THE RELATIONSHIPS BETWEEN PREVALENCE OF MUSCULOSKELETAL DISORDERS (MSDs) SYMPTOMS, ASSOCIATED RISK FACTORS, AND WORK PRODUCTIVITY AMONG INDUSTRIAL WORKERS IN A MANUFACTURE FACTORY

OOI ZI FENG

A project report submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Science (Hons) Environmental, Occupational Safety and Health

Faculty of Engineering and Green Technology
Universiti Tunku Abdul Rahman

May 2025

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

Signature : _____

Name : Ooi Zi Feng

ID No. : 20AGB01742

Date : 13/5/2025

APPROVAL FOR SUBMISSION

I certify that this project report entitled **"THE RELATIONSHIPS BETWEEN PREVALENCE OF MUSCULOSKELETAL DISORDERS (MSDs) SYMPTOMS, ASSOCIATED RISK FACTORS AND WORK PRODUCTIVITY AMONG INDUSTRIAL WORKERS IN A MANUFACTURE FACTORY"** was prepared by **OOI ZI FENG** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Science (Hons) Environmental, Occupational Safety and Health at Universiti Tunku Abdul Rahman.

Approved by,

Signature : 

Supervisor : Dr. Lim Fang Lee

Date : 14 May 2025

ACKNOWLEDGEMENTS

I would like to thank everyone who had contributed to the successful completion of this project. I would like to express my gratitude to my research supervisor, Dr. Lim Fang Lee for her invaluable advice, guidance and her enormous patience throughout the development of the research. Besides, I would also like to thank Dr. Siti Nurfahirah binti Muhamad for her precious advice on my questionnaire and guidance provided for the development of the research.

THE RELATIONSHIPS BETWEEN PREVALENCE OF MUSCULOSKELETAL DISORDERS (MSDs) SYMPTOMS, ASSOCIATED RISK FACTORS, AND WORK PRODUCTIVITY AMONG INDUSTRIAL WORKERS IN A MANUFACTURE FACTORY

ABSTRACT

Work-related Musculoskeletal Disorders (WMSDs) are among the most common occupational health issues and are frequently associated with repetitive physical activities. In the manufacturing sector, many jobs still require manual, repetitive tasks, heightening the risk of WMSDs due to sustained and repetitive motion over time. This study explores the connection between the presence of Musculoskeletal Disorders (MSDs) symptoms, associated risk factors, and work productivity among assembly line workers who regularly engage in repetitive tasks in a Heating, Ventilation, and Air Conditioning (HVAC) manufacturing factory. Data on ergonomic risk factors, MSDs symptoms, and productivity indicators (such as absenteeism, presenteeism, and self-rated work efficiency) were collected from 60 assembly line employees using the Modified Cornell Musculoskeletal Discomfort Questionnaire and an online Google form. Descriptive statistics, Chi-square tests, Mann-Whitney U tests, and binary logistic regression were conducted using Statistical Package for the Social Sciences (SPSS) version 30. The findings revealed a 93.3**%** overall prevalence of MSD symptoms among participants in the past week. The most affected areas were the neck (51.7%), lower back (50.0%), right shoulder (48.3%), right foot (45.0%), and left foot (40.0%). The Mann-Whitney U Test indicated that MSDs symptoms were significantly related to presenteeism and self-reported work efficiency (both $p < 0.001$). Further binary logistic regression analysis highlighted significant associations between right foot MSDs and gender (OR = 5.296, 95% CI = 1.123–24.975, p = 0.035), as well as previous injuries (OR = 43.886, 95% CI = 4.373–440.457, p = 0.001). Symptoms in

the right and left forearms were significantly linked to the workers' daily working hours with the p-value of 0.036 (OR = 0.212, 95% CI = 0.050–0.904) and 0.006 (OR = 0.062, 95% CI = 0.008-0.456), respectively, and MSDs in the right wrist were associated with the frequency of microbreaks (OR = 0.363, 95% CI = 0.138–0.956, p = 0.040). In summary, assembly line workers in an HVAC manufacturing facility showed a high rate of MSDs symptoms, which were closely tied to presenteeism and perceived work efficiency, and considered factors that directly influence overall productivity. To address these issues, the study recommends implementing health surveillance and ergonomic interventions based on the hierarchy of controls. Suggested measures include ergonomic workstation design, job rotation, specialized tools, and employee training, which aim at improving safety, reducing absenteeism, boosting morale, and enhancing productivity.

Keywords: Work-Related Musculoskeletal Disorders, Musculoskeletal Disorders Symptoms, Repetitive Tasks, Manufacturing Industry, Work Productivity

Subject Area: RC925–935 Diseases of the musculoskeletal system

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS / ABBREVIATIONS

BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CI	Confidence Level
CMDQ	Cornell Musculoskeletal Discomfort Questionnaire
DOSH	Department of Occupational Safety and Health
ERA	Ergonomic Risk Assessment
HAV	Hand-Arm Vibration
HVAC	Heating, Ventilation, and Air Conditioning
MSDs	Musculoskeletal Disorders
NMQ	Nordic Musculoskeletal Questionnaire
OR	Odd Ratio
RULA	Rapid Upper Limb Assessment
SOCSO	Social Security Organisation
SPSS	Statistical Package for the Social Sciences
VDUs	Video Display Units
WBL	Work-Bench Load
WBV	Whole-Body Vibration
WMSDs	Work-related Musculoskeletal Disorders
WRLLDs	Work-related Lower Limb Musculoskeletal Disorders
WRULDs	Work-related Upper Limb Musculoskeletal Disorders

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

In Malaysia, the manufacturing industry has been rapidly expanding since the post-COVID-19 pandemic, which has resulted in more employment opportunities among Malaysians and foreigners. According to the Malaysian Investment Development Authority (MIDA) (2022), 801 approved manufacturing sector-related projects were implemented in Malaysia, and 76,093 job opportunities were reported in the year 2022.

Although the manufacturing sectors in recent years have introduced an automotive process to ease the manufacturing process and relieve the heavy lifting burden on workers (Nur *et al*., 2014), some of the tasks still need to be performed manually by the workers. Assembly work is considered a common manual handling task that involves repetitive motion (Nur *et al*., 2014). Previous research has shown that individuals engaged in repetitive tasks are frequently affected by Work-related Musculoskeletal Disorders (WMSDs). Globally, Musculoskeletal Disorders (MSDs) are the second most disabling cause and the most prevalent occupational health issues in the workplace (Daneshmandi *et al.*, 2017).

The high employment of production line workers in the manufacturing sector indicates there will be higher numbers and a greater chance of workers experiencing MSDs. Various studies have demonstrated that workers who experience MSDs will affect their productivity by slowing down their working pace (Ng *et al.*, 2014) and might get more serious MSDs injuries. Eventually, the overall work productivity will

be lost and leading to lower profits made. Besides, the workers who suffer from MSDs will be affected in his/her daily lives, leading to poor living quality. Hence, the early detection of MSDs symptoms among workers is important for the organization to prevent or reduce the prevalence of MSDs or WMSDs among workers.

1.2 Problem Statements

Work-related Musculoskeletal Disorders (WMSDs) refer to occupational diseases that impair the musculoskeletal system, primarily resulting from the tasks performed by workers and the conditions of their work environment (Govaerts *et al*., 2021). According to Malaysia's Social Security Organisation (SOCSO), the manufacturing industry recorded approximately 553 MSDs-related claims between 2009 and 2014, including 16 cases of temporary disability and 537 cases of permanent disability (Rohani *et al*., 2016). This data highlights a significantly high occurrence of MSDs among manufacturing workers in Malaysia.

A previous local study conducted in an automotive manufacturing company by Nur *et al* (2014), reported a 76.97% prevalence of WMSDs among workers, indicating a notably high rate in the industry and questionnaire responses from automotive workers revealed the neck (49.3%) has the highest prevalence of MSDs, followed by the hand and wrist (48%) and shoulder (46.7%). Additionally, MSDs and their symptoms not only impact worker health but also affect performance, with a strong link to presenteeism and absenteeism found in previous studies. In the studies focus on absenteeism and presenteeism with work performance among the medical school's support workers in Thailand, both sickness absence and working with discomfort over the past year were strongly linked to a higher likelihood of reduced job performance and report rate of poor performance mostly among the workers with the condition of burnout and high level of stress (Tangchareonsamut *et al*., 2021). In another study on health-related absenteeism and presenteeism, findings show that improving working conditions can significantly reduce both absenteeism and presenteeism, leading to better employee health and productivity (Brunner *et al*., 2019).

Findings from Malaysia's Healthiest Workplace by AIA Vitality (2018) survey revealed that 85% of Malaysian workers experienced at least one or more musculoskeletal conditions, which cost the employers RM2.27 million as the absence and presenteeism of each employee, leading to a total annual loss of 73.1 workdays. In 2019, the survey showed an increase to 73.3 lost days per employee, costing employers RM 1.46 million monthly, up from the 2018 figure of RM 2.27 million annually. Additionally, SOCSO reported a substantial increase in compensation due to MSDs, from RM 1,049,700.86 in 2009 to RM 3,940,486.61 in 2014, with a total compensation of RM 13,593,357.59 over this period (Zainal Abidin *et al.*, 2018). Figure 1.2 illustrates an overall upward trend in compensation for MSDs and occupational diseases from 2009 to 2014. Therefore, addressing absenteeism and presenteeism among workers is crucial to minimizing employer losses in time and cost. *Figure 1.1* below shows the employees' compensation rate due to MSDs relative to occupational disease from 2009 to 2014.

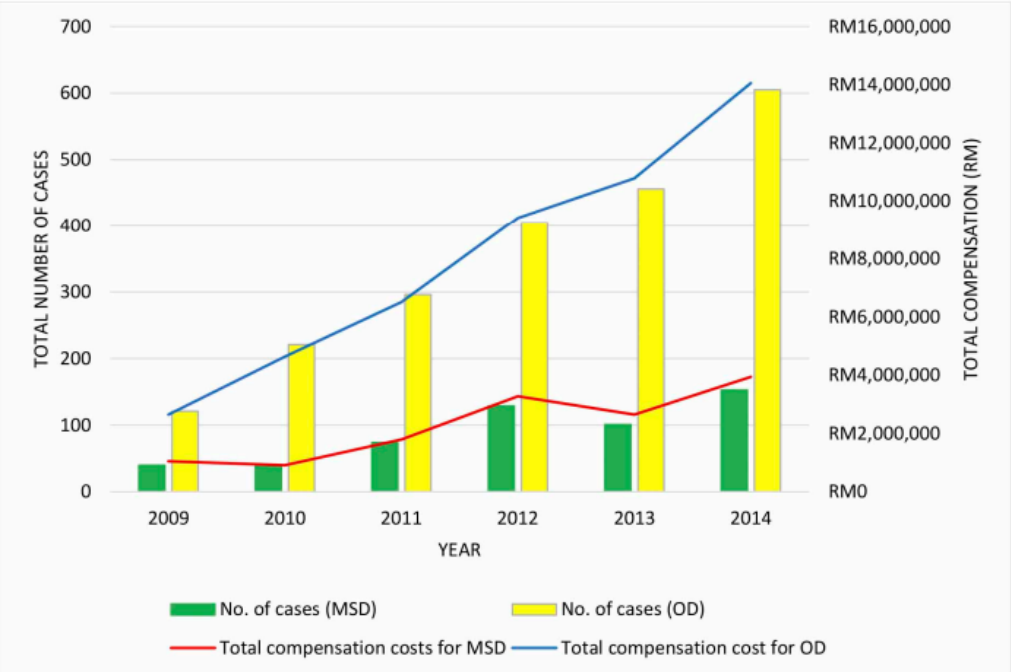


Figure 1.1: Employees' compensation due to Musculoskeletal Disorder relative to occupational disease from 2009 to 2014.

(Department of Safety and Health, 2017)

1.3 Significance of the Study

This study is important in providing empirical data and scientific evidence on the prevalence of Musculoskeletal Disorders (MSDs) symptoms among manufacturing workers. Such findings are essential for raising awareness among factory management about the severity of MSDs and encouraging proactive measures. These measures may include enhancing safety awareness and training, improving workplace ergonomics, and revising existing work procedures. Implementing these improvements can help lower the incidence of MSD-related symptoms, subsequently reducing absenteeism and presenteeism, as well as minimizing compensation costs associated with lost working time. Moreover, a better work environment and increased ergonomic awareness can lead to enhanced worker productivity, greater job satisfaction, and reduced employee turnover.

In addition, research on MSD symptoms related to individual and occupational risk factors within Malaysia's manufacturing industry remains scarce. This study addresses that gap by examining the associations between these risk factors and the development of MSD symptoms among factory workers. The results can serve as a foundation for future research and benchmarking, while also helping to identify the underlying causes of MSD complaints specific to this industry.

The insights gained from this study regarding the prevalence and contributing factors of MSD symptoms may also inform government agencies in enhancing current ergonomic regulations and guidelines. Existing standards often fall short in effectively addressing MSD risks, particularly in manufacturing. Furthermore, limited regulatory enforcement contributes to the underreporting of MSD cases. By exploring how physical and psychosocial workplace conditions impact health and productivity, this research can highlight deficiencies in current practices and offer evidence-based recommendations for improvement. These findings may lead to increased organizational compliance and a reduction in MSD prevalence among industrial workers.

1.4 Objectives of the Study

1.4.1 Research Aim

To show the relationships between the Musculoskeletal Disorders (MSDs) symptoms and work productivity of the workers.

1.4.2 Research Objectives

1. To determine the individual and work-related risk factors of Musculoskeletal Disorders (MSDs) symptoms, prevalence of MSDs symptoms, absenteeism, presenteeism, and self-reported work efficiency of the industry workers in an HVAC manufacturing factory.
2. To study the relationships between the prevalence of Musculoskeletal Disorders (MSDs) symptoms for different body parts with absenteeism, presenteeism, and self-reported work efficiency among the manufacturing workers.
3. To evaluate the individual and work-related risk factors of Musculoskeletal Disorders (MSDs) symptoms among the manufacturing workers.

