIGURE 11: AVERAGE PERCENTAGE OF THE PREVALENCE MUSCULOSKELETAL DISCOMFORT OF THE RIGHT HAND

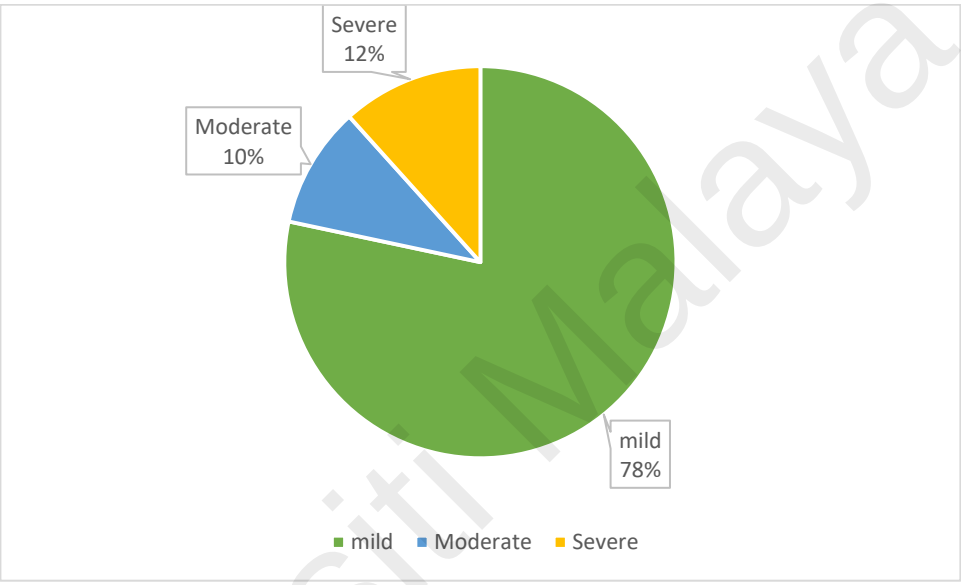

FIGURE 12: AVERAGE PERCENTAGE OF THE PREVALENCE MUSCULOSKELETAL DISCOMFORT OF THE LEFT HAND

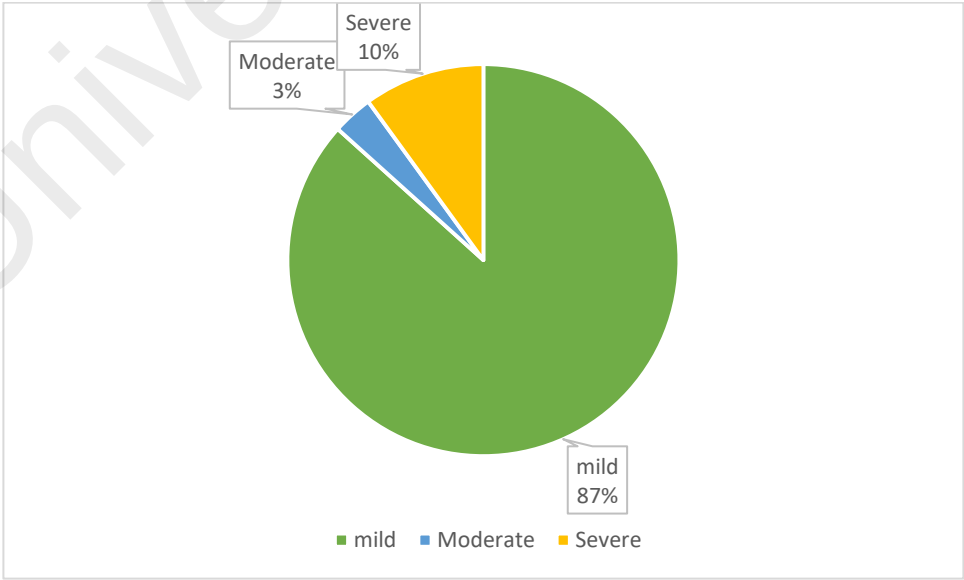

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FIGURE 13: MUSCULOSKELETAL HAND AREA

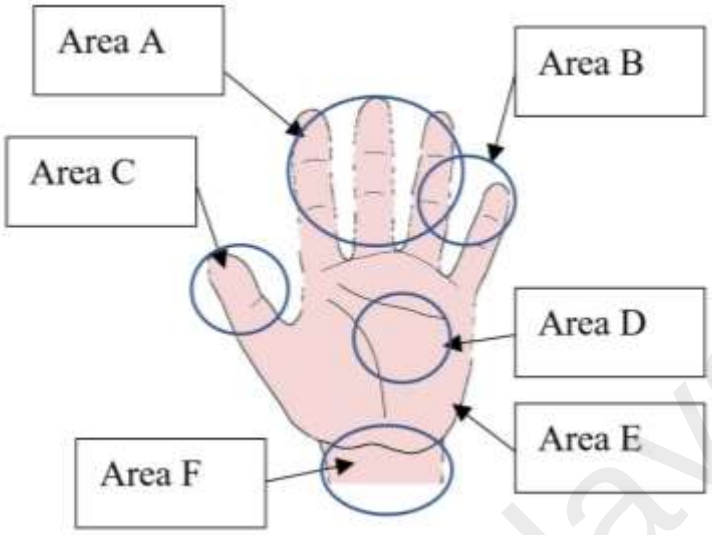

TABLE 17: TOTAL SCORE MUSCULOSKELETAL DISCOMFORT HAND

Body parts referred to the questionnaire	Frequency	Discomfort	Interfered	Discomfort Score	Percentage
Area A Right	388	80	74	2296960	11.96
Area B Right	368	74	75	2042400	10.64
Area C Right	231	73	76	1281588	6.68
Area D Right	273	73	72	1434888	7.47
Area E Right	285.5	72	79	1623924	8.46
Area F Right	291	77	76	1702932	8.87
Area A Left	292.5	75	76	1667250	8.68
Area B Left	237	71	74	1245198	6.49
Area C Left	258	73	75	1412550	7.36
Area D Left	236	73	71	1223188	6.37
Area E Left	354	73	74	1912308	9.96
Area F Left	258	70	75	1354500	7.05

