ERGONOMIC RISK AND ITS ASSOCIATION WITH MUSCULOSKELETAL DISORDERS AMONG COMPUTER USERS AT UNIVERSITI SAINS MALAYSIA, HEALTH CAMPUS

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by

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In the name of ALLAH, the most Merciful, the most Compassionate. All praise and thanks be to Him, by whose blessings all goods can be accomplished. May peace be upon Prophet Muhammad صلى الله عليه وسلم, his families and companions. I would like to express my gratitude to Allah SWT for giving me the opportunity and help me endlessly and for giving me the patience and perseverance in finishing this project. First, I would like to offer my sincerest gratitude to my dearest supervisor **Mr. Mohd Nasrom bin Mohd Nawi**, who kept his eyes on the progress of my project and always was available, for his continuous guidance, support, and patience. His excellent supervision, expertise, interest, motivation, genuine insight into the problems and his help to gain the deepest thoughts in research have made it possible for me to complete the research. A very special gratitude and thanks to my co-supervisors, **Dr. Mohd Nazhari Bin Mohd Nawi** and **Dr. Nurul Ainun Binti Hamzah**, for their encouragement, fruitful ideas, advice, and assistance, for commitment, patience in overcoming numerous obstacles. Moreover, in completing the research, I am extending my warmest thankful to my family who never fail to support, care, and pray for my success. Lastly, to my beloved parents, my gratitude for you can hardly be expressed by words.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURE

Page

LIST OF SYMBOLS

<	Less than
>	More than
%	Percentage
H_0	Null Hypotheses
H_1	Alternative Hypothesis
CDC	Centers for Disease Control and Prevention
Z	Standard normal distribution
N	Sample size
P	Proportion
BMI	Body Mass Index
CMDQ	Cornell Musculoskeletal Discomfort Questionnaire
CI	Confidence Interval
EU	European Union
HSE	Health and Safety Executive
ICT	Information and Communication Technology
MLgR	Multiple Logistic Regression
REBA	Rapid Entire Body Assessment
ROSA	Rapid Office Strain Assessment

RULA	Rapid Upper Limbs Assessment
MSDs	Musculoskeletal Disorders
MSP	Musculoskeletal Pain
NMQ	Nordic Musculoskeletal Questionnaire
OR	Odd Ratio
USM	Universiti Sains Malaysia
WRMSDs	Work-Related Musculoskeletal Disorders

LIST OF APPENDICES

RISIKO ERGONOMIK DAN HUBUNGANNYA DENGAN GANGGUAN OTOT RANGKA DALAM KALANGAN PENGGUNA KOMPUTER DI KAMPUS KESIHATAN UNIVERSITI SAINS MALAYSIA

ABSTRAK

Komputer digunakan secara meluas dalam setiap bidang masyarakat moden. Ia merupakan ciptaan sains yang paling hebat mengubah gaya hidup dalam dua dekad yang lalu. Di Malaysia, pengguna komputer telah meningkat kepada 85%. Tambahan pula, julat penggunaan komputer telah dilaporkan 6 hingga 12 jam sehari boleh menyumbang kepada perkembangan gangguan otot rangka (MSDs). Ini telah dikenalpasti sebagai ancaman kepada kesihatan pekerja. Oleh itu, kajian ini dijalankan untuk menentukan kelaziman MSDs dan faktor yang dikaitkan dengan MSDs dalam kalangan pengguna komputer di Universiti Sains Malaysia (USM), Kampus Kesihatan, Kubang Kerian. Kajian keratan rentas telah dijalankan melibatkan 346 staf yang menggunakan komputer dengan kadar respon 92%. Peserta dipilih melalui kaedah persampelan rawak dalam kalangan mereka yang memenuhi kriteria kemasukan. Data dikumpul melalui soal selidik yang diisi sendiri menggunakan Cornell Musculoskeletal Discomfort Questionnaires dan pemerhatian terus penyelidik menggunakan Rapid Office Strain Assessment (ROSA) untuk menentukan tahap risiko ergonomik bagi setiap stesen kerja. Data telah dianalisa menggunakan "Statistical Package for the Social Sciences" (SPSS) versi 26 untuk analisis deskriptif, regresi logistik sederhana dan berganda. Min ROSA adalah 3.81(1.058). Kelaziman gangguan otot rangka berkaitan kerja (WRMSDs) yang dilaporkan sendiri ialah 86.3%, 81% daripada peserta mengalami keterukan kesakitan yang ringan untuk, majoriti pekerja mengalami

ketidakselesaan di bahagian bawah belakang (62.8%), bahu kanan (53.4%), punggung pinggul (46.6%) dan bahu kiri (45.3%). Analisa korelasi Spearman's mendedahkan bahawa MSD pergelangan tangan kiri (r = -0.018, p = 0.034), MSD punggung pinggul (r = -0.116, p = 0.038), dan MSD paha kiri (r = -0.124, p = 0.030), adalah ketara berkorelasi dengan skor yang berkaitan dengan penggunaan tetikus dan papan kekunci, serta skor akhir ROSA berkorelasi secara ketara dengan MSD punggung pinggul (r = -0.114, p = 0.041) dan MSD bahu kiri (r = 0.124, p = 0.027). Berdasarkan pemodelan regresi logistik berbilang, umur dikaitkan secara ketara dengan WRMSD (Adjusted OR = 6.944, CI: 1.238-39.017, p = 0.028). Umur dan jantina masing-masing dikaitkan secara ketara dengan MSD leher (Adjusted OR = 3.908, 95% CI 1.342, 11.377, p = 0.012), (Adjusted OR = 2.042, 95% CI 1.199, 3.475, p = 0.009). Jantina, umur (51 - 60 tahun) badan adalah sihat dan berlebihan berat badan (BMI) masing-masing dikaitkan secara ketara dengan MSD lengan atas kanan (Adjusted OR = 1.795, 95% CI 1.091, 2.950, p = 0.021), (Adjusted OR = 3.303, 95 % CI 1.006, 10.849, p = 0.049), (Adjusted OR = 0.092, 95% CI 0.010, 0.814, p = 0.046), (Adjusted OR = 0.127, 95% CI 0.010, 2). Hanya penggunaan komputer (7 - 8 jam) dikaitkan secara ketara dengan MSD bahagian bawah belakang (Adjusted OR = 2.045, 95% CI 1.149, 3.638, p = 0.015). kesimpulannya pengguna komputer di Kampus Kesihatan USM mengalami kadar yang tinggi MSDs di pelbagai bahagian badan. Oleh itu, langkah kawalan ergonomik dan pencegahan peribadi yang sewajarnya perlu dilaksanakan untuk menambah baik kesihatan dan kesejahteraan pengguna komputer di Kampus Kesihatan USM