1.4.3 Alternative hypothesis

It was hypothesized that there were significant relationships between Musculoskeletal Disorders (MSDs) symptoms and work productivity among industrial workers in a manufacturing factory.

1.5 Conceptual Framework

This study examines the impact of various risk factors on work productivity, with a particular focus on Musculoskeletal Disorders (MSDs). The risk factors are categorized into individual, work-related, organizational, and psychological. Individual risk factors include personal attributes such as age, gender, and medical history, which may increase vulnerability to MSDs. Work-related factors involve physical job demands, repetitive motions, and poor posture, which are known contributors to musculoskeletal strain. Organizational culture, including leadership style, workplace communication, and support systems, plays a crucial role in shaping employee well-being and engagement.

Psychological distress, such as stress, anxiety, and emotional exhaustion, can further compromise an employee's physical health and productivity. Additionally, the physical working environment, such as workstation ergonomics, lighting, noise, and temperature, can influence comfort and the risk of developing MSDs. In this context, MSDs symptoms serve as the independent variables that potentially lead to three key dependent variables: absenteeism (missing workday due to MSDs), presenteeism (attending work while being unwell and underperforming), and self-reported work efficiency (reported work productivity due to the MSDs during presenteeism). These outcomes directly affect overall work productivity, making it essential to address the underlying risk factors to maintain a healthy and efficient workforce. *Figure 1.2* shows the overview of the conceptual framework for this study.

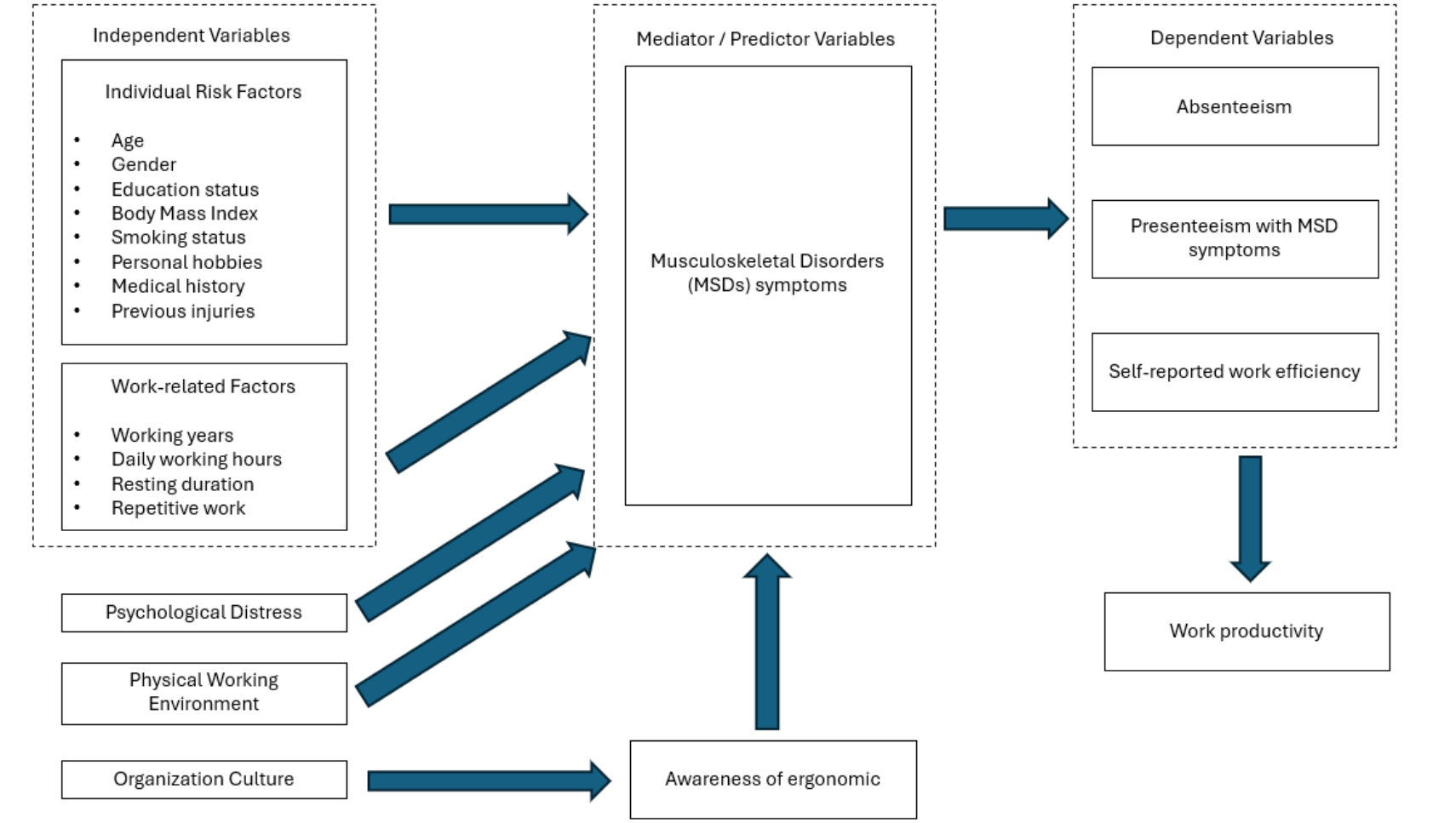


Figure 1.2: Overview of the conceptual framework

CHAPTER 2

LITERATURE REVIEW

2.1 Ergonomic

The International Ergonomic Association (IEA) defines “Ergonomics” as the branch of science that focuses on improving human welfare and system performance by using suitable techniques, theories, and data to our knowledge of how humans interact with other components of systems (Heidarimoghadam *et al*., 2022). In other words, applying a body of scientific information that is pertinent to a situation using techniques that are suitable for the circumstance and the body of knowledge is what ergonomics is all about (Baber and Young, 2022). The ultimate aims of ergonomics are to improve total system performance and well-being, and ergonomic treatments help to attain these goals (Heidarimoghadam *et al*., 2022).

According to Heidarimoghadam *et al*. (2022), interventions are classified into several categories: Teams, which include semi-autonomous and autonomous workgroups, quality circle participatory ergonomics, project teams, suggestion schemes, and self-managed teams; Organizational Design, covering elements like total quality management, flat hierarchies, electronic performance monitoring systems, decentralization and the promotion of healthy organizations; Management, which involves approaches such as supervisor training, improved communication, feedback systems, information sharing, and just-in-time scheduling; Increased Job Variety, such as cross-functional training, job enlargement, and job rotation; and Expanded Job Content and Responsibility, which includes vertical job enrichment and increased employee control over work tasks.

2.2 Work-Related Musculoskeletal Disorders (WMSDs)

WMSDs are occupational disease that affects and damages the human musculoskeletal system due to work factors (Department of Occupational Safety and Health, 2017). According to the Department of Occupational Safety and Health (2017), the muscles, ligaments, and other soft tissues surrounding the body's joints are commonly affected in the human musculoskeletal system. *Table 2.1* below shows the descriptions of the soft tissues affected.

Table 2.1: Descriptions of the soft tissues affected

No.	Soft Tissues	Descriptions
1	Muscle	Smooth, cardiac, and skeletal muscles, which make up the body's contractile tissues, are responsible for generating force and enabling motion.
2	Ligaments	Fibrous tissue that binds two bones together.
3	Tendons	Tenacious fibrous connective tissue that binds bone to muscle.
4	Nerves	Gather sensory data. The spinal cord and spinal column serve as the conduit for spinal nerves. Brainstem and cranial nerves are connected.
5	Spinal Discs	The discs that lie between the spinal bones' vertebrae are known as intervertebral discs.
6	Bursa sacs	Small sacs made of white fibrous tissue and filled with synovial fluid serve as cushions between muscles, tendons, and bones around a joint.

Source cited from Department of Occupational Safety and Health (2017)

Repetitive strain injury and occupational overuse syndrome are other synonyms for MSDs (Department of Occupational Safety and Health, 2017). Besides, Upper Extremity Musculoskeletal Disorders, Upper Limb Disorders, Cumulative Trauma Disorders, Repetitive Stress, and Repetitive Motion Injuries are also known as MSDs (Department of Occupational Safety and Health, 2017).

2.2.1 Work-Related Lower Limb Musculoskeletal Disorders (WRLLDs)

WRLLDs are caused by overusing certain muscles and repeated motions like kneeling and/or squatting, which affect the legs, knees, and hips, which can be caused by the extended periods spent standing still; repeated leaps from heights (Department of Occupational Safety and Health, 2017). The common WRLLDs include:

a) Conditions of the hips and thighs: joint discomfort, hamstring strains, osteoarthritis;
b) Lower leg/knee: bursitis, osteoarthritis;
c) Ankle/foot: sprained ankle, bunions, plantar fasciitis, Achilles tendonitis, foot corns;
d) Varicose veins.

(Department of Occupational Safety and Health, 2017)

2.2.2 Work-Related Upper Limb Musculoskeletal Disorders (WRULDs)

Any area of the neck, shoulders, arms, forearms, wrists, and hands might be affected by WRULDs (Department of Occupational Safety and Health, 2017). One activity that might result in WRULDs is reaching or working with one's hand above one's shoulder (Department of Occupational Safety and Health, 2017). The common WRULDs include:

a) Neck: Cervical spine syndrome, tension neck syndrome,
b) Shoulder: Thoracic outlet syndrome, bursitis, and tendinitis;
c) Elbow: cubital tunnel syndrome, radial tunnel syndrome, bursitis, and epicondylitis

d) Hand/Wrist: Tenosynovitis, trigger finger, synovial cyst, carpal tunnel syndrome, hand-arm vibration syndrome, and De Quervain's disease.

(Department of Occupational Safety and Health, 2017)

2.3 Factors Associated With Musculoskeletal Disorders

2.3.1 Individual Risk Factor

Past studies have shown that among all the individual risk factors, there were found significantly associated between gender and age with the prevalence of Musculoskeletal Disorders (MSDs) among people (Rohani *et al*., 2016). According to a study among United States (U.S.) workers on the relationship between MSDs and productivity, the average age of workers hospitalized due to lower back pain was 60.5 years old in 2007 (Summers *et al*., 2015). Certain MSDs are more common in older age groups. For example, osteoporosis is more common in those over 65, with diagnosis occurring in people 75 years of age and beyond in 55% of cases (Summers *et al*., 2015). Projections indicating a 40% rise in arthritis diagnosis over the next 25 years are partially based on the continued growth in life expectancy (Summers *et al*., 2015).

Besides, gender can be the risk factors that lead to the prevalence of MSDs. According to Tang *et al*. (2022), A stronger correlation was found between the female gender and a greater incidence of MSDs in the elbows. More than that, MSDs are found linked to BMI in different parts of the body and medical history, such as Obesity (Lin *et al*., 2020). Obesity and overweight with a high BMI were somewhat linked to a higher frequency of musculoskeletal complaints (Lin *et al*., 2020), and some studies indicated that weight reduction is associated with a reduction in musculoskeletal pain (Summers *et al*., 2015).

The study on metal industry workers in Turkey found that the workers with prior injuries had significantly higher odds of developing work-related MSDs due to

previous injuries led to vulnerabilities in specific body parts (Elif Altundaş Hatman *et al*., 2023). More than that, Workers with a history of wrist or shoulder injuries were more likely to experience recurring MSDs symptoms, especially under high-stress conditions like repetitive movements in the study in the footwear manufacturing industry (Leite *et al*., 2019).

Furthermore, some studies show that the results of the home life factors significantly impact musculoskeletal symptoms associated with jobs; for example, exercise habits during leisure time can result in the occurrence of musculoskeletal symptoms among workers and affect their work productivity at the workplace (Hagberg *et al*., 2002).

2.3.2 Work-Related Risk Factors

2.3.2.1 Ergonomics Risk Factor

An ergonomic risk factor refers to any element that may cause or contribute to musculoskeletal injuries, encompassing various exposures, characteristics, or attributes. The presence of these factors alone may not lead to injury, but when two or more are present simultaneously, the risk of injury increases. Common ergonomic risk factors that need assessment in ergonomic risk evaluations include repetitive movements, static or sustained positions, awkward postures, forceful or prolonged exertion, contact stress, vibration, and environmental hazards.

<u>Awkward Posture</u>

Awkward posture occurs when a person's body positioning deviates significantly from a neutral stance during tasks, examples include twisting, bending, working with hands above the head or elbows above shoulder level, excessive reaching, being unable to change posture and bending the neck or back beyond 30 degrees without support. (Department of Occupational Safety and Health, 2017). In the studies focus on the MSDs and awkward posture among assembly line workers in an automotive industry, found that workers whose reported Rapid Upper Limb Assessment (RULA) action

levels in high or very high had significantly higher odds of MSDs complaints, particularly in the lower back, shoulders, and wrists which also have significance with the awkward of the workers posture during the work (Anita, 2014). In another study focused on the manual workers in Calcutta, India, reported that 95% of manual material handling workers experienced MSDs, with 83% of observed postures requiring immediate corrective measures, and carrying the heavy load overhead is considered a harmful posture in this study (Sarkar *et al*., 2016).

Forceful and Sustain Exertion

When transferring or sustaining a weight, using high levels of force is referred to as forceful effort, which includes pushing, pulling, lowering, lifting, or transporting and transferring two loads with the use of hands or physical force (Department of Occupational Safety and Health, 2017). Sustained postures that put too much strain on joints and overwork muscles and tendons can also constitute a forceful effort (Department of Occupational Safety and Health, 2017). The studies focused on the United States (U.S.) manufacturing workers, found that workers spending more time in forceful hand exertions more than 33% of their time had double the chances of neck and shoulder MSDs rates (Zimbalist *et al*., 2022). The study focused on manual workers in Calcutta, India, and also highlighted that carrying heavy loads overhead leads to the chance of low back and neck pain prevalence increase by over four times (Sarkar *et al*., 2016).