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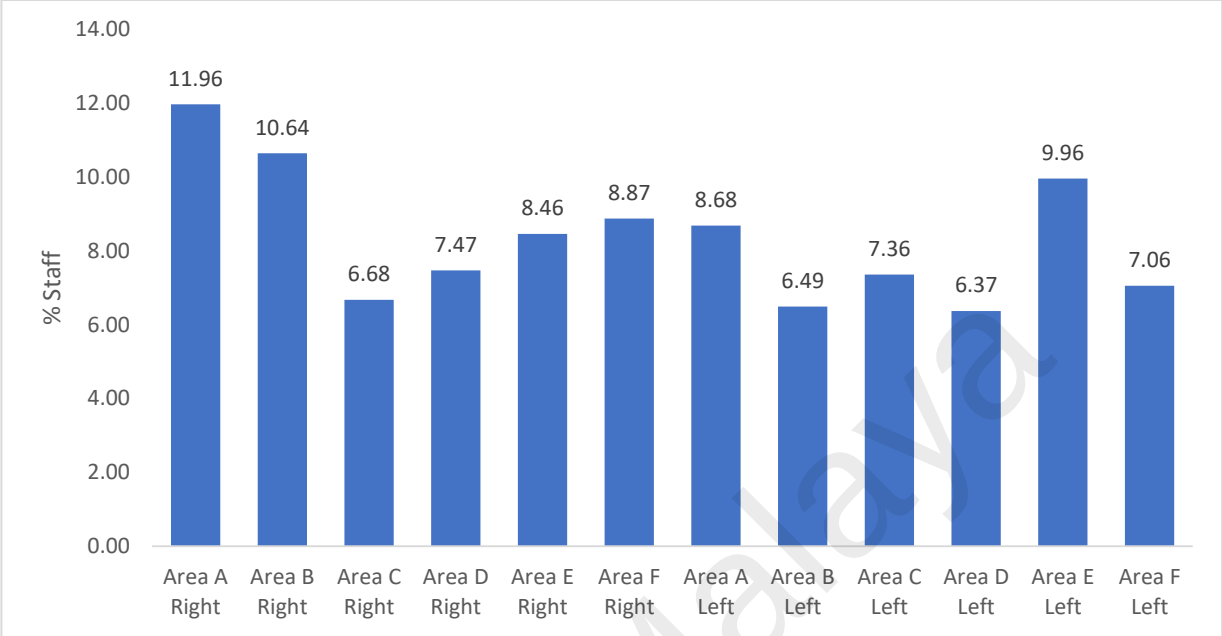
FIGURE 14: DISTRIBUTION OF EXISTING PAIN AND DISCOMFORT IN DIFFERENT AREAS OF THE BODY IN STUDY PARTICIPANTS



4.5.2.1 Result

The self-reported prevalence of hand discomfort questionnaire result (table 4.2 and figure 4.3) shows that most female computer workers had pain and discomfort in area A, the index finger, middle finger, and ring finger of the right hand (11.96%). Also, 10.64% of workers were more likely to feel pain and discomfort in Area B right hand, Area E (9.96%), which the thenar area of the left hand. Area F wrist right hand with (8.46%) of female computer workers felt pain and discomfort. Besides, referred in figure 4.4 and figure 4.5, 87% of the staff were more likely to attribute mild discomfort level and following by severe 12% for the right hand and 10% for the left hand.

4.5.2.2 Discussion

Cornell Musculoskeletal Discomfort Hand determined the highest discomfort area experienced by female computer workers in area A right hand, which allocated point finger,

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middle finger, and ring finger. The situation is may related to a repetitive motion on a finger and extensive use of a keyboard and mouse for an extended period(Al-Hashem & Khalid, 2008). The 2nd area is area B (Thumb). This condition may, because of extensive use of the keyboard and mouse, prolong repetitive motion while typing.

The result also found that most female workers are experienced mild hand discomfort level. This result was in line with (Rempel, 1999a) who mentioned that employees who were typing 6-8 hours per day were 2.1 times more likely to hand/ wrist disorder. A study from (James et al., 2018) s also found the computer workers are more likely to have impacted wrist/ hand discomfort. Other reviews by (Yeap Loh, Liang Yeoh, Nakashima, & Muraki, 2017) demonstrated that the condition of keyboard typing continuously could affect the median nerve. And a study from (A. Shariat et al., 2018) showed that the workers who had reported intensive keyboard use were significantly less likely to be diagnosed as having Carpal Tunnel Syndrome than was those who had reported little keyboard use.

Referring to the Rapid Office Strain Assessment result, the score obtained on a keyboard and mouse analysis was related to the fact that most workers use a keyboard, and mice average above 4 hours. This result shows that using a mouse for a long time contributes to the score of keyboard and mouse in ROSA assessment. It also shows that almost all the workers are felt discomfort at hand in areas A Right, B Right is because of the using mouse for an extended period. The discussion is in line with a study on (Matos & Arezes, 2015). As for the keyboard, most workers present the keyboard well-positioned with their hands straightened with the forearm. Although the keyboard and mouse positioning is suitable in most cases, their constant use puts pressure on the wrist area and thenar area for a long time, leading to more severe musculoskeletal symptoms around area B (Thenar Muscle) and area F (Wrist).

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4.6 Relationship between MSDs (Sedentary & hand) Score with ROSA Score

TABLE 18: PEARSON CORRELATION BETWEEN TOTAL MSDS SEDENTARY AND ROSA CHAIR SECTION, MONITOR AND TELEPHONE AND MOUSE AND KEYBOARD SECTION

		ROSA final score	**Monitor & Phone Score**	**Mouse & Keyboard Score**	**Chair Score**
Total MSDS score (sedentary)	Pearson Correlation	0.231	0.099	-0.055	.315*
	Sig. (2-tailed)	0.076	0.449	0.678	0.014
Total MSDs score (Right Hand)	Pearson Correlation	-0.008	0.140	0.027	-0.022
	Sig. (2-tailed)	0.952	0.288	0.840	0.868
Total MSDs (score (Left Hand)	Pearson Correlation	0.012	0.083	-0.025	0.171
	Sig. (2-tailed)	0.927	0.526	0.848	0.192

*. Correlation is significant at the 0.05 level (2-tailed).