ERGONOMIC RISK AND ITS ASSOCIATION WITH MUSCULOSKELETAL DISORDERS AMONG COMPUTER USERS AT UNIVERSITI SAINS MALAYSIA, HEALTH CAMPUS

ABSTRACT

Computers are widely used in every field of modern society. It was the greatest invention of science that changed the lifestyle in the last two decade. In Malaysia, computer users have increased up to 85%. Furthermore, the range of computer use has been reported to be from 6 to 12 hours per day which can contribute to the development of Musculoskeletal Disorders (MSDs). This have been recognised as a threat to the health of the workers. Therefore, this study was conducted to determine the prevalence of MSDs and their association with ergonomic risk factors among computer users at the Universiti Sains Malaysia (USM) Health Campus, Kelantan. A cross-sectional study was conducted among three hundred and forty-six computer staff with 92% response rate. Participants were selected through random sampling method among those who fulfilled the inclusion criteria. Data were collected through self-report questionnaires using Cornell Musculoskeletal Discomfort Questionnaires and researcher direct observation by Rapid Office Strain Assessment (ROSA) to determine the ergonomic risk level for each workstation. The data were analysed using SPSS "Statistical Package for the Social Sciences" version 26 for descriptive, simple and multipl logistic regrision analyses. The mean of ROSA was 3.81(1.058). The prevalence of self-reported Work Related Musculoskeletal Disorder (WRMSDs)

was 86.3%, 81% of the participants experiencing discomfort in the lower back (62.8%), right shoulder (53.4%), hip buttock (46.6%) and left shoulder (45.3%). Spearman's correlation analysis revealed that left wrist MSDs ($r = -0.018$, $p = 0.034$), hip buttock MSDs ($r = -0.116$, $p = 0.038$), and left thigh MSDs ($r = -0.124$, $p = 0.030$), were significantly correlated with scores related to the use of mouse and keyboard, as well as the final ROSA score were significantly correlated with hip buttock MSDs ($r = -0.114$, $p = 0.041$) and left shoulder MSDs ($r = 0.124$, $p = 0.027$). Based on multiple logistic regression modelling, age was significantly associated with WRMSDs (Adjusted OR = 6.944, CI: 1.238-39.017, $p = 0.028$). Age and gender were significantly associated with neck MSDs (Adjusted OR = 3.908, 95% CI 1.342, 11.377, $p = 0.012$), (Adjusted OR = 2.042, 95% CI 1.199, 3.475, $p = 0.009$), respectively. Gender, age (51 - 60 years) , healthty and overweight (BMI) were significantly associated with right upper arm MSDs (Adjusted OR = 1.795, 95% CI 1.091, 2.950, $p = 0.021$), (Adjusted OR = 3.303, 95% CI 1.006, 10.849, $p = 0.049$), (Adjusted OR = 0.092, 95% CI 0.010, 0.814, $p = 0.046$), (Adjusted OR = 0.127, 95% CI 0.014, 1.123, $p = 0.032$), respectively. Only computer use (7 - 8 hours) was significantly associated with lower back MSDs (Adjusted OR = 2.045, 95% CI 1.149, 3.638, $p = 0.015$). In conclusion, computer users in USM Health Campus experienced high occurrence of MSDs in various parts of the body. Therefore, appropriate ergonomic and personal preventive control needs to be implemented to improve the health and wellbeing of the computer users on USM Health Campus.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Musculoskeletal pain (MSP) is acute or chronic pain that affects single or multiple body sites, is often associated with musculoskeletal disorders (MSDs) (El-Tallawy *et al.*, 2021). According to CDC (2016), MSDs refer to injuries or disorders of the muscles, tendons, nerves, joints, spinal discs, and cartilage. This study focuses on self-reported pain and non-clinical examinations. In the working population, workers are exposed to different activities and work conditions that can cause or aggravate MSDs (Parent-Thirion *et al.*, 2017). A study review by Joseph *et al.* (2020) conducted in 23 different countries showed that the prevalence of MSDs ranged from 43.1% to 93%.

The computer users' duties influence the processing system's focus on accurate quick-reaction processes and human-machine relations. It was the greatest invention of science that changed our lifestyle in the last two decades. These main duties hire for a variety of mental processes, such as constant high concentration and focus, awareness, high vision, planning, improved memory and decision-making. Although there is no official definition of workload, it is widely accepted in the ergonomics community that to create these mental workloads and MSDs, much attention has been given to physical workload, factors related to workplace, and workstations (Darvishi *et al.*, 2016).

Computers are widely used in every field of modern society; in 2012, the percentage of computer users in the United States of America (USA) was more than 50%, and it reached 77% by 2016 (Bureau of Labor Statistics, 2016), whereas in Malaysia, computer users increased from 56% to 67% between 2013 and 2015 (DSMOP, 2016). Furthermore, the range of computer use has been reported to be between 6 and 12 hours per day (Mani *et al.*, 2016), office workers can set 10 hours per day during both the working week and weekend (Smith *et al.*, 2015). All of that enhances the development of MSDs symptoms.

Furthermore, MSDs depend on the apparently visible body region that possesses the movement mechanism, ergonomics, and mechanical design of the job. MSDs happen frequently when there is a lack of balance between a person's physical necessities and workload (Ezeukwu *et al.*, 2011). Imbalance happens when overstretching work appeared with continuous exposure to intense or extended activities in an unusual or unsympathetic condition (Besharati *et al.*, 2018). Health and Safety Executive (HSE) reported in 2017 that it influences 507,000 people annually in the Great Britain and yields 8.9 million layoff workdays. It reports that about 34% of annual workdays are missed due to illness, reducing productivity and putting the organization under challenge (Xu *et al.*, 2013). In Korea, MSDs account approximately 70% of all occupational diseases (Park *et al.*, 2021).