Repetitive Motion

Repetitive motion refers to the frequent, rapid, or prolonged use of the same muscle and joint groups (Department of Occupational Safety and Health, 2017). Thirty seconds or less in performing one cycle of the task is typically labelled as highly repetitive, and risk factors of forceful exertions and sustained postures will also contribute to the workers by perform this task (Department of Occupational Safety and Health, 2017). Research conducted on U.S. workers found a strong link between repetitive work and a higher occurrence of upper limb discomfort, carpal tunnel syndrome, and tendinitis (Latko *et al*., 1999).

Static and Sustain Posture

A static or sustained posture occurs during an extended period when a specific position of the body remains with little or no movement, and holding a fixed posture can lead to fatigue, discomfort, and injuries, increasing the risk of various health conditions (Department of Occupational Safety and Health, 2017). Prolonged sitting and standing are common examples of static and sustained posture, whereas prolonged standing refers to any activity that requires standing for over two hours, while prolonged sitting involves sitting for more than thirty minutes (Department of Occupational Safety and Health, 2017). However, these durations are approximate and may be adjusted based on individual evaluations by trained professionals (Department of Occupational Safety and Health, 2017). The study among the university employees focuses on musculoskeletal disorders and long-term static postures exposures, found that prolonged static postures were associated with lower back MSDs, mediated by increased levels of inflammatory cytokines that can lead to inflammation of the body joints (Dong *et al*., 2022).

Vibration

Two types of vibration stated in the Department of Occupational Safety and Health (2017) were Whole-Body Vibration (WBV) and Hand-Arm Vibration (HAV). Work-Bench Load (WBL) refers to when employees drive mobile machines or other work vehicles across uneven and rugged terrain, they are physically transmitting kinetic energy through their feet or seats (Department of Occupational Safety and Health, 2017). Hand-held power tools that vibrate and make noise are known HAV sources (Department of Occupational Safety and Health, 2017). The study in Calcutta, India, focused on manual workers and also acknowledged that the common risk factors of whole-body vibration in manual material handling tasks are contributors to the MSDs (Sarkar *et al*., 2016).

Contact Stress

Internal or external stress of the body can be considered as contact stress (Department of Occupational Safety and Health, 2017). Internal contact stress occurs when a blood vessel, nerve, or tendon is compressed or stretched around a bone or other structure (Department of Occupational Safety and Health, 2017). External contact stress happens when a body part presses against a workstation element, such as the edge of

a chair, seat pan, or desk (Department of Occupational Safety and Health, 2017). The study among US workers also considered other physical stressors, including contact stress, in relation to upper limb MSDs (Latko *et al*., 1999).

Environmental Risk Factors

Stressful environmental elements that have an impact on people's comfort, activity level, and health are referred to as environmental risk factors, Examples are temperature, light, noise, and conditions with high air pressure (Department of Occupational Safety and Health, 2017). Physical work environment including airborne particles, gases, temperature, illumination, ventilation, vibration, atmospheric pressure, and gravity within the workplace are the main topics discussed in environment ergonomics and might indirectly lead to the Musculoskeletal Disorders (MSDs) development among workers which caused by the continuous interaction and exposure of individuals to the environment (Mahdavi *et al*., 2020).

Work/Exposure Duration

The length of time a worker is subjected to a physical limitation determines, among other things, the likelihood that the exposure may ultimately show up as a negative impact on their health: The danger increases with exposure duration (Havet and Penot, 2022). The study focused on Korean wage workers associated with MSDs symptoms and long working hours, found that working 48 hours or more per week was significantly related to an increase in back pain risk, especially for both manufacturing businesses of small and medium-scale (Lee *et al*., 2018). The study focused on manual workers in Calcutta, India, and noted that tasks repeated 30–40 times daily contributed to a high frequency of MSDs among workers (Sarkar *et al*., 2016).

2.3.2.2 Psychological Risk Factors

Several studies have identified that psychological factors are the risk factors in Musculoskeletal Disorders (MSDs) development among workers. These include high workloads, monotonous tasks, limited job control, and insufficient support from colleagues and supervisors (Afsharian *et al*., 2023). A recent systematic review also

highlighted those low levels of workplace control, diminished decision-making authority, and reduced job satisfaction are significantly associated with a higher MSDs risk (Afsharian *et al*., 2023). Additionally, excessive workload, lack of autonomy, and inadequate social support are the common psychosocial factors that have been found to correlate with increased MSDs incidence (Afsharian *et al*., 2023).

In Malaysia, a study found that among public hospital nurses, work-related psychological factors, including iso-strain ratios, high job demands, and job strain, were significantly related to MSDs affecting various parts of the body (Amin *et al*., 2014). Similarly, research involving school teachers in Kuala Lumpur revealed that low social support, high psychological job demands, and symptoms of depression were significantly linked to increased reports of MSDs (Ng, Voo, and Maakip, 2019).

2.3.2.3 Organizational Culture

The studies have proven that the work practice of applying preventive measures for Musculoskeletal Disorders (MSDs) among workers is influenced by the organizational culture (Ziam *et al*., 2023). Studies also indicate that organizations with high best practice compliance rates have an organizational culture that is receptive to ongoing evaluation of professional practices. Hence, organizational culture can influence the awareness of the workers on MSDs (Ziam *et al*., 2023). The manager/Occupational Health and Safety (OHS) personnel and employees' informal and formal communication was mentioned in the descriptions of awareness techniques and communication through "toolbox talks" as casual "toolbox chats" "worker safety huddles" as official, scheduled events can help increase the awareness of workers (Van Eerd *et al*., 2022). Among those communication techniques, toolbox discussions in both official and informal methods were thought to be an efficient approach to raising MSDs awareness (Van Eerd *et al*., 2022).

2.4 Musculoskeletal Disorders Questionnaire

Musculoskeletal Disorders (MSDs) are often assessed through standardized questionnaires that help identify the presence, severity, and impact of symptoms in various parts of the body. These questionnaires are widely used in occupational health research and workplace assessments to gather data among workers on the prevalence of MSDs. Among the most commonly used tools are the Nordic Musculoskeletal Questionnaire (NMQ), which provides a detailed overview of discomfort of the person in different body parts, and the frequency of MSDs, severity of MSDs pain, and interference of discomfort with work are evaluate using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). These instruments are valued for their reliability, ease of use, and ability to support ergonomic interventions by linking reported symptoms to specific work tasks or environments.

2.4.1 Nordic Musculoskeletal Questionnaire

The Nordic Musculoskeletal Questionnaire (NMQ), developed with backing from the Nordic Council of Ministers, serves as a standardized instrument for evaluating musculoskeletal disorders, particularly in the general body, neck, shoulders, and lower back (Crawford, 2007). It can be utilized either as a self-administered questionnaire or through interviews. Interestingly, when applied in studies targeting work-related musculoskeletal disorders, the NMQ often results in higher reported rates of musculoskeletal issues compared to its use in general health assessments.

The questionnaire consists of two sections. Section 1 includes a basic set of 40 multiple-choice questions that help identify body regions associated with musculoskeletal problems. A clear body map illustrating nine symptom areas including neck, shoulders, upper back, elbows, lower back, wrists and hands, hips and thighs, knees, and ankles and feet will supports the participants in identifying affected areas.

Respondents are asked if they've experienced any musculoskeletal issues in the past week or 12 months that impacted their daily activities.

Section 2 contains additional questions focusing on the shoulders, neck, and lower back to gather detailed information. This section includes 25 forced-choice questions that address incidents affecting any body area, the functional impact on work and home life (such as task modifications), the duration, assessment by professionals health personnel, and any MSDs symptoms experienced during the last seven days.

2.4.2 Cornell Musculoskeletal Discomfort Questionnaire

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) is a widely used instrument for identifying the prevalence of Musculoskeletal Disorders (MSDs) within specific groups. It relies on self-reported data to assess 12 body regions for discomfort of the neck, shoulders, upper back, upper arms, lower back, forearms, wrists, hips, thighs, knees, lower legs, and feet. Suitable for both male and female workers in seated or standing roles, the CMDQ consists of three components: (1) frequency of discomfort, (2) severity of the discomfort, and (3) how the discomfort affects the ability to perform modified work tasks. This tool is a valuable part of routine ergonomic evaluations and acts as the medium in the prevention and monitoring of MSDs among employees (Omidi *et al*., 2017). *Figures 2.1 – 2.3* below show the CMDQ for men, women, and the Malay version. The *Guidelines on Ergonomics Risk Assessment at Workplace* (2017) have shown the four analysis ways for the CMDQ scores:

a) by simply counting the number of symptoms per person,
b) by summing the rating values for each person,
c) by weighting the rating scores to more easily identify the most serious problems as below.
d) by multiplying the Frequency Score in (3) with i) the Discomfort Score (1,2,3) or ii) the Interference score (1,2,3).

Rating scores weighting scale

Never	= 0
1-2 times/week	= 1
3-4 times/week	= 3.5
Every day	= 5
Several times every day	= 10

(Department of Occupational Safety and Health, 2017)

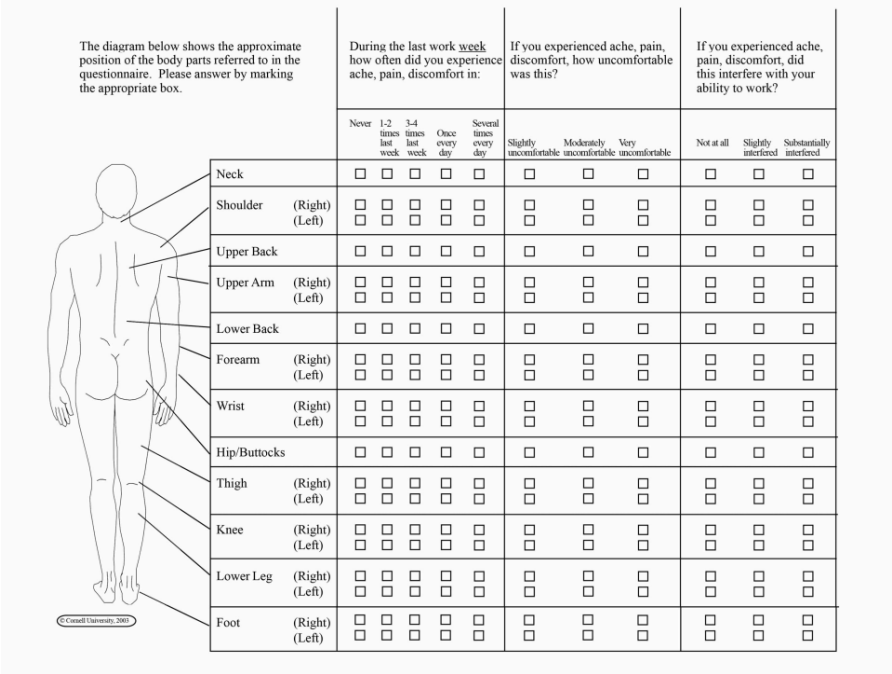
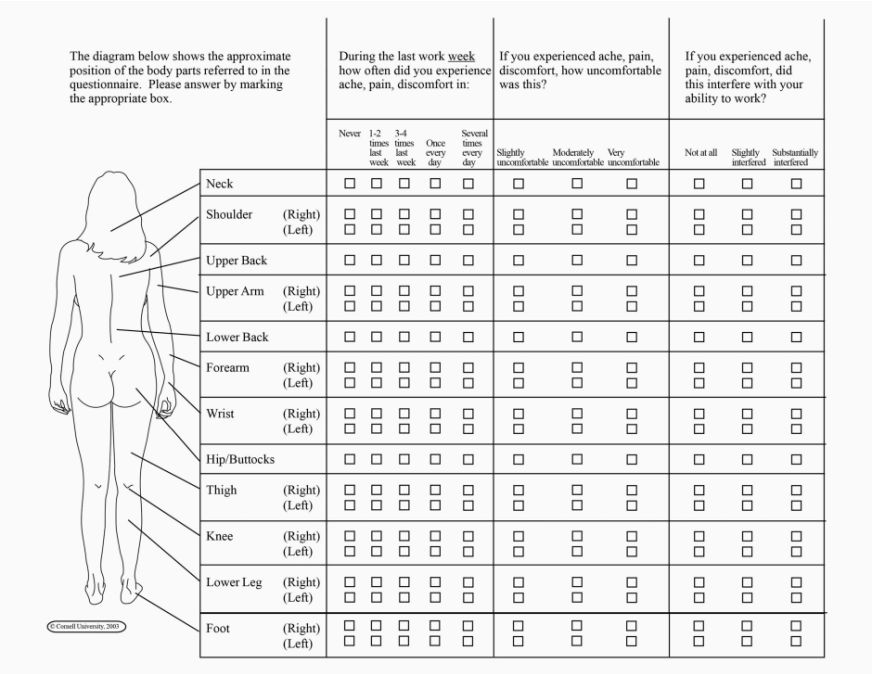


Figure 2.1: Cornell Musculoskeletal Discomfort Questionnaire for men

(Department of Occupational Safety and Health, 2017)

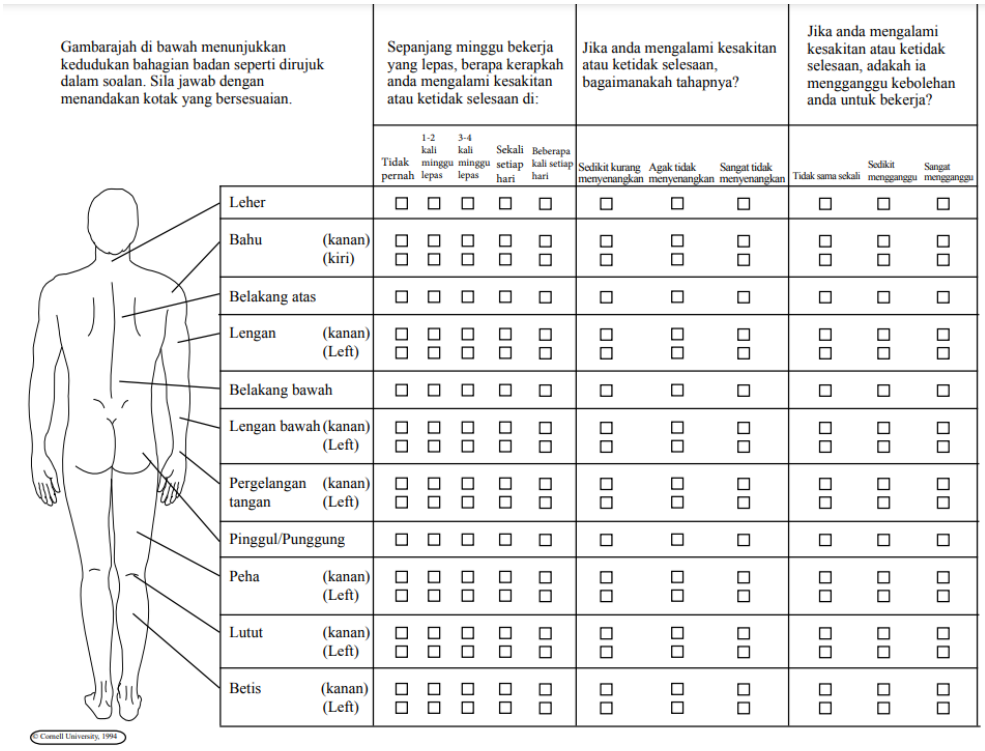


The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.