4.6.1.1 Result

Refer to table 17; there was a significant relationship observed between ROSA chair score and Total MSDS score. Nevertheless, there was no significant relationship between ROSA total scores and Total MSDS score (Sedentary), ROSA total score, total MSDs score for the right hand, and total MSDs score for the left hand. There also had no relationship between

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Monitor and phone score with Total MSDs for hand and sedentary area. No significant correlations were found between Mouse and keyboard score with total MSDs sedentary and both hand score.

4.6.1.2 Discussion

According to all subsection findings on ROSA score and the final score of MSDS hand and sedentary, a significant positive relationship was found between total discomfort sedentary and ROSA Chair score. These results are in line with a previous study that showed a significant link between sitting and working with musculoskeletal (Bontrup et al., 2019) and a study on (Ardalan SHARIAT et al., 2018). The research on low back pain and its relationship with sitting behavior among sedentary office workers mentioned a more significant association was found between sitting behavior and chronic lower back pain. Preferably, a recommendation to arrange for sitting posture and chair design with consideration anthropometric technique reduces the percentage score of MSDS sedentary score level, especially in Lower Back Pain. The correct posture while sitting considering physical posture and the environment surrounding. The length of sitting time may also impact lower back pain. The management arrangement on the work system and workstation is required to reduce musculoskeletal discomfort that produces from the inappropriate activity and poor design related to the chair

4.7 Level of Mental Workload of Employees by Using NASA-TLX & Carmen-Q

TABLE 19: LEVEL OF MENTAL WORKLOAD BY CARMEN-Q

Dimensions	Temporal demand	Performance Demand	Emotional Demand	Cognitive Demand	Overall MW
Mean	49.12	78.88	41.03	61.11	56.43

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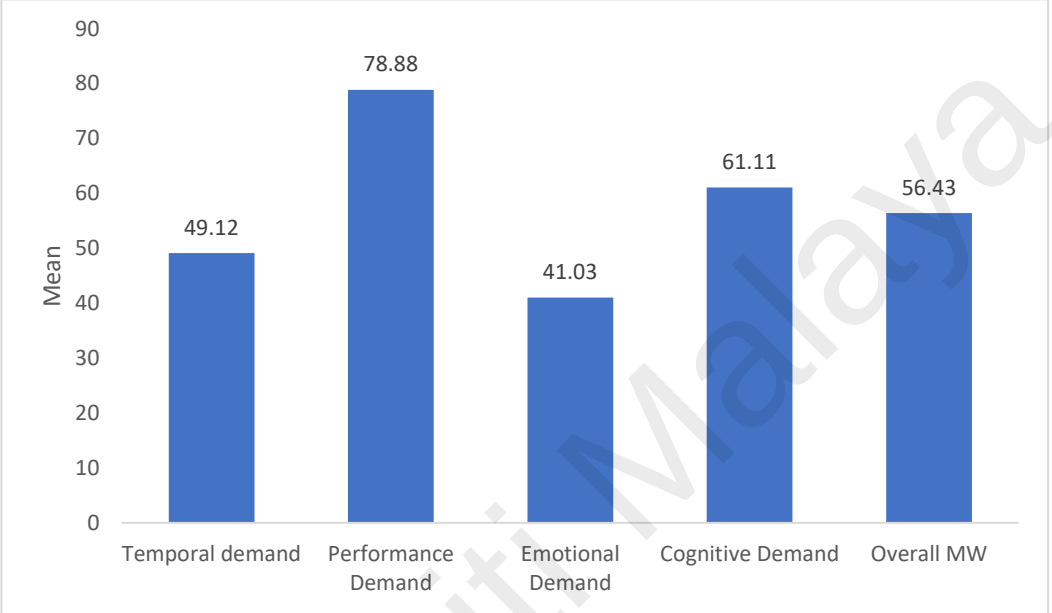
Std. Deviation	18.10	17.49	18.80	17.35	14.70

FIGURE 15: LEVEL OF MENTAL WORKLOAD BY CARMEN-Q



4.7.1.1 Result

Results of the ratings on workload measured by Carmen-Q are summarized in figure 13. The performance demand score obtained was the highest compared to others, with a mean score of 78.88. Furthermore, the results also indicate that the mean percentage score of cognitive demand was the second-highest (61.11%), followed closely by the overall mental workload (56.43%).

It is equal to service counter workers' activity required to assist the customers with a standard, time, and quality.

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TABLE 20: LEVEL OF WEIGHTED WORKLOAD NASA-TLX

Dimensions	FD	ED	PD	TD	OP	MD	WWL
N	60	60	60	60	60	60	60
Mean	52.08	64.08	61.33	63.67	47.75	63.58	61.97
Std. Deviation	22.82	20.78	21.45	21.21	22.86	18.64	16.15