Additionally, it has been noticed that MSDs harm the lives of workers across all sectors, but particularly in those that require manual labour. Indeed, MSDs have become one of the contemporary health issues in our modern societies and are prevalent among different sectors. Notably, research findings indicate high

prevalence rates among different occupational groups: 91.3% for Korean farmers (Min *et al.*, 2016), 33.8% for construction workers (Reddy *et al.*, 2016), 33.3% for transportation and storage workers (Laal *et al.*, 2018), 89.0% for human health and social work (Ribeiro *et al.*, 2017), 53.9% for factory workers (Thetkathuek & Meepradit, 2018), 70.2% for education (Ojukwu *et al.*, 2018) and 60.16% for office workers (Besharati *et al.*, 2018).

In 2015, 73% of European Union (EU) 28 workers encountered health problems, with 58% experiencing one or more MSDs in the preceding 12 months. Finland has the highest percentage of MSDs, while Hungary has the lowest rate at 40% (Parent-Thirion *et al.*, 2017). In 2016, MSDs constitute 38.5% of all occupational diseases in the USA (Bureau of Labor Statistics, 2016). Between the years 2009 and 2014, 150 claims were recorded in Malaysia related to MSD, which contributes to 25.22% of overall occupational diseases (Rohani *et al.*, 2016). In addition, MSDs caused Ontario companies $72 million in claim-related costs, which led to 462,000 missed days (Ontario, 2017). In Germany, this corresponds to 1.0% of the GDP, which is approximately €34.4 billion (EAf *et al.*, 2019). This high cost of MSDs in Malaysia is consistent with the USA trend of high costs for MSDs (CDC, 2016; DOSH, 2017).

It is well known that MSDs is an extensive problem among computer users working in governmental sectors (Khan *et al.*, 2020; Mahmud *et al.*, 2011), mainly to identify and eradicate potentially harmful effects on their musculoskeletal health necessary to be considered. In previous ergonomic surveys, it was mentioned that MSDs are prevalent among computer users at work (Bragatto *et al.*, 2016; Kaliniene

et al., 2016; Mohan *et al.*, 2019; Waongenngarm *et al.*, 2020); and there are many instruments used to determine the prevalence of neck, shoulders and lower back MSDs, which were stated to be high relative to pain in the other body regions among computer users (Mohan *et al.*, 2019; Ranasinghe *et al.*, 2011; Sadeghian *et al.*, 2014).

Office workers are exposed to individual, physical, psychosocial, and environmental factors that contribute and are prone to developing MSDs (Eltayeb *et al.*, 2009; Mani *et al.*, 2016; Strine & Hootman, 2007). The most frequently encountered potential risk factors are classified by the researcher as non-work-related MSDs factors (individual factors) and ergonomic risk factors (physical factors). Usually, the environmental factors are eliminated because universities continuously strivesto achieve the best environment working conditions, including temperature, noise, and lighting, with the help of a competent service team. There is no evidence in the previous study regarding psychosocial factors at universities; all universities have higher educational management, and workers presence and co-worker support are highly valued.

1.2 Problem Statement

Around 1.71 billion people experienced musculoskeletal conditions worldwide. Among them the burden due to lower back MSDs is the highest contributing to a prevalence of 568 million people distributed in 160 countries (Cieza *et al.*, 2020).

MSDs lead to restricted mobility and skills, early job retirement, and minimize the level of wellness and contribution to society. The growth of the world population

and ageing resulted in higher MSDs prevalence which has the prospect of rapid increase in the next few decades (WHO, 2021).

The widespread use of computers in all industries and services is the main precursor to the rise in the prevalence of MSDs, which has increased by 25% in the recent decade (Khan *et al.*, 2012). In Turkey, 66.5% of bank staff experienced MSDs (Ozvurmaz, 2017). The prevalence of MSDs was reported as 58% in two higher education academic institutions in Ireland (Collins & O'Sullivan, 2015). In Brazil, 70% of computer users in telecom companies suffered from MSDs (Antunes *et al.*, 2012). These studies show manifestation of MSDs which is not as a result of acute complaints but rather due to continuous and gradual accumulation of ailment over time.

The evolution in information and communication technology (ICT) in government agencies in Malaysia was initiated in 1996; about 900,000 employees had to transform the administrative processes and services into electronic (Khairuddin, 2005). Not only the governmental sector accomplishes its tasks using computers, but also the private sector. This results in a higher number of populations using computers and being exposed to MSDs.

In Malaysia, few published data have been reported on the prevalence of MSDs particularly among computer users. This creates a gap in the perceived knowledge and the subsequent implementation of the required preventive measures, despite the rise in the risks of MSDs among computer users. This also has its impacts on their society and consequently, in the whole country. The only two studies that reported the prevalence of MSDs among public universities, in the first study, the most

frequently affected body region by MSDs was the shoulder (51.6%) (Mahmud *et al.*, 2011), while in the second study, the prevalence of lower back MSDs was 37% (Damanhuri *et al.*, 2014). Besides, some of the governmental sectors have been studied by researchers (Maakip *et al.*, 2016; Ng *et al.*, 2019).

Up to date, there has been no study published or perhaps conducted on the association between computer users and MSDs at the Universiti Sains Malaysia (USM) Health Campus, even though USM is the second oldest university in Malaysia, one of the top ranking universities in the country, and has one of the highest numbers of employees working with a desktop computer at Kelantan State compared to other governmental and private organizations. Although The number of non-academic computer users at USM Health Campus has increased from 434 in December 2018 to 791 by 2020. Therefore, the main issues that arise due MSDs in workplace could not be justified clearly in the previous studies, and the top management did not acknowledge this issue. This study aims to present the current scenario of ergonomic risk levels at USM by using a structured model. Particularly in USM, there are no further assessments and analyses to address ergonomic issues among computer users. Thus, this study is conducted to determine the MSDs conditions and determine whether it is present or not, as well as to determine how serious the condition is. Since computer users play a substantial role in delivering the performance of university, their absenteeism from work may lead to low productivity, decrease their availability, and performance lost to achieve the university's yearly target. In addition, the objective of this project is to evaluate the current working conditions at USM that relate to the MSD problem for academic and non-academic faculties and supportive departments by using the Malay version

of the Cornell University Discomfort Questionnaire (CMDQ) and the Rapid Office Strain Assessment (ROSA) approach. Finally, the study also formulated and proposed corrective actions to related departments based on the findings.