	During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with your ability to work?		
	Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly uncomfortable	Moderately uncomfortable	Very uncomfortable	Not at all	Slightly interfered	Substantially interfered
Neck	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Back	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Back	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hip/Buttocks	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Foot (Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Foot (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 2.2: Cornell Musculoskeletal Discomfort Questionnaire for women

(Department of Occupational Safety and Health, 2017)



Gambarajah di bawah menunjukkan kedudukan bahagian badan seperti dirujuk dalam soalan. Sila jawab dengan menandakan kotak yang bersesuaian.

	Sepanjang minggu bekerja yang lepas, berapa kerapkah anda mengalami kesakitan atau ketidak selesaan di:					Jika anda mengalami kesakitan atau ketidak selesaan, bagaimanakah tahapnya?			Jika anda mengalami kesakitan atau ketidak selesaan, adakah ia mengganggu kebolehan anda untuk bekerja?		
	Tidak pernah	1-2 kali minggu lepas	3-4 kali minggu lepas	Sekali setiap hari	Beberapa kali setiap hari	Sedikit kurang menyenangkan	Agak tidak menyenangkan	Sangat tidak menyenangkan	Tidak sama sekali	Sedikit mengganggu	Sangat mengganggu
Leher	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bahu (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bahu (kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Belakang atas	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Belakang bawah	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan bawah (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan bawah (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pergelangan tangan (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pergelangan tangan (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pinggul/Punggung	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Peha (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Peha (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lutut (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lutut (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Betis (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Betis (Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 2.3: Cornell Musculoskeletal Discomfort Questionnaire Malay Version

(Shariat *et al*., 2016)

2.5 Ergonomic-Related Guidelines in Malaysia

The Department of Occupational Safety and Health (DOSH), under Malaysia's Ministry of Human Resources, has established detailed ergonomic guidelines aimed at fostering safer and healthier work environments (Department of Occupational Safety and Health, n.d.). These guidelines aim to assist employers and employees in identifying, assessing, and mitigating ergonomic risks, thereby reducing the incidence of WMSDs and enhancing overall productivity (Department of Occupational Safety and Health, n.d.). The ergonomic-related guidelines available in Malaysia include: Guidelines on Ergonomics Risk Assessment at Workplace (2017), Guidelines for Manual Handling at Workplace (2018), Guidelines on Occupational Safety and Health for Seating at Work (2024), Guidelines on Occupational Safety and Health for Standing at Work (2024), Guidelines on Occupational Safety and Health for Working with Display Screen Units (2024), Guidelines on Occupational Vibration (2003), Guidelines on Heat Stress Management at Workplace (2016).

2.5.1 Guidelines for Manual Handling at Workplace, 2018

DOSH has developed these guidelines to help identify manual handling duties and select a risk-reduction strategy that works (Department of Occupational Safety and Health, 2018). In order to bring down the manual handling-related accidents and disorders among employees, it offers basic recommendations to employers and workers on the identification, assessment, and control of ergonomic risk factors relevant to the task (Department of Occupational Safety and Health, 2018). The main goal of these guidelines is to encourage thorough and useful preventative measures that enhance the working environment at work involved manual handling actions listed in this guideline include lifting, lowering, pushing, tugging, carrying, restraining, or holding a weight manually with the use of human energy and forces (Department of Occupational Safety and Health, 2018).

2.5.2 Guidelines on Occupational Vibration, 2003

This guideline addresses vibration as it is a physical phenomenon that will bring an adverse influence on human safety and health in the workplace (Department of Occupational Safety and Health, 2003b). Direct vibration can have harmful consequences on a person's body, such as, generally speaking, vibration might result in impaired vision, unsteadiness, difficulty focusing, etc. (Department of Occupational Safety and Health, 2003b). Internal bodily organs may occasionally sustain irreversible harm from specific vibrational frequencies and intensities, and "White finger syndrome" is especially concerning in this regard (Department of Occupational Safety and Health, 2003b). This recommendation aims to raise employers' and workers' awareness of human body vibration associated with its effects and offer suggestions on mitigating the risk of pain and harm caused by vibration to the human body (Department of Occupational Safety and Health, 2003b).

2.5.3 Guidelines on Occupational Safety and Health for Seating at Work, 2024

These recommendations outline how comfortable sitting promotes employee health and safety at work, for instance, by reducing the likelihood of back discomfort, which is one of the most frequent reasons for missed work (Department of Occupational Safety and Health, 2024a). In addition to offering suggestions for seating arrangement and design, they also offer examples of sitting configurations for various types of work, but they don't really address seats in cars or mobile equipment like cranes and lift trucks (Department of Occupational Safety and Health, 2024a). The primary target audience for the guidelines' recommendations is expected to be employers, safety and health personnel, as well as producers, designers, and distributors of office and industrial furniture (Department of Occupational Safety and Health, 2024a). Weariness and pain might arise from sitting in the wrong chair, and this has a negative impact on workers' general well-being in addition to their safety and health (Department of Occupational Safety and Health, 2024a). Not only do employers who

offer appropriate seats accomplish their legal obligations, but they also improve worker productivity (Department of Occupational Safety and Health, 2024a). These rules mostly address how employees are seated at work, and additional seating needs to be appropriate for the situation, such as rest spaces should provide comfortable seating with calming features, and a bench could work well in shifting environments (Department of Occupational Safety and Health, 2024a).

2.5.4 Guidelines on Occupational Safety and Health for Working with Display Screen Equipment, 2024

The field of information technology and microelectronics has witnessed technological advancements that have led to a swift expansion in office automation across all industrial sectors (Department of Occupational Safety and Health, 2024c). In the workplace, Video Display Units (VDUs) or video display terminals, henceforth referred to as "VDUs" have become commonplace and concerns have been raised in relation to the health impacts of VDUs usage, which are mostly associated with musculoskeletal problems, visual discomfort, and other stress-related disorders, along with an increase in VDUs use (Department of Occupational Safety and Health, 2024c).

These rules are intended to give staff members information on the design, setup, use, application, and general management of tasks linked to VDUs (Department of Occupational Safety and Health, 2024c). When followed correctly, these recommendations can raise workplace VDUs' health and safety standards while also potentially increasing worker productivity (Department of Occupational Safety and Health, 2024c). Additionally, these guidelines are meant to lessen the negative health impacts that using VDUs might have on their users (Department of Occupational Safety and Health, 2024c).

2.5.5 Guidelines on Occupational Safety and Health for Standing at Work, 2024

These recommendations are meant to serve as a reference for risk assessment and identification in relation to standing at work (Department of Occupational Safety and Health, 2024b). It describes how an appropriately constructed standing workstation improves employee health and safety in the workplace and also offers guidance on how to handle a standing job properly, mainly for employers, safety and health officials, including producers, designers, and suppliers of industrial equipment (Department of Occupational Safety and Health, 2024b). Prolonged standing in an awkward position can lead to fatigue and pain and the overall well-being of the workforce may be impacted, which might bring the health and safety negative impact to the workers, hence, companies that give their employees enough standing workstations are not only adhering to the law but also improving worker productivity (Department of Occupational Safety and Health, 2024b).

2.5.6 Guidelines on Ergonomics Risk Assessment at the Workplace, 2017

The guidelines offer a systematic and objective framework for recognizing, evaluating, and controlling ergonomic risk factors linked to job duties and workplace activities (Department of Occupational Safety and Health, 2017). Employers, employees, and safety and health practitioners can use these recommendations to evaluate ergonomic risks more effectively and implement targeted control measures accordingly (Department of Occupational Safety and Health, 2017). Recently, numerous cases of occupational disorders have been linked to reported ergonomic risk factors, which indirectly affect productivity, profitability, and compensation costs (Department of Occupational Safety and Health, 2017). It is hoped that these guidelines will help industries address these challenges and reduce cases of occupational illnesses (Department of Occupational Safety and Health, 2017). The primary objectives of conducting an Ergonomic Risk Assessment (ERA) are to identify ergonomic risk factors that may pose harm to workers, determine the likelihood of damage from

exposure to these risk factors, and recommend suitable control measures to mitigate or reduce the risks (Department of Occupational Safety and Health, 2017).

2.6 Work Productivity

Productivity can be an indicator of social health and economic growth in an organization (Escorpizo, 2008). To understand the key factors affecting the sustainability of the working population, productivity plays a crucial role in uncovering business opportunities within society (Escorpizo, 2008). From time to time, terms of "Productivity" was used in different scopes and settings, however in terms of "economic" (Escorpizo, 2008), productivity can be the measurement of the efficiency of the processing plant, machine, individual, and product input, and output (Albeeli *et al*., 2020).

In industries, the productivity of the work can be determined by identifying the time in days or hours required to complete a certain activity or produce a certain number of product units (Albeeli *et al*., 2020). Besides, indicators such as absenteeism and presenteeism also need to be assessed due to the strong relationship with work productivity itself. The indicators can be assessed in two ways, which are observed work productivity and preserved work productivity (Escorpizo, 2008).

2.6.1 Observed Work Productivity

Observed work productivity is a measurement to examines work productivity by using objective measurements or observed data (Albeeli *et al*., 2020). Absenteeism, Presenteeism, and Disability are the indicators to be examined for work productivity (Albeeli *et al*., 2020). The disability of the workers is examined by observing the short-term disability and scattered illness absences taken by the workers themselves (Escorpizo, 2008). Besides, Presenteeism is evaluated based on the loss of time of the

workers who fail to produce a certain quantity of the product within working hours (Escorpizo, 2008).

2.6.2 Preserved Work Productivity

Preserved work productivity is an extremely useful self-report measurement that can be applied when there is no available observed work productivity data to quantify the work productivity of the workers (Escorpizo, 2008). Absenteeism and Presenteeism are the indicators to be examined for the self-report work productivity (Ng *et al*., 2014). Simple questions are used in the self-report measurement to collect the data for absenteeism and presenteeism (Ng *et al*., 2014).

2.7 Absenteeism and Presenteeism

The number of days a worker misses work during a specific period is what we refer to as their absence rate. The word "absenteeism" is used to denote an extended period of absences, as indicated by a high absence rate (Maestas *et al*., 2021). On the other hand, presenteeism happens when someone reports to work when ill. Lastly, the degree to which worker performance is negatively impacted by presenteeism may be assessed by the amount of productivity lost as a result of working whilst ill (Maestas *et al*., 2021). In addition, MSDs symptoms during presenteeism at work show a strong relationship with the work efficiency of the workers and have a direct impact on work productivity.

2.8 Previous Studies on Musculoskeletal Disorders and Work Productivity in Industries

From the survey of different studies, many workers in different industries have experienced Musculoskeletal Disorders (MSDs) symptoms, which eventually lead to low work productivity. Those industries include office personnel, nursing, palm oil harvesting, and manufacturing industries.

The study focuses on the MSDs among the office personnel and has shown high prevalence of MSDs and has a percentage of 83.7% among office personnel's body parts. Among all the body parts, low-back pain has the highest prevalence of 58.5%, and thigh pain has the lowest prevalence of 25.4% among the participants in the past studies. Besides, the relationships between the prevalence of MSDs and productivity loss during presenteeism are found to be significantly associated. More than that, MSDs and self-reported productivity loss during presenteeism were also found to have a relationship of significant association (Albeeli *et al*., 2020). In another study of MSDs among office personnel, the neck and lower back have the highest prevalence of MSDs symptoms of 41.6% and the highest severity of discomfort in those areas (Daneshmandi *et al*., 2017). They also found that the prevalence of MSDs has a significant association with the concentration and focus of productivity of the workers (Daneshmandi *et al*., 2017).

For the MSDs studies in the nursing field, a study on nurses in Taiwan shows MSDs symptoms with a high prevalence of 85.8% and 80.9% among the participants reporting discomfort in the right and left shoulder, respectively (Lin *et al*., 2020). Between August 2016 and December 2017, 65.16% of Taiwanese nurses reported experiencing physical discomfort, predominantly in the shoulder (41.31%), neck (32.25%), and lower back or waist (31.03%) regions (Lin *et al*., 2020). Another study in Taiwan found an average prevalence rate of MSDs symptoms of 34.2% among medical center nurses, with discomfort rates for the shoulder, neck, and lower back reported respectively at 62.6%, 63.5%, and 59.3% (Lin *et al*., 2020). The study also identified a link between increased MSDs risk and reduced workability, often due to moderate or heavy workloads among Taiwanese nursing staff (Ou *et al*., 2021).