FIGURE 16: LEVEL OF WEIGHTED WORKLOAD NASA-TLX

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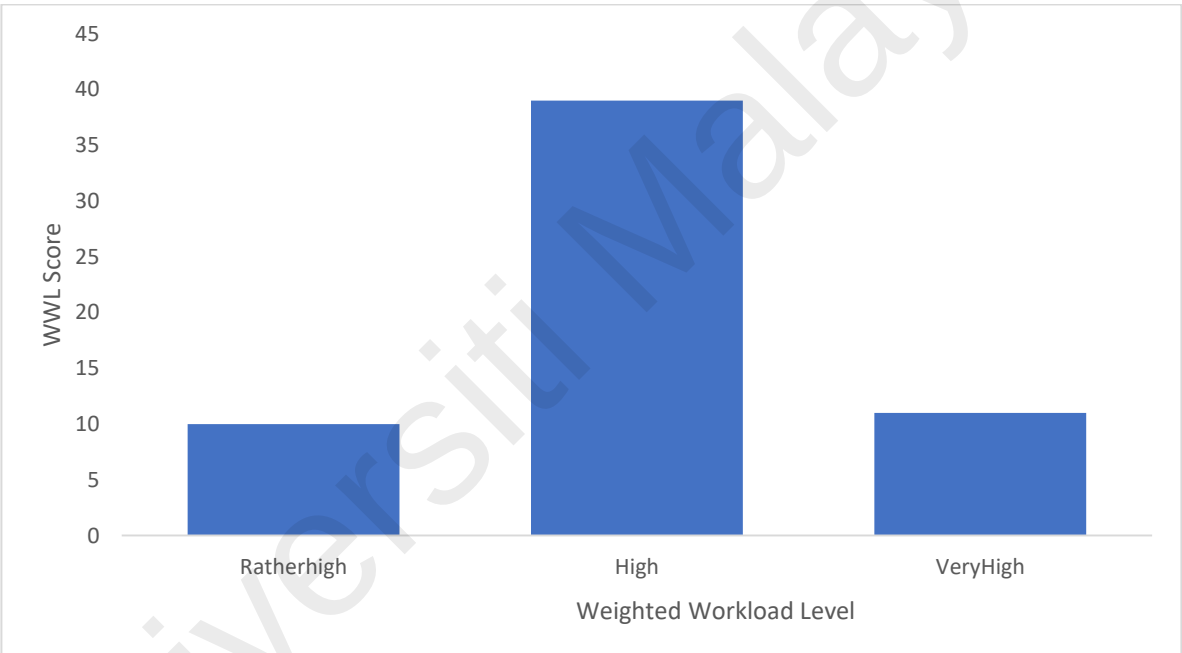
TABLE 21: LEVEL CATEGORY FOR NASA-TLX WEIGHTED WORKLOAD

Level	Frequency	Percent
Rather high	10	16.7
High	39	65.0
Very High	11	18.3

FIGURE 17: LEVEL CATEGORY FOR NASA-TLX WEIGHTED WORKLOAD



4.7.1.2 Result

Results of the subjective rating on the workers on workload measured by NASA-TLX are summarized in figure 16. The mean Effort demand score obtained was the highest than the others, with a mean score of 64.08 (SD=20.78), followed by the temporal demand mean score of 63.67 (SD=21.21) and mental demand 63.58(SD=18.64). Furthermore, the result also indicated that the mean of effort demand, temporal demand, mental demand, and performance demand had slightly different data compared to each other.

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NASA-TLX weighted workload results indicated that most female computer workers agreed that they are above experienced high-level mental workload with their job. 18.3% of over 60 workers are felt very high mental workload level, and 16.7% of respondents are agreed that they thought a relatively high level of mental workload

4.7.1.3 Discussion

The finding of the study of assessing the level of mental workload using the NASA-TLX revealed that female computer workers tolerate a certain degree of weighted workload. The Effort Demand is interpreted as the psychological and physical effort required by the human body. The effort demand question asks how hard the workers had to work (mentally and physically) to accomplish task performance levels. Although Physical Demand and Mental Demand each provided significant and relatively independent information about the workload of many experimental tasks, a single Effort Demand scale representing physical and mental is enough (Hart & Staveland, 1988b).

The researcher found that the Effort Demand for mental workload subscales level is high due to the service sector workers' activity being too subjective, similar to bank staff operation with a high level of effort demand because the activity is too subjective (E. Darvishi et al., 2016). Effort Demand's level is high among female computer workers because work nature required them to process their work operation and use psychological and physical effort to achieve task performance.

This situation and condition are relevant to the function of the service sector department. For example, the call center operator requires to answer as quickly as possible for any customer call inquiries and to check the information on the computer simultaneously. It also happens to the customer service where there a need to explain to all attended customers while searching the pertinent data using a computer. Secretary job nature requires physical and

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mental effort to prepare and submit the paperwork in a time given and collect all data for the paperwork to achieve the performance targeted by their divisions. This finding also supports by a study done by (Lowndes et al., 2020) mentioned that Effort Demand is the highest subscale score among surgeons who also have the same task requirements.

The 2nd segment of mental workload that female computer workers are burdened with is Temporal Demand, with 63.6% over the 60 respondents. The respondents' Temporal demand subscales scores were high because there is a specific task among service sector workers to achieve organizational goals and the company's work standards in exact time set up (Omolayo, 2013). Based on the NASA-TLX questionnaire, the Temporal Demand in question is how much time pressure workers feel due to the pace. Temporal Demand dimensions include aspects related to the rate of work and speed demand (Rubio-Valdehita et al., 2017). Temporal Demand becomes the 2nd highest for mental workload due to the situation among female workers in the service sector; in call center operators, the task required workers to respond to all incoming calls with a particular period. The call center operation task also needed them to answer specific customer calls with a certain period to measure the performance indicator. For office workstations, especially among secretary office positions, the position must prepare paperwork for management meetings that need to submit the paperwork in a time given without delay. Secretary job task is also to manage document matters and subjective work activity. Secretary's job task is also to manage document matters and subjective work activity. Some office work activities need them to a key-in certain amount of data. The activity has a specific time to accomplish to make sure all processes will not be interrupted. Most of the workers must provide quick response and swiftness to perform their tasks.

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On the other hand, they have a low level of performance demand, the same result (E. Darvishi et al., 2016) study on subjective mental workload and its correlation with musculoskeletal disorders. Based on figure 17, the 3rd highest level of mental workload among female computer workers in the service sector is Mental Workload; it is due to task behavior for each department and the activity using intensively on computer. The result supports the past studies that (Noyes & Bruneau, 2007) mentioned that a computer-based would demonstrate a significantly higher mental workload than paper-based forms. A study from (KESER & YILMAZ, 2014) also found that female computer workers are more prone to emotional exhaustion and a high mental workload. This result of level Mental workload among female computer workers can be due to computer workers' task behavior, time pressure procedure uncertainty, outcome uncertainty task difficulty, procedure requirements, task data quality, conflicting demands, and desired outcome (Cook & Salvendy, 1998).

An observational study by the researcher can be concluded that the high level of weighted workload among female computer workers can be related to the job task and nature physical work of computer workers that require a complex physical work environment, interactions among the various dimensions of the workstation and equipment, speed of data entry, position and lighting of visual targets (screen and documents), and job content.