1.3 Research Question.

1. What is the prevalence of WRMSDs among computer users at the USM Health Campus?
2. Which region of the body has the higher prevalence of MSDs among computer users at the USM Health Campus?
3. What is the mean of Rapid Office Strain Assessment (ROSA) and pain severity score among computer users at Universiti Sains Malaysia, Health Campus?
4. Is there a correlation between the ROSA score and WMSDs pain severity score among computer users at Universiti Sains Malaysia, Health Campus?
5. Is there a correlation between the ROSA score and MSDs pain severity score in different body regions among computer users at Universiti Sains Malaysia, Health Campus?
6. What are the factors associated with WRMSDs among computer users at Universiti Sains Malaysia, Health Campus?
7. What are the factors associated with MSDs in different body regions among computer users at Universiti Sains Malaysia, Health Campus?

1.4 Objective

General objective:

This study evaluated the MSDs and their correlation with ergonomic risk factors among computer users at the Health Campus of Universiti Sains Malaysia in Kubang Kerian, Kelantan.

Specific Objectives:

1. To determine the prevalence of self-reported Work Related Musculoskeletal Discomfort among computer users at Universiti Sains Malaysia, Health Campus.
2. To determine the prevalence of self-reported Musculoskeletal Discomfort in different body regions among computer users at Universiti Sains Malaysia, Health Campus.
3. To determine the mean of the Rapid Office Strain Assessment (ROSA) and pain severity score among computer users at Universiti Sains Malaysia, Health Campus.
4. To determine the correlation between ROSA score and WRMDs pain severity score among computer users at Universiti Sains Malaysia, Health Campus.
5. To determine the correlation between the ROSA scores and MSDs pain severity score in different body regions among computer users at Universiti Sains Malaysia, Health Campus.
6. To identify the potential risk factors associated with the WRMSDs among computer users at Universiti Sains Malaysia, Health Campus.
7. To identify risk factors associated with the MSDs from different body regions among computer users at Universiti Sains Malaysia, Health Campus.

1.5 Hypotheses

Null Hypotheses (H_0)

a) There is no significant association between WRMSDs and risk factors among computer users at the Universiti Sains Malaysia, Health Campus.

b) There is no significant association between MSDs in different body region and risk factors among computer users at the Universiti Sains Malaysia, Health Campus.

c) There is no correlation between each ROSA score and WRMDs pain severity score among computer users at Universiti Sains Malaysia, Health Campus.

d) There is no correlation between final ROSA score and MSDs pain severity score in different body regions among computer users at Universiti Sains Malaysia, Health Campus.

1.6 Study Rationale

In Malaysia, the guideline on ergonomic risk assessment at the workplace among computer users is optional to implement (DOSH, 2017). This study established the initial local baseline prevalence of MSDs data among computer users at USM Health Campus, determine the associated risk factors (Socio-demographic and ergonomic factors), and determine the ergonomic risk level using a valid and reliable Malay version of the ROSA instruments (Kibria *et al.*, 2023) that has been translated in this project, which would be much quicker and less expensive to manage by direct supervisor.

The project would be of immense benefit to the computer users and the USM Health Campus management. Once assessment and planning have been achieved, as well as the analysis of the collected data and risk factors and ergonomic levels are determined, the preceding step is implementing the strategies and interventions that will comprise the workplace health programme.

The study will increase the awareness of computer users regarding the use of adjustable workstation and mechanism to accommodate individual needs, apply the attitude of good working posture and work habits, elucidate ergonomic concerns with the supervisor, and reduce ergonomic risk levels to be safe.

The USM management can set up office ergonomic standards using the project questionnaire to prevent the development of MSDs symptoms and visual strain from working at a computer workstation.

1.7 Conceptual Framework

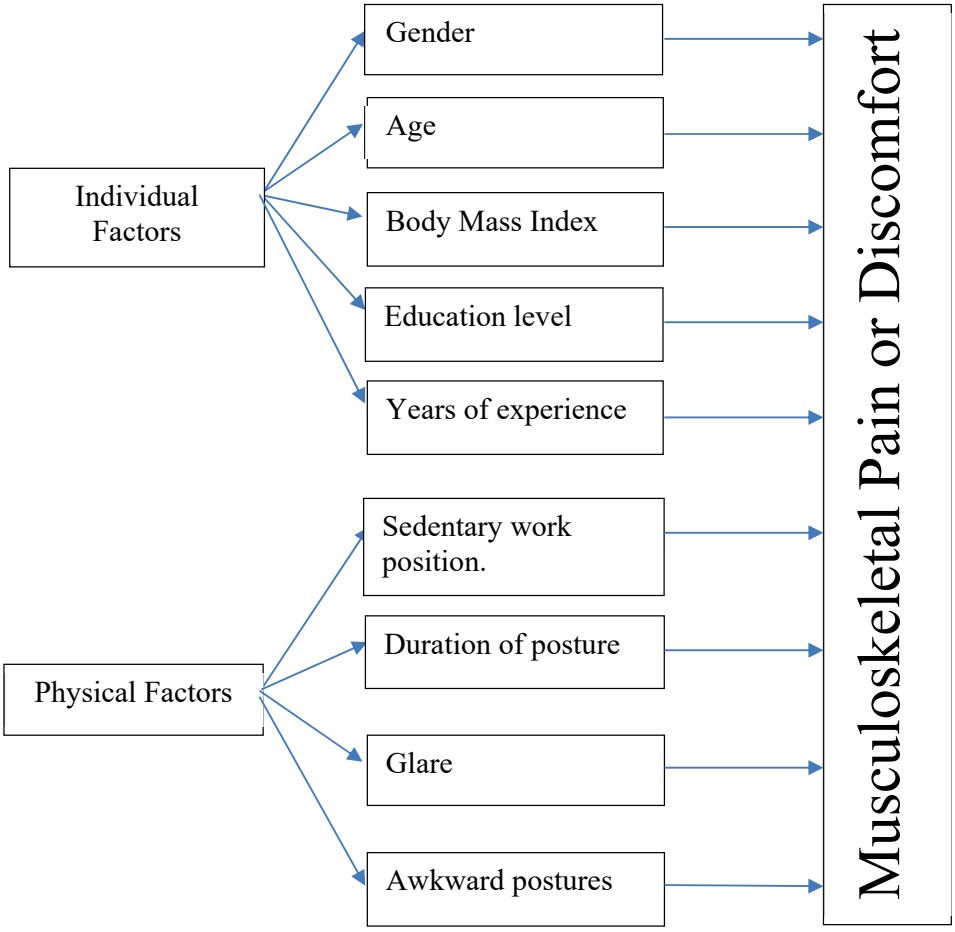

Figure 1.1: Conceptual framework.