In the palm oil harvesting industry, a study found that the highest prevalence of MSDs symptoms was found among nine body regions, was the lower back, affecting 58% of respondents (Ng *et al*., 2014). Additional affected areas included the knee (45.5%), shoulder (32.9%), neck (32.2%), upper back (28.0%), hand/arm (26.6%), ankle/foot (25.2%), thigh (21.0%), and elbow (Ng *et al*., 2014). The same study highlighted that individual factors like Body Mass Index (BMI), age, and smoking were significantly related to increased MSDs-related absenteeism and reduced daily productivity among harvesters (Ng *et al*., 2014). Acute MSDs during the previous working week were also shown to significantly reduce the quantity of harvest, with affected workers producing roughly half as much as their healthier counterparts (Ng *et al*., 2014).

In the automotive manufacturing sector, one study found an overall prevalence of MSDs symptoms of 76.97% among workers, with the highest rate of MSDs within the past 12 months affecting the neck (49.3%), followed by the hand/wrist (48.0%) and shoulder (46.7%) (Nur *et al*., 2014). Upper limb regions were identified as the most commonly affected by work-related musculoskeletal disorders (WMSDs) among manufacturing workers, often leading to upper limb MSDs (Nur *et al*., 2014). However, the connection between MSDs and productivity remains unclear due to insufficient data, underscoring the need for more research to explore the prevalence of MSDs symptoms and their impact on productivity in this industry (Nur *et al*., 2014

Table 2.2: Summary table of previous MSDs studies

No.	Author(s)	Year	Main Study Variables	Main Study Findings
1	Albeeli *et al*.	2020	**Independent Variables:** Self-reported musculoskeletal disorders (MSDs) **Dependent variables:** 1. Absenteeism 2. Presenteeism 3. Self-evaluated productivity levels during presenteeism	Musculoskeletal disorders (MSDs) were widespread among office employees, with 83.7% reporting discomfort in at least one area of the body. Lower back pain emerged as the most frequently cited issue, affecting 58.5% of respondents, whereas thigh pain was the least common, reported by 25.4%. Furthermore, presenteeism significantly hinders productivity, diminishing both the quality and output of employees' work.
2	Daneshmandi *et al*.	2017	**Independent Variables:** Musculoskeletal problems **Dependent variables:** 1. Fatigue 2. Productivity	The results showed that, within the past week, the neck (41.6%), lower back (41.6%), and shoulders (40.6%) were the most frequently reported areas of musculoskeletal discomfort. Additionally, neck, lower back, buttocks, and thighs with higher levels of pain and discomfort were linked to lower scores in productivity related to concentration and focus.

3	Lin *et al*.	2020	**Independent Variables:** Prevalence of musculoskeletal disorders (MSDs) **Dependent variables:** Risk Factors	The body areas most frequently affected by musculoskeletal disorder (MSD) symptoms included the right shoulder (85.8%), left shoulder (80.9%), neck (62.4%), right wrist (62.2%), and lower back (60.4%).
4	Ou *et al*.	2021	**Independent Variables:** Prevalence of MSDs **Dependent variables:** Risk Factors	Nurses were identified as being at elevated risk for musculoskeletal disorders (MSDs) affecting both upper and lower limbs. A heavier workload, especially at moderate to high levels, was linked to a greater likelihood of developing MSDs, which in turn adversely affected their ability to perform work tasks.
5	Ng *et al*.	2014	**Independent Variables:** Prevalence of MSDs symptoms **Dependent variables:** Productivities	There was a notable association between the acute occurrence of musculoskeletal disorders (MSDs) and reduced productivity, as evidenced by increased presenteeism and a decrease in daily harvest output.

6	Nur *et al*.	2014	**Independent Variables:** Prevalence of MSDs symptoms **Dependent variables:** work productivity	Over the past year, musculoskeletal disorders (MSDs) were most frequently reported in the neck (49.3%), followed by the hand/wrist (48.0%) and shoulder (46.7%). In total, the prevalence of MSDs among workers was notably high, at 76.97%.

CHAPTER 3

METHODOLOGY

3.1 Study Design

A cross-sectional study was employed in this research to explore the relationships between Musculoskeletal Disorders (MSDs) symptoms and work productivity at a Malaysian Heating, Ventilation, and Air Conditioning (HVAC) manufacturing company. A cross-sectional study collects relevant data at one specific point in time, without tracking changes over a period, as all information is obtained within the same timeframe (Kesmodel, 2018). Such studies are commonly used to assess the prevalence of conditions, attitudes, or knowledge within a population, and are frequently applied in validation research (Kesmodel, 2018). The cross-sectional approach was selected for this study due to its practicality in measuring disease prevalence within a limited timeframe and because it does not require continuous data collection to establish meaningful relationships between variables.

3.2 Study Location

The study location was held at an HVAC manufacturing factory in Bandar Baru Bangi, Selangor. This HVAC manufacturing facility in Malaysia produces a wide variety of HVAC equipment for both domestic and international export markets, including commercial and residential air conditioning systems, refrigerators, large-tonnage chillers, compressors, and environmental testing units. The indoor and outdoor components, and the electricity component assembly line, were selected for the study

location due to the highly repetitive job characteristics during the assembly job. *Figure 3.1* below shows a photo of the HVAC manufacturing factory for this study taken during the visit.

Figure 3.1: Photo of the HVAC manufacturing factory for this study

3.3 Study Population

The study population in this study was the assembly line workers who perform the repetitive task of manual assembly in the manufacturing factory. Nowadays, the manufacturing factories have adapted to automation and semi-automation of manufacturing processes (Nur *et al*., 2014). However, a lot of tasks cannot be done by the machine, such as the manual assembly of the manufacturing part, which is performed by workers, and this manual handling is considered a repetitive task (Nur *et al*., 2014). The repetitive movements in the manual assembly can be raising, hitting, pulling, pushing, gripping, turning, reaching, or drawing (Jansen *et al*., 2012). WMSDs are one of the major occupational injuries commonly caused by repetitive tasks performed by workers (Nur *et al*., 2014). In this study, the study population were from the assembly line with a similar work process shown in the figures below, starting with the welding of piping, screwing of the air conditioner parts, leak testing, assembling

air conditioner parts and packaging of the final product. *Figures 3.2 – 3.6* below show the work process of the assembly line workers in an HVAC manufacturing factory.

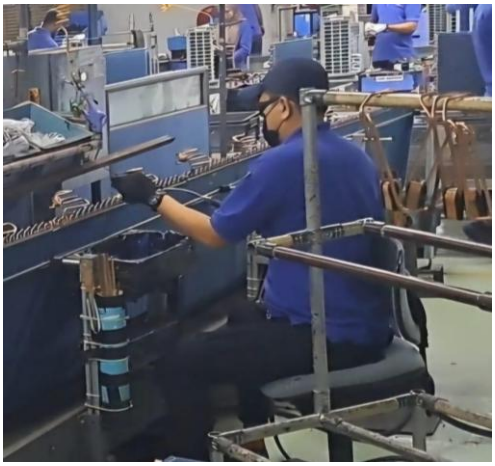


Figure 3.2: The assembly line worker is welding pipes for the air conditioner

Figure 3.3: The assembly line worker is screwing the air conditioner parts

Figure 3.4: The assembly line worker is doing the leak testing for the refrigerant gases

Figure 3.5: The assembly line workers are assembling air conditioner parts

Figure 3.6: The assembly line worker is doing the packaging for the final product

3.4 Sampling Method

In this study, a non-probability sampling method was used, where the sample was chosen based on the researcher's subjective judgment rather than random selection (Berndt, 2020). Common non-probability sampling techniques include snowball sampling, quota sampling, self-selection sampling, and purposive sampling.

In this study, a purposive sampling method was applied, allowing the researcher to select participants based on specific criteria. Examples of purposive sampling include typical case sampling, expert sampling, and maximum variation sampling (Berndt, 2020). Purposive sampling enables researchers to support their choices with theoretical justifications, analytical, or logical, making it useful in qualitative research with multiple phases or objectives (Berndt, 2020). Additionally, purposive sampling is effective for quickly obtaining a targeted sample when proportional representation is not a primary goal (Blessing Oribhabor and Anyanwu, n.d.). In this study, a certain number of assembly line workers for indoor and outdoor part assembly with similar characteristics of repetitive work performed were purposely selected as the study population to represent the group. Besides, the indoor and outdoor components and the electricity component assembly line workers, with the work process of manual handling, were selected as the target study. The workers with the

characteristics of being pregnant and working as office personnel, cleaners, and maintenance staff were not selected as the target respondents due to the difference in job characteristics.

3.5 Sample size

An appropriate sample size was determined, and it is a vital aspect of health-related research, as it ensures the study includes a sufficient number of participants to detect the expected effect and achieve its objectives (Fahim and Negida, 2018). For this study, the minimum required sample size was determined using Epi Info, which is a tool developed on the internet by the Centers for Disease Control and Prevention (CDC). This free software is widely used by public health professionals and researchers across the globe (Centers for Disease Control and Prevention, n.d.). *Epi Info* offers user-friendly features for designing forms and databases, entering customized data, and performing epidemiological analyses with statistics, maps, and charts, making it particularly useful for users with limited training in biostatistics or IT (Centers for Disease Control and Prevention, n.d.).

The target population for this study consisted of 152 assembly line workers who shared similar job roles characterized by repetitive motion tasks. Based on the prevalence of MSDs found in prior research among industrial workers (76.97%), the minimum sample size calculated was 49 for a 95% confidence level, as illustrated in *Figure 3.7* below.

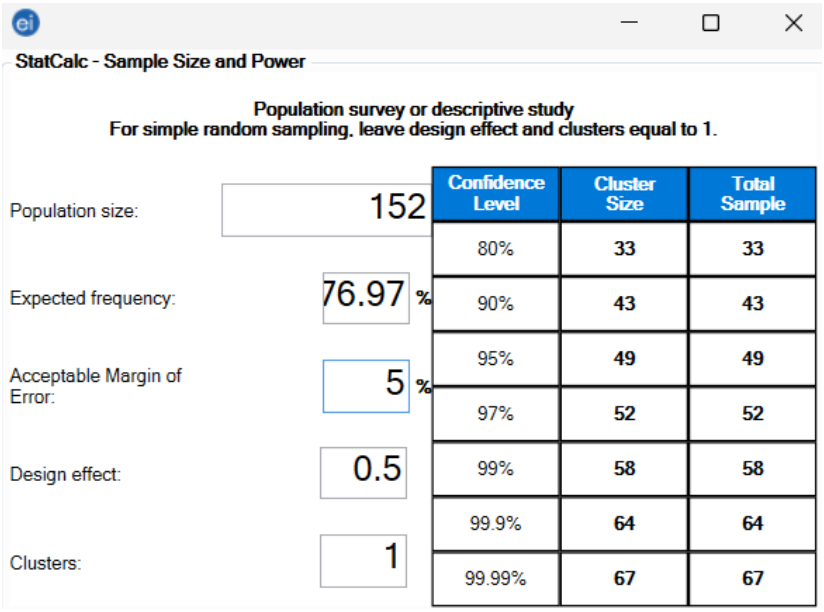


Figure 3.7: Epi Info sample size calculator

(Centers for Disease Control and Prevention, n.d.)

3.6 Research Equipment and Instrument

3.6.1 Questionnaire

A self-reported questionnaire was prepared before field data collection. The self-reported type of questionnaire was used to identify the prevalence of Musculoskeletal Disorders (MSDs) symptoms among industry workers with the characteristics of repetitive work and their judgment on work efficiency due to the MSDs symptoms. The self-report instrument is commonly used in research and is effective in gathering data on workplace exposure to both physical and psychosocial factors (Nur *et al*., 2014). English and back-to-back translations of Malay versions of questionnaires were prepared for local and foreign workers. Three sections of data were collected through the questionnaire, which are the socio-demographic, employment history, and modified CMDQ. Socio-demographic and employment history questions were collected using the online survey form, whereas the CMDQ was given in hard copy form to make it easier for the respondents to answer the questions.

3.6.1.1 Socio-demographic

An online survey form was used to gather individual socio-demographic information, including name, age, weight (kg), height (cm), highest education level, smoking status, medical history, frequency of physical activity per week during leisure time, and duration of physical activity per week. After data collection, Body Mass Index (BMI) was calculated by using the BMI calculator with the recorded weight (kg) and height (cm) for each participant collected from the questionnaire.

3.6.1.2 Employment History and Work Practices

Employment history and work practices questions, including the number of working years (s) in the current job position, daily working duration, and frequency of microbreaks, were collected using the online survey form. The data collected through the online survey form will be transferred into data analysis software, and data cleaning procedures will be conducted to check for any missing data.

3.6.1.3 Cornell Musculoskeletal Discomfort Questionnaire

The modified CMDQ was used to assess the prevalence of MSDs symptoms among assembly line workers (Fahim and Negida, 2018). Previous studies have frequently utilized the Cornell and Nordic Musculoskeletal Questionnaires to identify MSDs symptoms in workers. The CMDQ was chosen for this study because it is specifically designed to evaluate both work performance in individuals experiencing MSDs symptoms and the prevalence of these symptoms among workers (Albeeli *et al*., 2020). The questionnaire covers various body parts, including the neck, right shoulder and left shoulder, upper back, right upper arm and left upper arm, lower back, right forearm and left forearm, right wrist and left wrist, hip/buttocks, right thigh and left thigh, right

knee and left knee, right lower leg and left lower leg, and right foot and left foot (Jansen *et al*., 2012).

Participants were requested to answer six questions about their discomfort. These questions include:

1.) Circle the body part if you have previous injuries.