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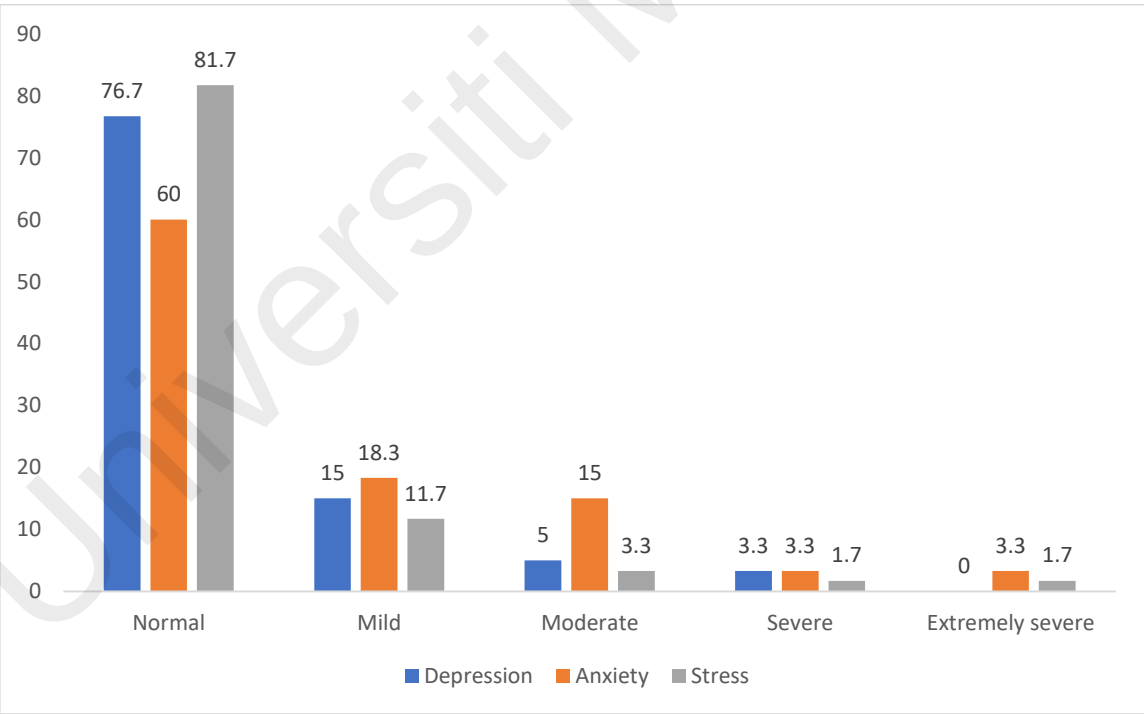
4.8 Level of depression, anxiety, and stress of employees by using DASS-21

TABLE 22: LEVEL OF DEPRESSION, ANXIETY, AND STRESS USING DASS 21

	Depression		Anxiety		Stress	
Subscale	Total	(%)	Total	(%)	Total	(%)
Normal	46	76.7	36	60.0	49	81.7
Mild	9	15.0	11	18.3	7	11.7
Moderate	3	5.0	9	15.0	2	3.3
Severe	2	3.3	2	3.3	1	1.7
Extremely severe	0	0	2	3.3	1	1.7

FIGURE 18: LEVEL CATEGORY OF DEPRESSION, ANXIETY, AND STRESS USING DASS 21



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4.8.1.1 Result

The results of the DASS are presented in figure 16. The majority of the female computer workers had an average level of stress (81.7%), depression (76.7%), and anxiety (60%). It was recorded that 18.3% of the participant had mild anxiety levels, and (15%) had moderate Anxiety levels. Furthermore, 11.7% of the total participants had a moderate level for the level of stress, 3.3 % had a severe level, and 1.7% had an extremely severe level.

4.8.1.2 Discussion:

From the statistical analysis, stress holds the highest percentage (81.7%). Anxiety level is the highest percentage of employees who have mild (18.3%), moderate (15%), and severe (3.3%). This figure has mentioned the stress level condition in an acceptable condition where 81.7% of participants agreed that they have stress in normal condition. Refer to study on perceptions of work stress causes and effective intervention in employees working in public, private and nongovernmental organization: a qualitative study conclude the common causes of work stress is impracticable demands, lack of support, poor decision attitude, discriminating treatment, lack of appreciation, effort-reward imbalance, conflicting roles, lack of transparency and poor communication, all the causes did not significantly happen on this organization and did not impact on mental stress level among workers. According to the theory of transactions, stress can occur when a particular transaction is evaluated by individuals relating to their well-being. In other words, people will face pressure when there is a perceived mismatch between ask or event demands and individuals' resources to cope with it (Alsuraykh et al., 2019). Anxiety holds the highest category with a symptom with a percentage (mild 18.3%, moderate 15%, severe 3.3%, and extremely severe 3.3%). This figure has passed the percentage of stress. Previous research found that 5% of Anxiety disorder category panic more prevalent in women, 5.1% generalized anxiety disorder more

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frequent in females, 1% of the general population 30-50% in traumatized population have Anxiety in category Post Traumatic Stress Disorder is women and 13.3% anxiety social phobia is more common in women than men. The researcher concluded the high-level symptom of Anxiety might occur due to gender background (Shri, 2010).

Depression is 2nd highest among DASS 21 category. The percentage for each level of depression is (mild 15%, moderate 5 %, severe 3.3 %). A study by (Cohidon, Santin, Imbernon, & Goldberg, 2010) mentions that the contributing factor that causes significant depressions in an occupational role is time pressure, lack of job control among managers, and associated with low social support.

The result from a study of depression in tax office workers in Istanbul found that the depression state could be regarded as composed of several factors such as high anxiety scores, discord with co-workers, low job satisfaction, and backache (Issever et al., 2008).

The report from WHO, The Global Burden of Disease In 2004 Update, reported that depression is prevalent among women, with 50% higher than men (Organization, 2004).

From the data and facts above, the researcher concludes that the high level of depression symptoms among female computer workers in the service sector in Shah Alam could be due to gender background, increased anxiety scores, and the high level of backache and work activities.