The study of interest is about MSDs. It is conducted to identify the prevalence of musculoskeletal disorders with associated individual and physical risk factors among computer users at the USM Health Campus. Individual factors and physical factors are the independent variables, as they influenced the outcome of the study. The prevalence of MSDs is the dependent variable that measured through CMDQ (Figure 1.1).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

At present, it is crucial to acknowledge that computers play a significant role as essential components in various service operations. Computers have become an integral part of daily life and routine; it can be at home or at workplace. In the recent time, the effects of technology evolution, especially computers and its skills application, have resulted to a core part of job opportunities, job content, and work reward. Computer programming is becoming a crucial course undertaken by computer education students, and some soft skills have become a core competence for engineering and computer science students to obtain a reasonable employment (Besharati *et al.*, 2018; Juzad *et al.*, 2022; Muraina *et al.*, 2021). Since 1930, majority of workers have used the first computer innovation during their job duties, and both women and men have become computer users for teletype machines (Haynes, 2001). Every daily routine and activities can be executed in a more efficient and effective manner, beginning with collection of data, writing of paperwork, and making any decision. Computers are becoming a cornerstone for every organization, especially in the service sector (Hollingsworth, 1992; Voulodimos *et al.*, 2018). MSDs have been observed most commonly in the manufacturing business, although the prevalence of occupational injuries has been steadily rising in the service of industry in recent years as shown in Figure 2.1.

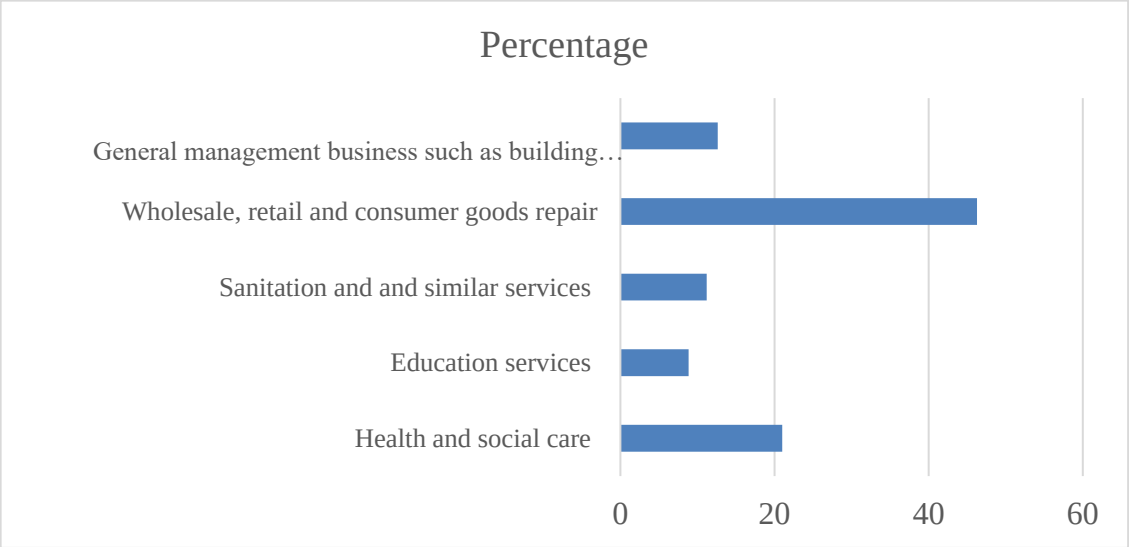

Figure 2.1: MSDs distribution for data released from Korea Worker's Compensation and Welfare Service from Choi *et al.* (2017).

Computer activity in the office had increased rapidly, combined with the rapid growth of information technology (Lowe, 1997; Ra *et al.*, 2019). Generally, most of studies highlighted that the use of a computer leads to a more qualified work and less physical movement. In addition, those personnel working with computers permanently clearly demonstrates more physical and psychosocial issues compared to those who use computers on part-time. Over the past twenty years, the result of the quick expansion of computer use across European countries has increased from 40% to more than 60%. Furthermore, computer use in low-skilled occupations has significantly increased in several European countries (Salvatori *et al.*, 2018). MSDs are still one of the most common occupational diseases in Europe, and between 2013 and 2020, they continued to be one of the top issues on the agenda for occupational health and safety (Rial-González *et al.*, 2020). Following a recent report by the Korean government, more than 80% of employees used computers more than once per week in 78.3% of companies, and 70.3% of companies had at least one computer (Agency, 2012). Therefore, due to the significance and need of

computers for life, work, career, industry, economy, and its widespread use, the use of computers will affect the well-being of human either physically, emotionally, or mentally. Many epidemiological studies show many complaints, especially in musculoskeletal discomfort among employees (Anggiat *et al.*, 2018; Basakci Calik *et al.*, 2022; Kaliniene *et al.*, 2016).

2.2 Prevalence of Musculoskeletal Disorder

The workplace involves different risks; the MSDs rate has increased to be the most common and related to worker tasks. MSP is frequently reported not only among physical workers (Anwar *et al.*, 2019; Lop *et al.*, 2017) but also among computer users (Damanhuri *et al.*, 2014; Shariat *et al.*, 2016a). Information technology advances led to significant changes in work (Murray, 2015) and reshaped the way workers do their jobs (Alcácer & Cruz-Machado, 2019; Posada *et al.*, 2015).