2.) During the last work week, how often did you experience aches, pain, or discomfort in each of the body parts:;

3.) If you experienced ache, pain, or discomfort, how uncomfortable was this?;

4.) If you experienced pain, discomfort, or discomfort, did this interfere with your ability to work?;

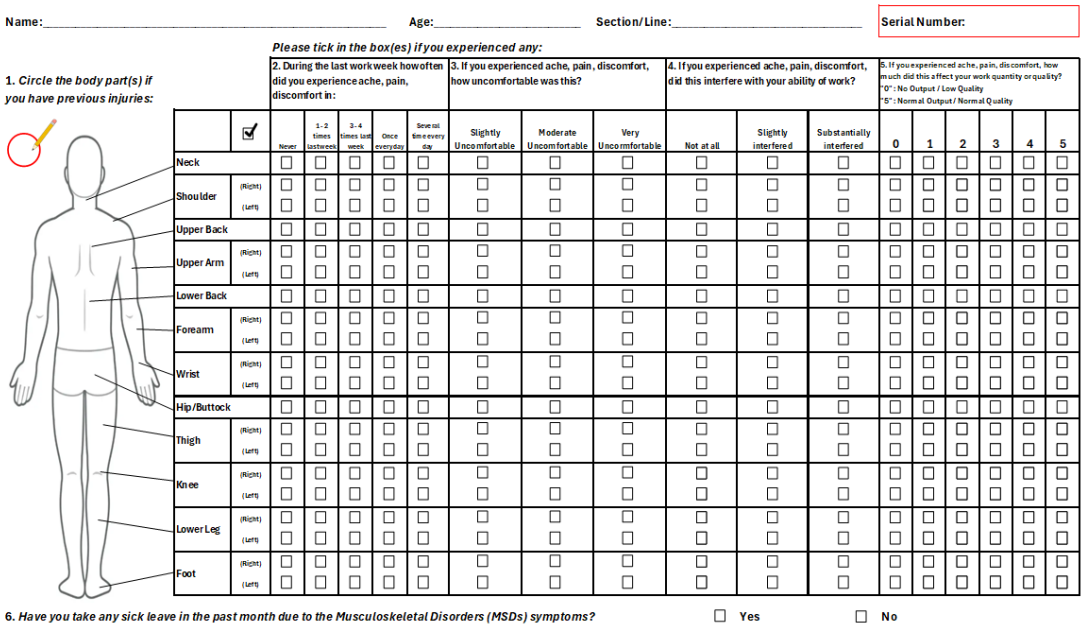
5.) If you experienced aches, pain, or discomfort, how much did this affect your work quantity or quality?;

6) Have you taken any sick leave in the past month due to the Musculoskeletal Disorders (MSDs) symptoms?

For this study, a Likert scale was used for specific questions in the modified Cornell Musculoskeletal Discomfort Questionnaire. The scales for each question are as follows:

- **Question 2**: "Never," "1-2 times last week," "3-4 times last week," "Once every day," and "Several times every day."
- **Question 3**: "Slightly uncomfortable," "Moderately uncomfortable," and "Very uncomfortable."
- **Question 4**: "Not at all," "Slightly interfered," and "Substantially interfered."
- **Question 5**: A numerical rating scale from "0" to "5."

Figure 3.8 below provides the modified Cornell Musculoskeletal Discomfort Questionnaire that was applied in this study.



Name:_____ Age:_____ Section/Line:_____ Serial Number:

Please tick in the box(es) if you experienced any:

1. Circle the body part(s) if you have previous injuries:

		2. During the last work week how often did you experience ache, pain, discomfort in:					3. If you experienced ache, pain, discomfort, how uncomfortable was this?			4. If you experienced ache, pain, discomfort, did this interfere with your ability of work?			5. If you experienced ache, pain, discomfort, how much did this affect your work quantity or quality? "0" : No Output / Low Quality "5" : Normal Output / Normal Quality					
	☑	Never	1 - 2 times last week	3 - 4 times last week	Once everyday	Several time every day	Slightly Uncomfortable	Moderate Uncomfortable	Very Uncomfortable	Not at all	Slightly interfered	Substantially interfered	0	1	2	3	4	5
Neck		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hip/Buttock		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Foot	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Have you take any sick leave in the past month due to the Musculoskeletal Disorders (MSDs) symptoms? ☐ Yes ☐ No

Figure 3.8: Modified Cornell Musculoskeletal Discomfort Questionnaire

3.6.1.4 Absenteeism, Presenteeism, and Work Efficiency

In this study, worker productivity of the workers was evaluated through three indicators in a self-reported questionnaire: sick leave (absenteeism), presenteeism, and work efficiency during episodes of Musculoskeletal Disorders (MSDs) symptoms. Absenteeism was assessed based on responses regarding sick leave taken in the previous month due to MSDs symptoms (Ng *et al*., 2014). For presenteeism, respondents will rate the level of discomfort experienced during work hours in the past week, with options such as "slightly," "moderate," and "very uncomfortable," to capture the extent to which MSDs symptoms interfered with work.

Work efficiency was evaluated based on workers' self-assessment of their performance and quality of work when experiencing discomfort or pain. This was

measured on a numerical scale from "0" to "5," where "0" indicates "No output / Low quality" and "5" represents "Normal output / Normal quality" (Ng *et al*., 2014). In line with the Guideline on Ergonomic Risk Assessment at Workplace 2017, each individual's MSDs score will be calculated by recording symptoms in different body parts, with one point assigned per affected area if symptoms occurred more than 1–2 times in the past week (Department of Safety and Health, 2017). The cumulative MSDs score was tallied for each worker and used for further statistical analysis.

3.7 Statistical Package for the Social Sciences (SPSS)

The Statistical Package for the Social Sciences (SPSS), a comprehensive data analysis tool, was employed to conduct the analysis for the data collected (Ng *et al*., 2014). SPSS offers a variety of software tools for managing data, conducting statistical analysis, entering data, and presenting results. It can be used to produce tabular reports, descriptive statistics, and conduct complex statistical analyses, as well as create charts and maps that illustrate distributions and trends (Varghese *et al*., n.d.).

3.8 Overall Data Collection Procedures

The research procedures started with drafting and sending the drafted questionnaire for content validity checking by the experts from the occupational safety and health fields. The research proposal with the questionnaire was submitted for ethical clearance application from Universiti Tunku Abdul Rahman (UTAR) ethical committee. Ethical clearance is crucial and needed before the researcher can proceed to data collection. This is to minimize any detrimental effects on the study subject; ethical principles, protocols, and good clinical practice must be followed for any research to proceed (Wardhono and Lestari, 2023). Besides, Questionnaire was submitted to Occupational Safety and Health expert for the purpose of validation to

make sure the questionnaire was able to identify the risk factors and can be easily understood by the industrial workers.

After obtaining validated questionnaire and ethical clearance approval, an application to conduct a questionnaire study, together with a copy of the questionnaire, was sent to the person in charge of the HVAC manufacturing company for approval. Once the application was approved by the HVAC manufacturing company, the scheduled time for data collection was identified and arranged. During data collection day, a briefing of the questionnaire was given to the indoor and outdoor part assembly line workers during the morning briefing, together with the line supervisor, before the researcher handed over the questionnaire to the targeted workers.

On-site supervision and guidance were provided to the workers when they were filling up the questionnaire to ensure the workers could understand the questions, which would increase the reliability of the data collected. Firstly, the workers were given an online survey form to collect their sociodemographic and working history data before distributing the hard copy of the modified version of the CMDQ. *Figure 3.9* below shows the flow chart for the overall data collection procedures.

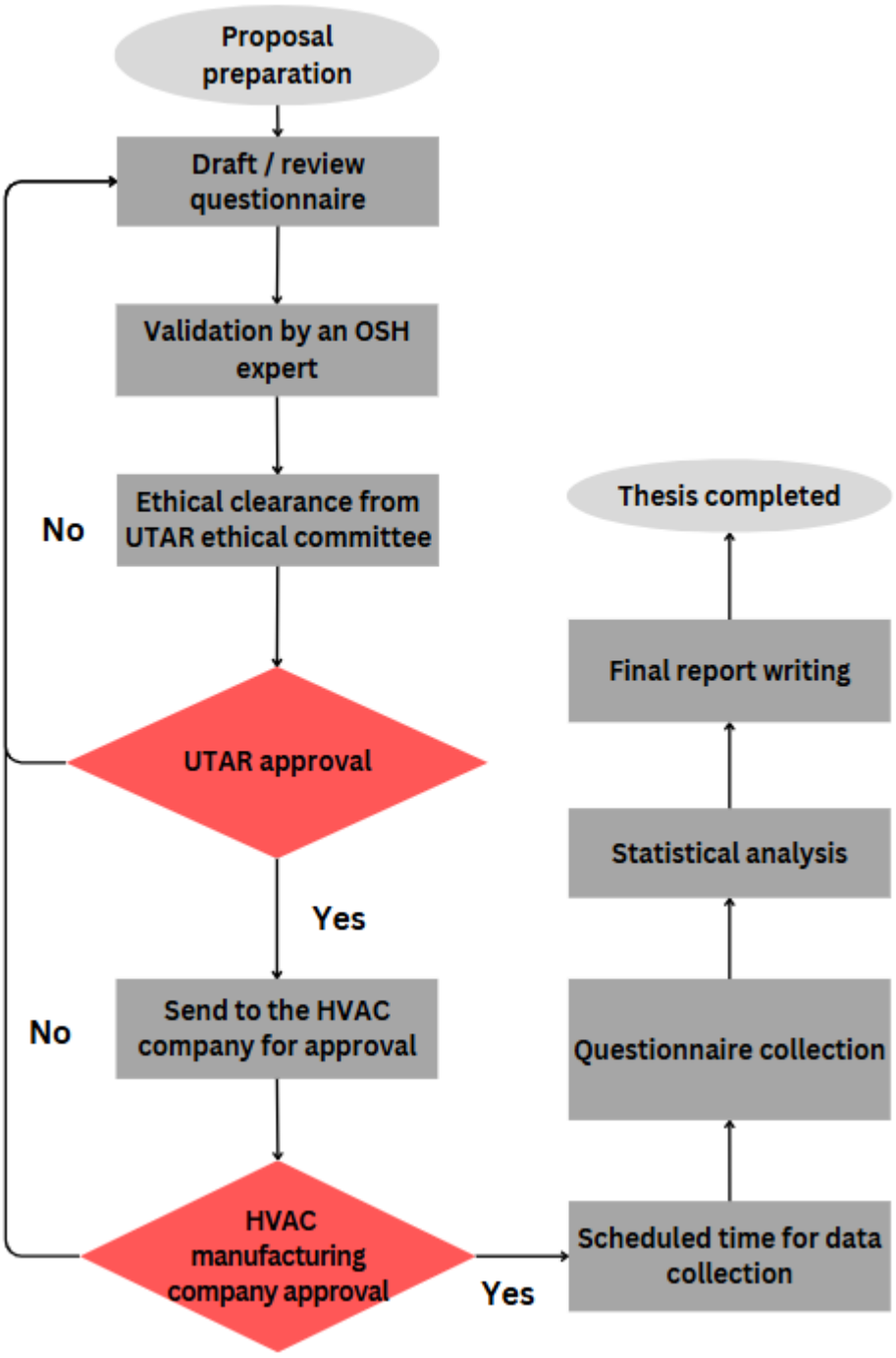


Figure 3.9: Overall procedures for the entire research project

3.9 Data Analysis

Descriptive statistics were chosen for data analysis to examine the socio-demographic factors and the prevalence of Musculoskeletal Disorders (MSDs) symptoms over the past work week. The Chi-square test, Mann-Whitney U test, and Binary logistic regression were applied to explore the relationships between the impact of MSD symptoms on participants' productivity, focusing on absenteeism, presenteeism, and self-assessed productivity during periods of presenteeism (Ng *et al*., 2014).

Table 3.1: Statistical analysis techniques are used to analyze data collected

No.	Specific objective(s)	Statistical test
1	To determine the individual and work-related risk factors of Musculoskeletal Disorders (MSDs) symptoms, prevalence of MSDs symptoms, absenteeism, presenteeism, and self-reported work efficiency of the workers in a HVAC manufacturing factory.	Descriptive statistics test
2	To study the relationships between the prevalence of Musculoskeletal Disorders (MSDs) symptoms for each body part and absenteeism among the manufacturing workers.	Chi-square
	To study the relationships between the prevalence of MSDs symptoms for each body part with presenteeism and self-reported work efficiency among the manufacturing workers.	Mann-Whitney U test
3	To evaluate the individual and work-related risk factors of Musculoskeletal Disorders (MSDs) symptoms among the manufacturing workers	Binary logistic regression

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Descriptive Statistical Analysis for Individual and Work-Related Risk Factors of Musculoskeletal Disorders (MSDs) Symptoms, Prevalence of MSDs Symptoms, Absenteeism, Presenteeism, and Self-Reported Work Efficiency Among Workers with Monotonous Repetitive Work in a HVAC Manufacture Factory.

4.1.1 Individual Information on Socio-demographic Among the Industrial Workers in a Manufacture Factory

There were a total of 60 assembly line workers from a manufacturing factory participating in this volunteer-based survey. Table 4.1 shows the sociodemographics among the industry workers in a manufacturing factory. In this study, the average age of the respondents was 31.53 years old and most of the workers were male (60.0%). According to the study on the WMSDs in a medical device manufacturing industry among manual assembly workers, the average age of the respondents was 29 years (Harun, Che, and Noh, 2025). In another study on the prevalence of Musculoskeletal Disorder (MSDs) symptoms in a printing manufacturing company among production line workers, the average age of the respondents was 33.46 years old and 174 (69.6%) of them were male (Foong *et al*., 2014).

The respondents in this study have an average weight and height of 65.49 kg and 162.97 cm, respectively. In the same study in a printing manufacturing company among production line workers, the average weight and height of the respondents were 64.22 kg and 1.65 m, respectively, whereas the Body Mass Index (BMI) was 23.43

(Harun, Che, and Noh, 2025). The average BMI among the assembly workers in this study was 24.69, which is considered a normal BMI (National Heart, Lung, and Blood Institute, n.d.).

The highest educational background of the workers was secondary school (80.0%), and only 7 of them graduated from university (11.7%). The study in a printing manufacturing company among production line workers, 198 (74.0%) of the workers had a highest education level of secondary education and 32 (12.8%) of the workers graduated from the tertiary education including pre-university, technical or vocational school, college and university (Foong *et al*., 2014). Forty-seven (78.3%) of the workers in this study never smoked before. In the study on the musculoskeletal symptoms in a manufacturing company in Brazil, they found that 192 (85.0%) of the workers do not have the habit of tobacco smoking (Hembecker *et al*., 2017). Besides, 966 (68.27%) of the workers do not have the habit of smoking in the study on musculoskeletal symptoms among industrial employees in a modern industrial region in Beijing, China (Wang *et al*., 2019). Fifty-seven (95.0%) of the workers in this study do not have any medical history. In a similar study in the medical device manufacturing industry among the manual assembly workers, 131 (85.0%) of the workers do not have any medical history, including the current pregnancy (Harun, Che, and Noh, 2025).