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4.9 Relationship between level of Mental Workload, DASS21, and Musculoskeletal Discomfort

4.9.1 Relationship between level of mental workload and Dass21

TABLE 23: PEARSON CORRELATION BETWEEN LEVEL OF MENTAL WORKLOAD AND DASS21

Dimensions		Overall MW	Percent TD	Percent PD	Percent ED	Percent CD
DASS_STRESS	Pearson Correlation	.278*	0.119	-0.020	.432**	.278*
	Sig. (2-tailed)	0.032	0.365	0.879	0.001	0.031
DASS_ANXIETY	Pearson Correlation	.279*	0.126	0.053	.372**	.284*
	Sig. (2-tailed)	0.031	0.336	0.686	0.003	0.028
DASS_DEPRESSION	Pearson Correlation	0.225	0.087	0.001	.391**	0.191
	Sig. (2-tailed)	0.084	0.509	0.992	0.002	0.143

*Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

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4.9.1.1 Result

A Pearson Correlation for table 4.15 determines a positive correlation between overall mental workload Carmen-q with stress (r=300, p=0.020) and anxiety (r=307, p=0.017). The result explained that if the mental workload increases, stress, anxiety, and depression will increase accordingly. There is a strong positive correlation between stress and effort demand (r=0.432, p=0.001) and a positive correlation between stress with cognitive demand (r=278, p=0.031). A strong positive correlation between anxiety and effort demand (r=0.372, p=0.003) and a positive correlation between anxiety and cognitive demand (r=0.284, p=0.028). Another strong positive correlation between depression and effort demand (r=0.391. p=0.002).

4.9.1.2 Discussion

Based on the correlation analysis, it can be concluded that there is a significant correlation between mental workload and depression, anxiety, and stress among female computer workers. The result shows that the highest demand for the task's effort and workers' stress level increases.

The result also indicates the same situation on anxiety correlation with effort demand; when the job among female computer workers required high demand of effort, the possibilities to impact stress, anxiety, and depression are high.

The result showed that the relationship between WWL with stress is supported by a study by (Alsuraykh et al., 2019) that concluded stress and MWL are highly connected. Those experiences of focus should be considered when evaluating MWL.

As expected from the data presented, stress has a positive correlation with effort demand, and the result was supported with study form. (MacDonald, 2003) mentioned that stress would increase with highly repetitive work (effort demand).

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Based on the previous study, the researcher can conclude that there is a correlation between Mental Workload and Stress, depression, and anxiety. Future work regarding mental workload must consider participants' experiences of both stress and mental workload.

4.9.2 Relationship Between the level of Musculoskeletal Discomfort and Mental Workload

TABLE 24: PEARSON CORRELATION BETWEEN MSDS SEDENTARY TOTAL SCORE AND NASA-TLX

Dimensions		Total score WWL	Mental Demand	Physical Demand	Temporal Demand	Performance Demand	Effort Demand	Frustration
Total MSDS Sedentary score	Pearson Correlation	**.289***	0.202	0.195	0.085	0.123	-0.051	0.164
	Sig. (2-tailed)	0.025	0.122	0.135	0.521	0.349	0.698	0.212
Total Discomfort score Lower back	Pearson Correlation	0.175	**.317***	0.069	0.246	-0.081	-0.203	0.124
	Sig. (2-tailed)	0.181	0.014	0.602	0.058	0.539	0.120	0.345

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Total Discomfort score Neck	Pearson Correlation	0.175	**.317***	0.069	0.246	-0.081	-0.203	0.124
	Sig. (2-tailed)	0.181	0.014	0.602	0.058	0.539	0.120	0.345
Total Discomfort score Shoulder R	Pearson Correlation	0.055	0.165	-0.098	0.158	-0.130	-0.138	**.291***
	Sig. (2-tailed)	0.677	0.207	0.458	0.228	0.321	0.292	0.024
Total Discomfort score Shoulder R	Pearson Correlation	0.142	0.243	0.082	0.123	-0.028	-0.194	0.185
	Sig. (2-tailed)	0.279	0.061	0.531	0.350	0.829	0.138	0.158

* Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

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TABLE 25: PEARSON CORRELATION BETWEEN MENTAL WORKLOAD NASA-TLX AND MSDS (HAND) SCORE

Dimensions		Mental Demand	Physical Demand	Temporal Demand	Performance Demand	Effort Demand	Frustration	WWL Score
MSDS Right Hand	Pearson Correlation	**.311***	**.405****	**.305***	**.279***	**.303***	**.352****	**.393****
	Sig. (2-tailed)	0.015	0.001	0.018	0.031	0.019	0.006	0.002
MSDS Left Hand	Pearson Correlation	0.223	**.368****	**.316***	**.257***	**.352****	**.417****	**.372****
	Sig. (2-tailed)	0.087	0.004	0.014	0.047	0.006	0.001	0.003

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

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4.2.1 Pearson Correlation Between mental health DASS21 and MSDs (Sedentary) Score

TABLE 26: PEARSON CORRELATION BETWEEN MENTAL HEALTH DASS21 AND MSDS (SEDENTARY) SCORE

Dimensions		Stress	Anxiety	Depression
MSDS (sedentary)	Pearson Correlation	0.250	**.338****	0.097
	Sig. (2-tailed)	0.054	0.008	0.461
MSDS Right Hand	Pearson Correlation	0.055	0.026	-0.064
	Sig. (2-tailed)	0.677	0.842	0.626
MSDS Left Hand	Pearson Correlation	0.126	0.164	0.025
	Sig. (2-tailed)	0.337	0.212	0.850

4.9.2.1 Result

The correlation results were presented in Tables 25 and 26. It was found that there was a significant positive correlation between total weighted workload and MSDS Sedentary(r=0.289, p=0.025), a positive correlation between mental demand and total discomfort score for lower back (r=0.317, p-=0.014). A positive correlation between mental demand with total MSDS score for the neck (r=0.317, p=0.014), positive correlation between frustration and total MSDS score shoulder right (r=0.291,p=0.024).