Associations between computer use and MSDs have been demonstrated in several studies. In Malaysia, a study reported by Shariat *et al.* (2018) that office computer users often experience MSDs. In a population of Malaysian public service office workers, the prevalence of MSDs discomfort was 92.8% (Maakip *et al.*, 2016), in a shared service centre 74.4% had MSDs symptoms (Jefferelli *et al.*, 2016). In the higher education sectors of Malaysia, 73.5% suffered from MSDs (Khan *et al.*, 2020).

Studies have documented MSDs in at least one human body part or body region. The prevalence of MSDs has varied between 40% and 95% according to the study population in different countries; in the USA, Nigeria, China, Iran, and Malaysia,

the prevalence of MSDs was 78%, 65.2%, 50%, 78.8%, and 66.7%, respectively (Anton & Weeks, 2016; Deros *et al.*, 2014; Mozafari *et al.*, 2015; Odebiyi *et al.*, 2016; Yu *et al.*, 2012).

The prevalence of MSDs among computer bank office employees was 40.4% (Moom *et al.*, 2015); in another country, the prevalence of MSDs among bankers in Ethiopia was 65.5% (Kasaw Kibret *et al.*, 2020), and the prevalence of MSDs among computer users in Nigeria was 75.6% (Abaraogu *et al.*, 2018). In Turkey, bank employees experienced work-related upper extremity musculoskeletal complaints anywhere in the upper body area 61.1% of the time (Ozvurmaz & Mandiracioglu, 2017).

Previous studies reported that the most commonly reported sites of MSDs among computer users were the shoulder, neck, and upper back regions (Cho *et al.*, 2012; Moom *et al.*, 2015), while disorders in other body regions were also reported (Gerr *et al.*, 2006; Haynes & Williams, 2008); in the upper body area, 61.1% were reported; and the most common complaint was reported in the left neck (66.5%) and left shoulder (28.5%) areas (Ozvurmaz & Mandiracioglu, 2017).

2.3 Musculoskeletal Disorders Risk Factors

Computer users are more likely to develop MSDs associated with prolonged sitting duration, awkward postures, long working hours physically demanding and stressful tasks, as well as repetitive tasks in front of computers without enough rest and recovery time (Abledu & Abledu, 2012; Etana *et al.*, 2021).

The prevalence of MSDs across a broad areas of jobs scope, as well as those involve with heavy biomechanical task, such as manufacturing and factory jobs, including those with less physically demanding loads, such as office work. These issues have been seen to result more frequently in people who have unsuitable ergonomic situations during working time (Borhany *et al.*, 2018; Park *et al.*, 2018). MSDs are on the rise among office employees, who constitute a significant portion of the labor force in Malaysia (Shariat *et al.*, 2018). Numerous physical ailments and conditions are prevalent among individuals who engage in prolonged sitting at office desks. These issues can lead to both work absences and discomfort, as individuals experience fatigue and discomfort in different body parts, including the neck, lower back, shoulders, and knees.

2.3.1 Individual Risk Factors

Individual risk factors are crucial for developing MSDs. These factors, such as gender, age, body mass index, and years of work experience, might independently or together impact an individual based on their particular characteristics and potentially contributing to MSDs, particularly with prolonged computer usage.

2.3.1(a) Gender

The research indicated that the prevalence rate of MSDs was present at upper extremity disorders in women higher than in men (Chen *et al.*, 2018; Dagne *et al.*, 2020; Elshaer, 2017; Sarquis *et al.*, 2016). Gender variances were identified only for upper back MSDs symptoms, with women reporting much higher pain than men (Cook *et al.*, 2000). In China, Holzgreve *et al.* (2021) reported that females were found to be 2.059 times more likely than males to experience neck and shoulder

discomfort. In another study, female gender was linked to the presence of discomfort in several body regions (Silva *et al.*, 2016). In a study conducted among Malaysian office workers, Shariat *et al.* (2018) found a significant correlation between gender and pain severity on either sides of the shoulders respectively (X^2 = 6.174, p = 0.046) and (X^2 = 6.373, p = 0.041). In Iran, the study of office worker in a university revealed that gender had correlation with MSDs score (Azadchehr *et al.*, 2023). Women consider are more likely to be affected by both physical and psychosocial risk factors (van den Berge *et al.*, 2021)

2.3.1(b) Age

There is an association between increasing age and loss of tissue strength; this relation contributes to other work-related factors in developing MSDs (Darvishi *et al.*, 2016; Johnston *et al.*, 2008). The prevalence of Neck MSDs is generally higher in women than in men among office workers in high-income countries (Flodin *et al.*, 2018). There has been evidence that those between the ages of 15 and 45 are still more likely to experience MSDs (Geyik *et al.*, 2002).

2.3.1(c) Obesity/Body Mass Index

Obesity has reached pandemic level in Europe (Boutari & Mantzoros, 2022), and its adverse impact on various health-related diseases has increasingly become a research focus. MSDs is one of the obesity-associated diseases. Obese people have a major issue with continuous MSDs (Rosa *et al.*, 2021). The literature reported their prevalence rate of low back MSDs and BMI (Shariat *et al.*, 2018). In study by Mendonça *et al.* (2020) explored the prevalence of MSDs among adults with abdominal obesity, categorizing it by the specific location and intensity of the pain;

the study discovered a correlation between a certain level of obesity and experiencing pain in the ankle/foot region in the United States. Furthermore, the study conducted within the American population revealed that an increased BMI is connected to a heightened risk of experiencing back MSDs (Smuck *et al.*, 2014).

2.3.1(d) Educational Level

The educational level has the potential to be in a significant association with MSDs (Carvalho-e-Silva *et al.*, 2020; Jamil *et al.*, 2022; Krishnan *et al.*, 2021). A study showed that work activities associated with MSD were associated with education level with hip and thigh pain (Aleid *et al.*, 2021). People with lower levels of education might have restricted knowledge and skills in ergonomic issues at work (Kibret *et al.*, 2020).

2.3.1(e) Work Experience

The work experience can be in a significant association with MSDs (Yazgan *et al.*, 2021). The review paper by Tavakkol *et al.* (2020) revealed a clear relationship between job experience and musculoskeletal disorders.