For the physical activity practices among the study respondents, 26 (43.3%) out of 60 of the workers did not have any physical activity during their leisure time, and 28 (46.7%) of them had 1-2 times per week during their leisure time. Among those who had physical activities during their leisure time last week, the majority (30.0%) had a physical activity duration of less than 1 hour, and 11 (18.3%) had a physical activity duration of 1 - 2 hours. In the study among palm oil mill workers, 54 (45.0%) of the workers had physical activity during their leisure time, and the physical activity included sports, fishing, and farming (Razak, 2014). In another study in cooled food-processing facilities focus on the self-estimated work ability and musculoskeletal symptoms with the factors associated among male and female workers, 131 (56.0%) of the workers who reported shoulder pain have no physical activity during their leisure time, whereas 296 (66.0%) of the workers have 1 to 2 times of physical activity during their leisure time (Sormunen *et al*., 2009).

Table 4.1: Sociodemographic among the industry workers in a manufacture factory (n=60)

Sociodemographic	N (%)	Mean (Std Deviation)
Age (year)	60 (100%)	31.53 (9.680)
Gender		
Male	36 (60.0%)	
Female	24 (40.0%)	
Weight (cm)	60 (100%)	65.49 (14.131)
Height (m)	60 (100%)	162.97 (7.985)
BMI	60 (100%)	24.69 (5.268)
Highest Education Background		
No formal education	0 (0.0%)	
Primary school	1 (1.7%)	
Secondary school	48 (80.0%)	
Pre-university, technical or vocational school or college (e.g., STPM, UEC, A-level, Foundation, Diploma, etc.)	4 (6.7 %)	
University	7 (11.7%)	
Smoking Status		
Heavy smoker	3 (5.0%)	
Light smoker	5 (8.3%)	
Occasionally smoker	1 (1.7 %)	
Ex-smoker	4 (6.7%)	
Never smoke	47 (78.3%)	
Current Medical History		
None	57 (95.0%)	
Diabetes mellitus	0 (0.0%)	
Thyroid disease	0 (0.0%)	
Arthritis	2 (3.3%)	
Hypertension	1 (1.7%)	
Gout	1 (1.7%)	
Inguinal hernia	1 (1.7%)	
Orthopedics	1 (1.7%)	
Gastroesophageal reflux disease (GERD)	1 (1.7%)	
Frequency of physical activity		
None	26 (43.3%)	
1 – 2 times	28 (46.7%)	
3 – 4 times	5 (8.3 %)	
> 5 times	1 (1.7%)	
Duration of physical activity		
None	26 (43.3%)	
< 1 hour	18 (30.0%)	
1 – 2 hours	11 (18.3%)	
3 – 4 hours	5 (8.3%)	
> 4 hours	0 (0.0%)	

4.1.2 Employment History Among the Industry Workers in a Manufacture Factory

Table 4.2 shows the employment history among the industry workers in a manufacturing factory. The working years of the workers between 1 – 10 years were 36 (60.0%), which is the highest, and the working years that were less than 1 year were 14 (23.3%). This research findings was having similar trend as a previous study on the WMSDs among the assembly workers, which shows 66.9% of the workers work between 1 year - 10 years and 33.0% workers had a working experience of less than 1 year in the factory (National Institute of Occupational Safety and Health, 2014).

For daily working duration, the majority (76.7%) of the workers worked 9 hours per day, and there were also some workers who worked 10 hours (8.3%), and more than 10 hours (5.0%) per day. In a previous study which focused on the workstyle and MSDs among the Malaysia workers, 340 (81.5%) of the workers work 40 to 45 hours per week which ranging from 8 hours to 9 hours per day, whereas 54 (12.9%) of the workers work more than 55 hours per week which more than 10 hours per day (Maakip, Keegel and Oakman, 2015) have shows the similar trend with the daily working duration in this study.

The workers who did not take any microbreak (5 minutes) during the work was around 14 (23.3%) whereas most of the workers (53.3%) take 1 – 2 times microbreak during the work and 13 (21.7%) out of 60 workers have taken 3 – 4 times microbreak during the work. These research findings are similar to a past study on the prevalence of WMSDs among solvent manufacturing workers in Shah Alam, Selangor, in which 78 (60.0%) of the workers tend to only take one break time throughout the working process (Ali and Roslan, 2024).

Table 4.2: Employment history among the industry workers in a manufacture factory (n=60)

Employment history	N (%)
Working years	
< 1 year	14 (23.3%)
1 – 10 years	36 (60.0%)
11 – 20 years	3 (5.0%)
21 – 30 years	7 (11.7%)
> 30 years	0 (0.0%)
Daily Working duration	
8 hours	6 (10.0%)
9 hours	46 (76.7%)
10 hours	5 (8.3%)
> 10 hours	3 (5.0%)
Frequency of microbreak	
None	14 (23.3%)
1 – 2 times	32 (53.3%)
3 – 4 times	13 (21.7%)
5 – 6 times	1 (1.7%)
> 6 times	0 (0.0%)

4.1.3 Past Injuries for Different Body Parts Among the Industry Workers in a Manufacture Factory

Table 4.3 shows the past injuries for different body parts among the industry workers in a manufacturing factory. The total past injuries for different body parts reported by the workers was 36 (60%) and the highest reported body parts reported was lower back (30.0%), followed by right foot (26.7%), right shoulder (25.0%), neck (18.3%), and right wrist (18.3%). There were no past injuries reported for the left forearm (0.0%) among 60 workers. Similar trends have shown in the study of musculoskeletal disorders and work-related injuries among factory workers in a major city of China, which out of 214 workers whose reported injury history, 146 (68.2%) of them have reported MSDs symptoms which is considered high prevalence of MSDs symptoms among those whose injury history (Yua, *et al*., 2012)

Table 4.3: Past injuries for different body parts among the industry workers in a manufacture factory (n=60)

Body parts	N (%)
Neck	11 (18.3%)
Right Shoulder	15 (25.0%)
Left Shoulder	4 (6.7%)
Upper back	8 (13.3%)
Right Upper Arm	5 (8.3%)
Left Upper Arm	1 (1.7%)
Lower Back	18 (30.0%)
Right Forearm	4 (6.7%)
Left Forearm	0 (0.0%)
Right Wrist	11 (18.3%)
Left Wrist	5 (8.3%)
Hip/Buttock	6 (10.0%)
Right Thigh	2 (3.3%)
Left Thigh	1 (1.7%)
Right Knee	6 (10.0%)
Left Knee	1 (1.7%)
Right Lower Leg	7 (11.7%)
Left Lower Leg	1 (1.7%)
Right Foot	16 (26.7%)
Left Foot	7 (11.7%)
Overall	36 (60%)

4.1.4 Prevalence of MSDs Symptoms for Different Body Parts Among the Industry Workers in a Manufacture Factory

Table 4.4 shows the prevalence of Musculoskeletal Disorders (MSDs) symptoms for different body parts among the industry workers in a manufacturing factory. The prevalence of MSDs symptoms among the workers was 56 (93.3%), and the average MSDs symptoms of the body parts reported by the workers was 5.73 (4.606). The most prevalent MSDs symptoms of the body parts reported by the workers were neck (51.7%), followed by lower back (50.0%), right shoulder (48.3%), right foot (45.0%), and left foot (40.0%). This study shows that the prevalence of MSDs symptoms among the workers in the manufacturing industry was high (93.3%), with a past study of the MSDs symptoms prevalence of 76.97% among the workers in the same sector (Nur *et al*., n.d.). From the same past study, the high job demand and short cycle time from repetitive tasks can lead to the symptoms of Neck and Shoulder pain (Nur *et al*., n.d.).

In another study among the the manual assembly workers in a medical device manufacturing industry, there was 82.0% of the WMSDs prevalence among the manual assembly workers and the most affected body parts were neck (86%), lower back (85%), right shoulder (76%), upper back (73%), and left shoulder (65%) (Harun, Che and Noh, 2025) which shows a same trend with this study for the prevalence of MSDs symptoms and affected body parts.

Besides, the prolonged standing of the workers will lead to the reduce of the blood flow at the lower limb areas including foots that can cause discomfort such as numbness and pain to the workers as according to the past study, there are strong correlations between lower limb discomfort and blood flow (Antle *et al.*, 2013). The repetitive task performed by the workers including welding pipes, assembly parts, screwing parts, leak testing, and packaging. Those tasks required the workers to repeat once to twice every minute, hence, these are considered repetitive tasks (Department of Occupational Safety and Health, 2017). Besides, most of the workers performed their tasks in a standing position and will experience discomfort in the lower limb area.

Table 4.4: Prevalence of MSDs symptoms for different body parts among the industry workers in a manufacture factory (n=60)

Body parts	N (%)
Neck	31 (51.7%)
Right Shoulder	29 (48.3%)
Left Shoulder	20 (33.3%)
Upper back	20 (33.3%)
Right Upper Arm	12 (20.0%)
Left Upper Arm	11 (18.3%)
Lower Back	30 (50.0%)
Right Forearm	11 (18.3%)
Left Forearm	9 (15.0%)
Right Wrist	16 (26.7%)
Left Wrist	14 (23.3%)
Hip/Buttock	12 (20.0%)
Right Thigh	10 (16.7%)
Left Thigh	9 (15.0%)
Right Knee	11 (18.3%)
Left Knee	12 (20.0%)
Right Lower Leg	19 (31.7%)
Left Lower Leg	17 (28.3%)
Right Foot	27 (45.0%)
Left Foot	24 (40.0%)
Overall prevalence	56 (93.3%)
Overall MSDs score Mean (Std. deviation)	5.73 (4.606)

4.1.5 Absenteeism Among the Industry Workers in a Manufacture Factory

Table 4.5 shows the absenteeism rate among the industry workers in a manufacturing factory. Absenteeism can be identified by the sick leave taken by the workers due to the Musculoskeletal Disorders (MSD symptoms for the past month. The result shows that the absenteeism rate of workers due to the MSDs symptoms in the body parts last month was 65.0% (39), and 35.0% (21) of them did not take any sick leave last month due to the MSDs symptoms in the body parts. A similar trend is shown in the study on absenteeism in the plastic manufacturing industry, where the absenteeism days due to ergonomic health problems among the workers are the highest, with 103 days (29.26%) compared to other non-ergonomic health problems (Quiroz-Flores *et al*., 2023). Besides, in 2017, the Social Security Organisation (SOCSO) reported that WMSDs

accounted for 61.6% of absenteeism among industrial workers in Malaysia, establishing it as the most prevalent occupational disease in the nation (Harun, Che and Noh, 2025).

Table 4.5: Absenteeism rate among the industry workers in a manufacture factory (n=60)

	N (%)
Absenteeism (Sick leave due to MSDs)	
Yes	39 (65.0%)
No	21 (35.0%)

4.1.6 Presenteeism Rate Among the Industry Workers in a Manufacture Factory

Table 4.6 shows the presenteeism among the industry workers in a manufacturing factory. Presenteeism can be represented by the uncomfortable or pain experienced by workers in a body part during the last working week. The presenteeism of the workers is equivalent to the prevalence of the Musculoskeletal Disorders (MSDs) symptoms, which was 93.3% for those who reported MSDs symptoms feeling uncomfortable during their work. Among the 31 (51.7%) workers with neck pain, 20 (33.3%) of them feel slightly uncomfortable, and 11 (18.3%) of them feel moderately uncomfortable. For the workers with lower back pain, 12 (20.0%) of them feel slightly uncomfortable, 11 (18.3%) of them feel moderately uncomfortable, and 7 (11.7%) feel very uncomfortable. Of 29 (48.3%) workers with right shoulder pain, 14 (23.3%) of them feel slightly uncomfortable, 13 (21.7%) of them feel moderately uncomfortable, and 2 (3.3%) feel very uncomfortable. For the workers with right foot pain, 8 (13.3%) of them feel slightly uncomfortable, 15 (25.0%) of them feel moderately uncomfortable, and 4 (6.7%) feel very uncomfortable. In the study of garment factory workers in Myanmar, they found out that although there was no significant absenteeism reported by the workers, the presenteeism rate reported was 35% only within one week of work (Oo, 2021).