The experimental result in Tables 25 shows the correlation between MSDS right hand and left hand with NASA-TLX mental workload. The table shows a strong positive correlation between MSDs Right hand and frustration, (r=0.352, p=0.006) the same results also found on the correlation between MSDs' left hand and frustration (r=0.417, 0.001). Strong positive

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correlations also can be found on relationship between MSDs right hand with physical demand (r=0.405, p=0.001) and MSDS left hand with physical demand (r=0.405, p=0.004) and effort demand (r=0.352, p=0.006). Others positive correlation can found on relationship between MSDs right hand with temporal demand (r=305,p=0.018), MSDs right hand with performance demand (r=0.279, p=0.031), weighted workload (p=0.393, p=0.002), and for relationship MSDs left hand with temporal demand (r=0.368, p=0.014), performance demand (r=0.257, p=0.047), weighted workload (r=0.372, p=0.003).

4.9.2.2 Discussion

The result of this study points out six elements on NASA-TLX mental workload (mental demand, physical demand, temporal demand, performance demand, effort demand, and frustration) and a higher score of Cornell musculoskeletal discomfort among female computer workers (lower back, neck, shoulder right, and shoulder left). The correlation's overall score can conclude a significant correlation between mental workload and musculoskeletal discomfort among female computer workers in the service sector.

In this study, the result shows that has a positive correlation between the weighted workload score and musculoskeletal discomfort total score with (r=0.289), this result support by the previous study by (Habibi et al., 2015; Khandan & Mosaferchi, 2018; S. Zakerian & 2, 2011; S. A. Zakerian & Subramaniam, 2015). The obtained results showed a significant association between weighted workload and the MSDS score, meaning that MSDS increased by the elevation in the staff's mental workload. In this regard, the finding is in line with the results obtained by (Heidarimoghadam et al., 2019); the result also in line with a study result obtained by(Ebrahim Darvishi & Meimanatabadi, 2015) that indicated a direct and significant correlation between weighted averages of rating on six subscales of the Mental Workload and MSDS.

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The highest MSDS score lower back showed a significant correlation with mental demand that share the same result with a study by (Buruck, Tomaschek, Wendsche, Ochsmann, & Dorfel, 2019; Habibi et al., 2015) that mentioned a significant correlation between chronic low back pain and mental workload. With the high MSDS score in the lower back area, the metal demand score will be increasing.

The MSDS neck score also significantly correlates with mental demand, which mentioned that when female workers experienced discomfort in the neck, their mental workload also increased.

The result indicating the correlation between MSDS hand and mental workload has shown a strong correlation between all segment mental workload NASA-TLX with MSDS hand. The left-hand area for MSDs score correlates with all segments on NASA-TLX mental workload except mental demand.

In general, the result of the present study showed that the workload was physically and psychologically increased in female computer workers. This study showed that the overall mental workload score could influence the incidence of MSDS. The central part of the body region that the employer needs to consider is the area hand region, which impacts musculoskeletal and mental workload issues.

Recognition of risk factors in creating MSDs, significantly mental workload factors in the initial phase of development, is vital in the workplace. Because MSDS are major health issues, evaluating risk factors can help create and modify and improve preventive and intervention strategies. It seems that the scales of Mental Workload function as a risk factor in creating MSDs.

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CHAPTER 5: PROPOSAL ON ERGONOMICS IMPROVEMENTS TO CONTROL THE RIKS RELATING MUSCULOSKELETAL DISORDER AND MENTAL WORKLOAD

This section of the report explains the risk control measures that can be implemented to control the issue relating to musculoskeletal, mental workload, and mental health that have been previously identified in the result section. The recommendations are based on the previous study, ergonomics standards, and best practices.

5.1 Summary of musculoskeletal discomfort risk factors

A few ergonomics risks factors have been identified through the Rapid Office Strain Assessment conducted and a few previous studies on related subjects. The risk factors were as below:

- Unsupported back/ awkward sitting posture
- The monitor is too low for the user
- Usage of a laptop without a proper docking station
- The keyboard and mouse are too high
- Armrest not fully utilized
- Wrist contact stress

5.2 Ergonomic Management Program

From the documentation reviewed, it can be concluded that the ergonomics component is absent within the organization. The assessment clearly shows the ergonomic, and safe working practices element with consideration of psychosocial and physiological are lack among the staff. One possible explanation for this scenario could be because there is no ergonomics management programmed implemented within the organization to check and balance the situation. In long term impact, it is recommended that the organization develop

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an ergonomic Management Program with cover psychological and physiological aspect may include the following:

Leadership Characteristic:

- Strong Demonstrated Management Commitment
- To include Psychological and physiological policies and principles
- Review the goal and company performance gradually

Organization Characteristic:

- Supportive Engineering intervention
- A proposal in establishment General practitioner Clinic lead by Occupational health doctor
- Integrated Organization for ergonomics, occupational health assisted by Occupational Health Doctor

Operational Characteristic

- Effective Communication
- Continuous ergonomics and organizational behavior coaching
- Effective audits and re-evaluations

The Ergonomics Management Program should have at least consisted of the four minimum elements as described below:

5.3 Prevention and intervention strategies

Refer to the data presented, the risk factors, cost of intervention, and symptomatic individuals' presence. The most effective intervention is the elimination of the risk. Control strategies, in orders of preference, include:

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5.3.1 Engineering Controls

- Workstation design
- Work methods that reduce awkwardly or prolong static postures, contact stress.
- Tool design

5.3.2 Administrative Controls:

- Adjustments of hours and production rates
- Rest periods, reassignment, job rotation, job enlargement
- Training in essential mental health and ergonomics principles

5.3.3 Health management

Eliminates or reduces the risk of developing early symptoms of musculoskeletal disorders and early signs of a psychological issue.

- Baseline health surveillance
- Early recognition and notification of any degenerative issues among employees associated with ergonomic hazards and illnesses.
- Systematic medical evaluation

5.3.4 Ergonomics Knowledge

Form the result and discussion chapter and clearly shows the issues regarding musculoskeletal discomfort, mental stress, and mental workload are because of a lack of knowledge among staff. The staff does not know how to utilize the ergonomic part embed at the workstation. It is highly recommended that the management provide frequent briefing awareness talk and training related knowledge on how to use an ergonomic part provided and

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basic ergonomic knowledge. Listed below the elements which should be incorporated in the ergonomics training:

Proper workstation setup such as:

5.3.4.1 Arrangement of frequency use items on the table:

- Adjustment of the height monitor according to eye height
- Adjustment of the location of the keyboard, mouse, and monitor according to the body preference rater that just follows as it was set up by the IT department (most female computer workers never attempted to make any adjustment of the workstation according to their body preference and just adapt themselves to the default arrangement by the IT department).