A study conducted by Aleid *et al.* (2021), their findings indicated that the occurrence of MSDs is significantly associated with work experience among critical care unit. In another study which was conducted to determine the prevalence of Upper Cross Syndrome (UCS) in Pakistan, the study found a statistically significant relationship between gender, years of professional experience, and the duration of working posture determined in hours with disability (Mubashir, 2021). Similarly, lack of work experience increased the odds for MSDs (Ekpenyong & Inyang, 2014). Examining a specific population of sawmill workers in Bangladesh,

the findings, reported among 254 worker, revealed that job experience had a significant association with the development of MSDs (Rahman *et al.*, 2017). Furthermore, in another study of 454 health care workers, the work experience was associated with low back MSDs (Attarchi *et al.*, 2014).

2.3.1(f) Computer Use

This could indicate the duration of time worked every day or the number of days the work was performed. The longer the period of uninterrupted employment, the greater the risk of musculoskeletal problems associated with work as reported by Tanzila *et al.* (2021). Due to the COVID-19 pandemic, working from home became essential for those working in the technology sector. According to the study's findings, information technology workers who worked from home had a higher risk of MSDs connected to their jobs, most commonly in the shoulder, neck, wrist, elbow, and lower back (Patel & Ghosh, 2022). In a previous study, being male, more age, smoking and drinking habits, job duration, and poor working posture were contributors to increase MSD in bank office computer employees (Moom *et al.*, 2015). Prolonged periods of computer use in conjunction with workers' experiences, gender, sitting, and using workstation components have been associated with the development of MSDs (Collins & O'Sullivan, 2015; Dagne *et al.*, 2020; Kasaw Kibret *et al.*, 2020; Mahmud *et al.*, 2011).

2.3.2 Physical Risk Factors

Office work involves a complex interplay of physical risk factors, including interactions among workstation dimensions, sedentary positions, repetitive tasks, long working hours, glare, and awkward postures. This is an example of ergonomic

risk factors, which are the aspects of a job or task that develop MSDs. Many studies used ROSA, RULA tools to identify ergonomic risk level among computer users (AlOmar *et al.*, 2021; Azadchehr *et al.*, 2023; Kaliniene *et al.*, 2016; Mohammadipour *et al.*, 2018; Poochada & Chaiklieng, 2015; Rafeemanesh *et al.*, 2019).

2.3.2(a) Repetitive Work

Muscles that have reached maturity can produce very high forces. Excessive usage of body muscles may also exert forces for longer durations, allowing for repeated movements and awkward postures. This is classified as an "overuse injury" and often affects the elbows, wrists, and hands of computer users. These overuse injuries are described by pain, swelling, joint stiffness, weakness, and numbness; painful muscles and tendons increasing associated fatigue that can lead to MSD.

Workers are at risk for developing a series of diseases known as repetitive strain injury (RSI), which can be caused by excessive usage of a computer or other related movements or tools. Carpal Tunnel Syndrome (CTS) is a leading cause of upper extremity MSDs that targets computer users wrists and causes pain in the hands, affects those who use their hands in a repetitive way, such as typing (Demissie *et al.*, 2023; Graveling, 2018).

2.3.2(b) Body Posture

The expression "posture" refers to the body's position at a particular moment or it may refer to an ongoing pattern of muscular activity (Josey, 2016). Computer posture refers to how a user sits at their computer. Users using computers in the workplace need to be aware of their posture and adopt the correct work posture,

which includes the correct positioning of the user's neck and monitor, as well as the body and chair, the keyboard, and the arms (Figure 2.2).

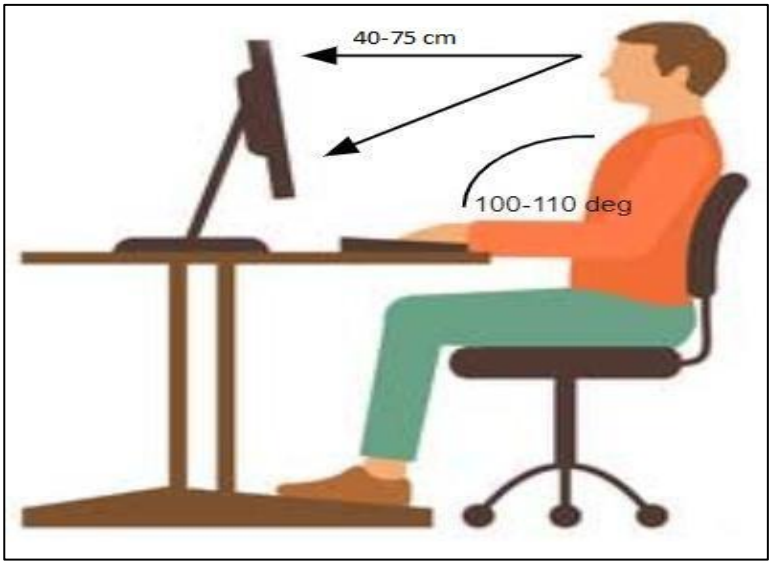

Figure 2.2: Ergonomic good body posture adapted from Ergonomic-Trends (2021).

According to studies, the ideal chair recline angle is 135 degrees, which is almost hard to work with, thus a standing desk is the best option overall (Figure 2.3). Poor body posture is a major cause of spinal discomfort because it produces more mechanical stress in the lower back and renders the tendons and ligaments weaker, which results in lower back MSDs (Du *et al.*, 2023).

A study conducted in Iran revealed that a 88.4% of office workers in a university experience MSDs due to the poor posture imposed by their workstations (Mohammadipour *et al.*, 2018). Similarly, study conducted among 422 computer user bankers in Ethiopia, it was found that there is a significant association between MSDs and bad body posture (Demissie *et al.*, 2022).

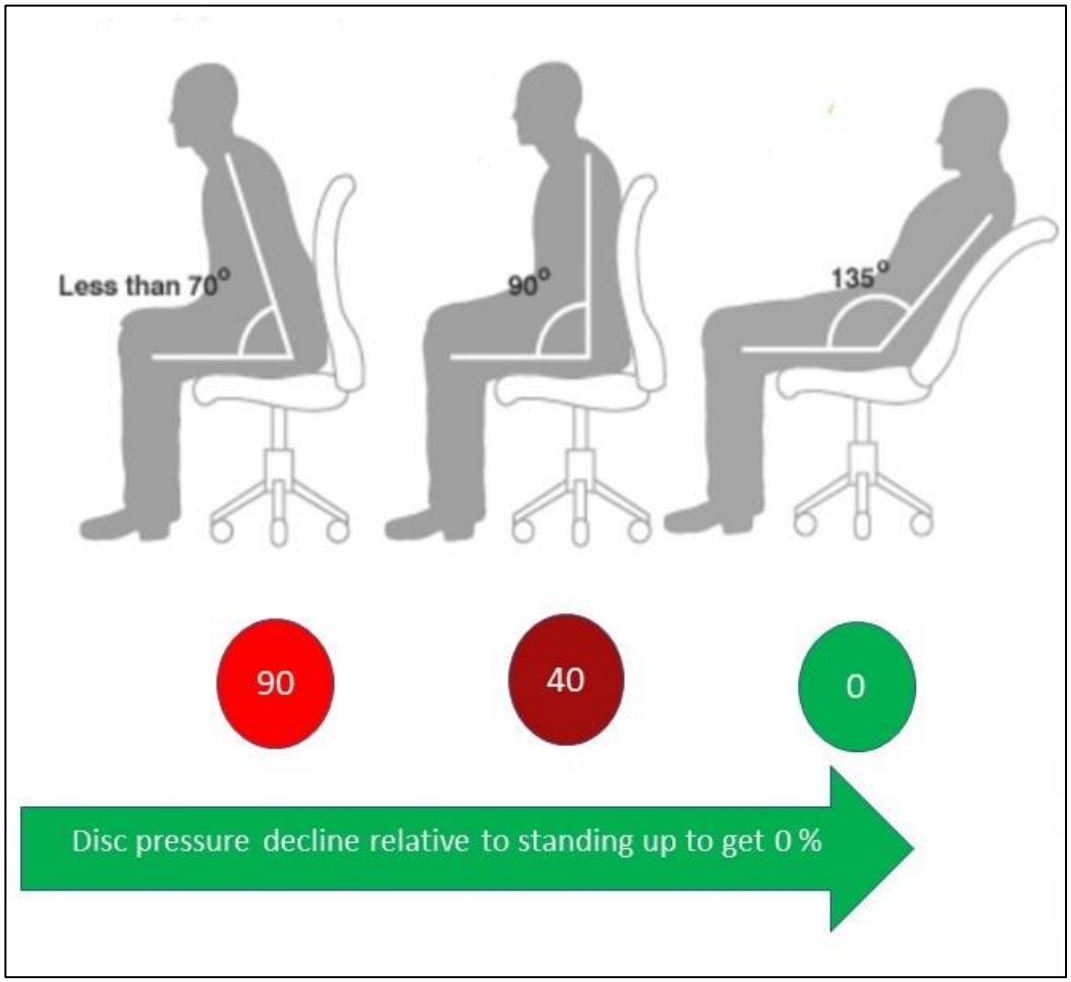

Figure 2.3: The best angle for a person to sit at 130 degree, causing the least stress on the spine, adapted from Gurney (2020)

2.3.2(c) Static Posture

Static postures are those in which the individual spends many hours standing in the same position. Muscle fatigue and injury result from stiffness, which restricts blood circulation. Ergonomic adaptations may decrease the negative effects of static posture (Köşker, 2019). In addition, Yue *et al.* (2012) reported that physical exercise, extended standing and sitting, and static posture were associated with MSDs in the neck and shoulder, while lower back MSDs was more often associated with a twisted posture. In a study involving 593 bank employees, it was found that

those who sat for more than 9 hours a day reported lower back MSDs around 1.5 times more than regular computer user (Ali *et al.*, 2020).

2.3.3 Lifestyle

The new modern lifestyle, marked by excessive hours spent in front of computers and a growing number of people smoking, causes adverse effects on health. However, a systematic study conducted by Moreira-Silva *et al.* (2016) indicates that making changes in one's lifestyle, such as adding a 20-minute stretching practice three times a week, can have a positive effect on lowering MSDs in different body regions.

2.3.3(a) Smoking

Smoking tobacco is recognized to have negative effects on most human body systems, limited research has been conducted on the musculoskeletal system, which is one of the largest human body systems, in comparison to the adverse effects of smoke on high-mortality disorders like cancer and cardiovascular and respiratory problems (Al-Bashaireh *et al.*, 2018).

The study conducted on 408 male participants with lung cancer revealed a substantial decrease in bone mineral density (BMD) (Pompe *et al.*, 2017); the low BMD increased the risk for fracture, increased joint disease and increased the MSDs. In reviewing the literature to study the relationship between smoking and MSDs, numerous studies indicate that tobacco is a hazardous substance. It has been demonstrated that smoking affects practically every organ in the body. It is a major cause of cardiovascular disease, some cancers, and many other musculoskeletal problems (Tarakji *et al.*, 2017).

A study of a large sample of people in Afghanistan and Iraq showed an association between continuous and lifetime smoking and moderate to severe musculoskeletal discomfort (Green *et al.*, 2017). In cross-sectional conducted in 2019, which involved 10,000 adults, examined the link between lifestyle and MSDs revealed that smoking has an association with an increased risk of MSDs (Kirsch Micheletti *et al.*, 2019), while a study among Nigerian computer workers found no correlation between neck discomfort and smoking (Abaraogu *et al.*, 2018). In Lahore, a cross-sectional study was conducted among computer users as participants, revealed an association between smoking and gender with neck discomfort (Ishaq, 2018). Moreover, in the research of 63 bank employees in India, both private and public bank employees used the computer and mouse in their daily work, and the prevalence of MSDs was significantly affected by smoking behaviours (Dhengre *et al.*, 2021).

2.3.3(b) Physical Activity

The term "physical activity" refers to various forms of exercise, such as routine actions like walking or biking for commuting, engaging in active play, work-related movement, participating in energetic recreational pursuits (such as gym workouts), dancing, tending to gardens, actively playing games, and involvement in organized and competitive sport (PAGEG, 2011). Indeed, Sosso and Raouafi (2017) mentioned that any muscular practise that serves to improve or maintain physical fitness, as well as general health and wellness, is a physical exercise.

Frequency (the number of times an individual participates an action over a certain period, such as a week) and duration can be used to quantify physical activity (the