5.3.4.2 Neutral sitting postures, proper chair fit, and adjustments:

From the assessment, it can be detected that some staff does not know the chair adjustment. Therefore, this situation leads to awkward sitting postures, and it is highly recommended that a short briefing by the suppliers about the features of chairs be conducted when a purchase of new chairs. This will enable the staff to understand the chairs better and fully utilize the components rather than adapt themselves to the chair and workstation.

Correct sitting postures are an essential element. As shown in the result section, specific staff practices wrong sitting technique on the ergonomics chair. Ergonomics chair does not serve its purposes. If the posture is improper, providing ergonomics chairs to people who do not know how to use them will not yield any positive outcome.

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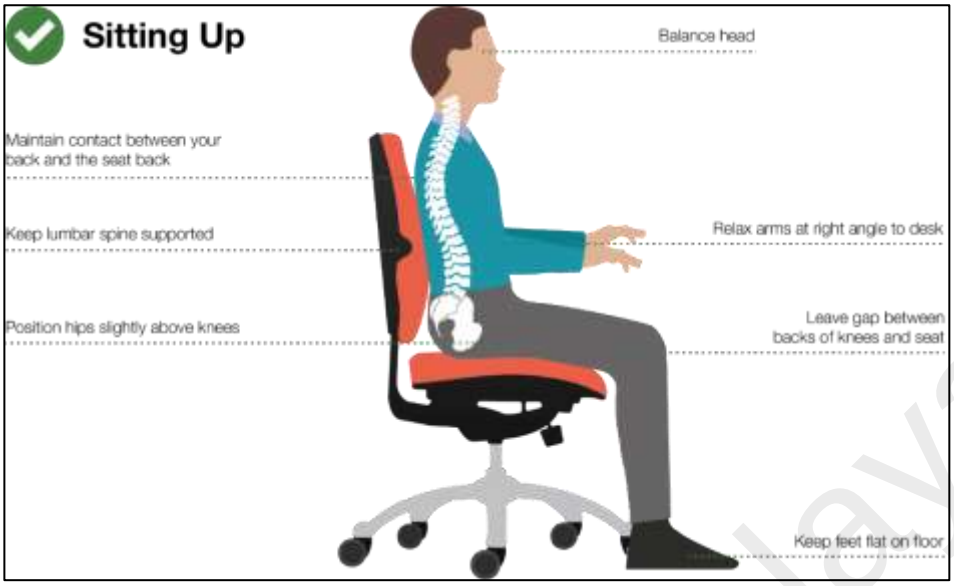
FIGURE 19: CORRECT ERGONOMIC POSTURE FOR COMPUTER WORKERS



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CHAPTER 6: CONCLUSION & RECOMMENDATIONS

6.1 Conclusion

In conclusion, this study's significant result showed that the MSDS level among female computer workers in the service sector is pretty high, and the highest MSDS in the body region identified is in the area lower back, neck, and shoulder. For the MSDS hand, the level of MSDS is medium where most of the female computer workers felt mild condition and the critical area is on Area A Right (Index finger, middle finger and ring finger), Area B(Ring Finger and Pinkie Finger) and Area E Left (Thenar muscle).

The ROSA shows the ergonomic risk level of workstation female computer workers in the service sector is high. It also noticed that workers' interaction with the task and the computer's adopted sitting posture all day affect a muscular level essentially for the lower back, neck, and shoulder. ROSA assessment tool is a helpful, suitable, and easy tools to assess the ergonomic risk associated with a computer activity.

The study also revealed that the highest mental health that symptomizes among female computer workers is anxiety and depression. The factor that can be considered is because of gender background. The result also showed that there is a positive correlation between overall mental workload Carmen-Q and stress. From the result, it can conclude that the amount of mental workload will affect the level of stress.

According to the result, musculoskeletal disorder and mental workload were significantly correlated among female computer workers in the service sector. Furthermore, a significant correlation was observed between total WWL and total MSDS sedentary score and a strong correlation between MSDS hand and Mental Workload. Hence, the mental workload should

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be evaluated as a risk factor in creating MSDS, and the intervention program for MSDS must include physiological and psychological aspects.

To conclude, the following recommendations are proposed:

1. Modifying the workstation and computer peripheral (monitor and mouse) additional computer features like paper holders is an adjustable platform for the individual who performs intensive computer activity with long-term static tasks
2. Recognition of risk factors creating MSDS, especially psychological factors in the initial phase of MSDS symptoms development.
3. Design a proper recharge area for workers to release stress and reduce mental workload
4. Cognitive-behavioral educational interventions to raise awareness regarding the disadvantages of mental health problems.

6.2 Significant finding

The data obtained analyzed that workstation among female computer workers in the services sector at Shah Alam is necessary to do an ergonomic intervention. It was noticed, the interaction of workers with the job task and the adopted sitting posters throughout the day and improper ergonomic design from the workstation in the chair, keyboard, and mouse is the significant factors that the lower limb, neck, and shoulder had a high level of MSDS.

Female computer workers have experienced a high level of anxiety and depression level in mental health symptomize; based on the previous research, the issues are because of gender background.

The overall mental workload correlates with the total score and has a very strong positive correlation with MSDS hand. The initial phase of MSDS development, particularly on hand,

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can be related to mental workload. Mitigation action to reduce the level of mental workload can help prevent the ascending trend of MSDS.

6.3 Future Recommendation

The study and data obtained show the issues regarding prevention of MSDS, mental stress, and mental workload among female computer workers are lacked to be discussed in the services sector operation. It is recommended that future research need to focus on the development of an ergonomic management program, including redesign computer workstations, education, and work process with examining simultaneously MSDS, Psychosocial and mental workload as a factor to be contributed.

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