Table 4.6: Presenteeism among the industry workers in a manufacture factory (n=60)

Body parts	Presenteeism, N%			
	No complaint	Slightly Uncomfortable	Moderate Uncomfortable	Very Uncomfortable
Neck	29 (48.3%)	20 (33.3%)	11 (18.3%)	0 (0.0%)
Right Shoulder	31 (51.7%)	14 (23.3%)	13 (21.7%)	2 (3.3%)
Left Shoulder	40 (66.7%)	14 (23.3%)	4 (6.7%)	2 (3.3%)
Upper back	40 (66.7%)	9 (15.0%)	8 (13.3%)	3 (5.0%)
Right Upper Arm	48 (80.0%)	7 (11.7%)	4 (6.7%)	1 (1.7%)
Left Upper Arm	49 (81.7%)	7 (11.7%)	3 (5.0%)	1 (1.7%)
Lower Back	30 (50.0%)	12 (20.0%)	11 (18.3%)	7 (11.7)
Right Forearm	49 (81.7%)	6 (10.0%)	4 (6.7%)	1 (1.7%)
Left Forearm	51 (85.0%)	4 (6.7%)	5 (8.3%)	0 (0.0%)
Right Wrist	44 (73.3%)	6 (10.0%)	8 (13.3%)	2 (3.3%)
Left Wrist	46 (76.7%)	6 (10.0%)	8 (13.3%)	0 (0.0%)
Hip/Buttock	48 (80.0%)	4 (6.7%)	7 (11.7%)	1 (1.7%)
Right Thigh	50 (83.3%)	2 (3.3%)	6 (10.0%)	2 (3.3%)
Left Thigh	51 (85.0%)	2 (3.3%)	6 (10.0%)	1 (1.7%)
Right Knee	49 (81.7%)	5 (8.3%)	5 (8.3%)	1 (1.7%)
Left Knee	48 (80.0%)	7 (11.7%)	4 (6.7%)	1 (1.7%)
Right Lower Leg	41 (68.3%)	8 (13.3%)	9 (15.0%)	2 (3.3%)
Left Lower Leg	44 (73.3%)	5 (8.3%)	10 (16.7%)	1 (1.7%)
Right Foot	33 (55.0%)	8 (13.3%)	15 (25.0%)	4 (6.7%)
Left Foot	38 (63.3%)	7 (11.7%)	11 (18.3%)	4 (6.7%)
Presenteeism	4 (6.7%)		56 (93.3%)	

4.1.7 Self-reported Work Efficiency Among the Industry Workers in a Manufacture Factory

Table 4.7 shows the self-reported work efficiency among the industry workers in a manufacturing factory. The body parts that reported the most reported work efficiency by the workers were the lower back (40.0%), neck (40.0%), right foot (33.3%), right shoulder (31.7%), and left foot (28.3%). For lower back, 36 (60.0%) workers think the prevalence of MSDs symptoms at lower back will not affect their work productivity, however, 14 (23.3%) of then think the prevalence of Musculoskeletal Disorders (MSDs) symptoms at lower back will slightly affected their output of work, 7 (11.7%) think moderately affected their output, 1 (1.7%) of them think very affected their output, 1 (1.7%) think substantially affected their output and 1 (1.7%) of them think eventually no output. For neck, 40 (66.7%) workers think the prevalence of MSDs symptoms at neck will not affect their work productivity, however, 7 (11.7%) of then think the prevalence of MSDs symptoms at neck will slightly affect their output of work, 10 (16.7%) think moderately affected their output and 3 (5.0%) of them think very affected their output. For right foot, 40 (66.7%) workers think the prevalence of MSDs symptoms at right foot will not affect their work productivity, however, 7 (11.7%) of then think the prevalence of MSDs symptoms at right foot will slightly affect their output of work, 11 (18.3%) think moderately affected their output, 1 (1.7%) of them think substantially affected their output, and 1 (1.7%) think eventually no output.

In summary, for those whose reported productivity loss in this study, the majority of them think that the MSDs symptoms will either slightly or moderately affect their output of work, whereas fewer of them think the MSDs symptoms will very or substantially affect their output of work. However, only one of the respondents reported that the MSDs symptoms in the right and left foot would lead to no output of work. In the study on musculoskeletal disorders and its association with self-reported productivity, they found that 96.7% of productivity loss reported by the workers and 213 (53.3%) of them think that some of the time MSDs pain will limit their working quality whereas only 20 (5.0%) of them think the MSDs pain will limit their working quality for all of the time (Albeeli *et al*., 2020). However, in the another study focus among cooled food processing facilities among the workers who reported neck pain,

740 (81.0%) of the workers think the neck pain will not lead to abnormal productivity, whereas 110 (95.0%) of the workers think that the neck pain will lead to the poor productivity (Sormunen *et al*., 2009). In the same study, the workers who reported lower back pain, 553 (63.0%) of the workers think the lower back pain will not lead to abnormal productivity, whereas 91 (84.0%) of the workers think that the neck pain will lead to the poor productivity (Sormunen *et al*., 2009). This study has shown similar affected body parts that can lead to abnormal productivity, with the past study among food processing facility workers

Table 4.7: Self-reported work efficiency among the industry workers in a manufacture factory (n=60)

Body parts	N (%)					
	Normal	Slightly affected output	Moderately affected output	Very affected output	Substantially affected output	No output
	0	1	2	3	4	5
Neck	40 (66.7%)	7 (11.7%)	10 (16.7%)	3 (5.0%)	0 (0.0%)	0 (0.0%)
Right Shoulder	41 (68.3%)	6 (10.0%)	8 (13.3%)	5 (8.3%)	0 (0.0%)	0 (0.0%)
Left Shoulder	44 (73.3%)	7 (11.75)	5 (8.3%)	3 (5.0%)	0 (0.0%)	1 (1.7%)
Upper back	46 (76.7%)	2 (3.3%)	10 (16.7%)	1 (1.7%)	1 (1.7%)	0 (0.0%)
Right Upper Arm	49 (81.7%)	4 (6.7%)	6 (10.0%)	1 (1.7%)	0 (0.0%)	0 (0.0%)
Left Upper Arm	50 (83.3%)	3 (5.0%)	5 (8.3%)	1 (1.7%)	1 (1.7%)	0 (0.0%)
Lower Back	36 (60.0%)	14 (23.3%)	7 (11.7%)	1 (1.7%)	1 (1.7%)	1 (1.7%)
Right Forearm	51 (85.0%)	5 (8.3%)	4 (6.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Left Forearm	52 (86.7%)	4 (6.7%)	4 (6.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Right Wrist	47 (78.3%)	5 (8.3%)	5 (8.3%)	3 (5.0%)	0 (0.0%)	0 (0.0%)
Left Wrist	50 (83.3%)	2 (3.3%)	5 (8.3%)	3 (5.0%)	0 (0.0%)	0 (0.0%)
Hip/Buttock	50 (83.3%)	3 (5.0%)	4 (6.7%)	1 (1.7%)	1 (1.7%)	1 (1.7%)
Right Thigh	53 (88.3%)	3 (5.0%)	2 (3.3%)	2 (3.3%)	0 (0.0%)	0 (0.0%)
Left Thigh	54 (90.0%)	2 (3.3%)	2 (3.3%)	2 (3.3%)	0 (0.0%)	0 (0.0%)
Right Knee	51 (85.0%)	3 (5.0%)	5 (8.3%)	1 (1.7%)	0 (0.0%)	0 (0.0%)
Left Knee	51 (85.0%)	2 (3.3%)	6 (10.0%)	1 (1.7%)	0 (0.0%)	0 (0.0%)
Right Lower Leg	47 (78.3%)	6 (10.0%)	6 (10.0%)	1 (1.7%)	0 (0.0%)	0 (0.0%)
Left Lower Leg	48 (80.0%)	4 (6.7%)	7 (11.7%)	1 (1.7%)	0 (0.0%)	0 (0.0%)
Right Foot	40 (66.7%)	7 (11.7%)	11 (18.3%)	0 (0.0%)	1 (1.7%)	1 (1.7%)
Left Foot	43 (71.7%)	7 (11.7%)	8 (13.3%)	0 (0.0%)	1 (1.7%)	1 (1.7%)

4.2 The Relationships Between Prevalence of Musculoskeletal Disorders (MSDs) Symptoms for Different Body Parts with Absenteeism, Presenteeism, and Self-reported Work Efficiency Among Workers with Monotonous Repetitive Work in a HVAC Manufacture Factory

4.2.1 Prevalence of MSDs Symptoms and Absenteeism Among the Industry Workers in a Manufacture Factory

Table 4.8 shows the relationships between the prevalence of Musculoskeletal Disorders (MSDs) symptoms and absenteeism for different body parts among the industry workers in a manufacturing factory. The relationships between the prevalence of MSDs symptoms and absenteeism for each body shows significance in right forearm (p-value = 0.028, OR = 4.375), left forearm (p-value = 0.004, OR = 9.250), right lower leg (p-value = 0.019, OR = 4.263), and right lower leg (p-value = 0.006, OR = 6.050). However, the result of the relationships between the overall prevalence of MSDs and absenteeism is not significant (p-value = 0.129, OR = 2.308). According to a past study that shows similar trends, the data analysis shows that there was no relationship between the prevalence of MSDs symptoms and absenteeism among the public office workers in Putrajaya, Malaysia. (Albeeli *et al*., 2020). However, another study shows that workers tend to take both holiday leave (20%) and sickness leave (27%) due to the MSDs symptoms in their body parts (Drake, 2020). Those who take holiday leave say they will still get paid during the leave and help to keep their MSDs condition record clean in their organization profile to avoid any issues arising from their MSDs condition (Drake, 2020).

Table 4.8: The relationship between the prevalence of MSDs symptoms and absenteeism for different body parts among the industry workers in a manufacture factory (n=60)

Body parts	Present (n=39)	Absent (n=21)	OR	95% CI	p-value[a]	Total (n=60)
Neck	17 (43.6%)	14 (66.7%)	2.588	0.856 – 7.824	0.109	31 (51.7%)
Right Shoulder	16 (41.0%)	13 (61.9%)	2.336	0.787 – 6.931	0.176	29 (48.3%)
Left Shoulder	12 (30.8%)	8 (38.1%)	1.385	0.455 – 4.213	0.579	20 (33.3%)
Upper back	12 (30.8%)	8 (38.1%)	1.385	0.455 – 4.213	0.579	20 (33.3%)
Right Upper Arm	6 (15.4%)	6 (28.6%)	2.200	0.608 – 7.958	0.223	12 (20.0%)
Left Upper Arm	7 (17.9%)	4 (19.0%)	1.076	0.276 – 4.199	0.916	11 (18.3%)
Lower Back	19 (48.7%)	11 (52.4%)	1.158	0.400 – 3.348	1.000	30 (50.0%)
Right Forearm	4 (10.3%)	7 (33.3%)	4.375	1.105 – 17.320	**0.028***	11 (18.3%)
Left Forearm	2 (5.1%)	7 (33.3%)	9.250	1.711 – 50.006	**0.004****	9 (15.0%)
Right Wrist	12 (30.0%)	4 (19.0%)	0.529	0.147 – 1.912	0.377	16 (26.7%)
Left Wrist	10 (25.6%)	4 (19.0%)	0.682	0.185 – 2.516	0.565	14 (23.3%)
Hip/Buttock	5 (12.8%)	7 (33.3%)	3.400	0.921 – 12.545	0.058	12 (20.0%)
Right Thigh	7 (17.9%)	3 (12.3%)	0.762	0.175 – 3.316	0.717	10 (16.7%)
Left Thigh	5 (12.8%)	4 (19.0%)	1.600	0.380 – 6.739	0.519	9 (15.0%)
Right Knee	7 (17.9%)	4 (19.0%)	1.076	0.276 – 4.199	0.916	11 (18.3%)
Left Knee	6 (15.4%)	6 (28.6%)	2.200	0.608 – 7.958	0.223	12 (20.0%)
Right Lower Leg	8 (20.5%)	11 (52.4%)	4.263	1.341 – 13.549	**0.019***	19 (31.7%)
Left Lower Leg	6 (15.4%)	11 (52.4%)	6.050	1.785 – 20.506	**0.006****	17 (28.3%)
Right Foot	16 (41.0%)	11 (52.4%)	1.581	0.544 – 4.600	0.428	27 (45.0%)
Left Foot	15 (38.5%)	9 (42.9%)	1.200	0.408 – 3.528	0.787	24 (40.0%)

[a]Analysis performed using the Chi-square test
***p<0.05**
****p<0.010**
*****p<0.001**

4.2.2 Prevalence of MSDs Symptoms and Self-reported Work Efficiency for Different Body Parts Among the Industry Workers in a Manufacture Factory

Table 4.9 shows the relationships between the prevalence of Musculoskeletal Disorders (MSDs) symptoms and self-reported work efficiency for different body parts among the industry workers in a manufacturing factory. The relationships between the prevalence of MSDs symptoms and self-reported work efficiency for each body part were significant for every body part (p-value < 0.001). From the result of the Mann-Whitney U test in Table 8, the workers who reported MSDs symptoms have lower work efficiency compared to those who reported no MSDs symptoms, according to the mean rank shown as mean rank for “Yes” is more than “No”. This indicates that most of the workers with the prevalence of MSDs symptoms in their body parts reported a reduction in work efficiency and think that the symptoms will more or less affect their work efficiency or work performance.

The study on the musculoskeletal disorder and its association with self-reported productivity among office workers has also shown that a high rate (97.7%) of participants agreed that working during the presenteeism period will eventually affect their work performance and lead to a loss of normal efficiency of work (Albeeli *et al*., 2020). Hence, the self-reported work efficiency method to evaluate the work productivity of the workers can be considered due to its reliability and analyzed together with the other work productivity indicators, such as absenteeism and presenteeism.

Table 4.9: The relationships between the prevalence of MSDs symptoms and self-reported work efficiency for different body parts among the industry workers in a manufacture factory (n=60)

Body Parts	Mann-Whitney U	Mean Rank		p-value[a]
		Yes	No	
Neck	159.500	39.85	20.50	**< 0.001*** **
Right Shoulder	155.000	40.66	21.00	**< 0.001*** **
Left Shoulder	111.500	44.93	23.29	**< 0.001*** **
Upper back	120.000	44.50	23.50	**< 0.001*** **
Right Upper Arm	55.500	49.88	25.66	**< 0.001*** **
Left Upper Arm	24.500	52.77	25.50	**< 0.001*** **
Lower Back	90.000	42.50	18.50	**< 0.001*** **
Right Forearm	81.500	47.59	26.66	**< 0.001*** **
Left Forearm	25.500	53.17	26.50	**< 0.001*** **
Right Wrist	97.000	46.44	24.70	**< 0.001*** **
Left Wrist	92.000	46.93	25.50	**< 0.001*** **
Hip/Buttock	48.000	50.50	25.50	**< 0.001*** **
Right Thigh	75.000	48.00	27.00	**< 0.001*** **
Left Thigh	76.500	47.50	27.50	**< 0.001*** **
Right Knee	80.000	47.73	26.63	**< 0.001*** **
Left Knee	72.000	48.50	26.00	**< 0.001*** **
Right Lower Leg	123.000	44.53	24.00	**< 0.001*** **
Left Lower Leg	107.500	45.68	24.50	**< 0.001*** **
Right Foot	139.000	41.85	21.21	**< 0.001*** **
Left Foot	126.000	43.25	22.00	**< 0.001*** **

[a]Analysis performed using the Mann-Whitney U test
***p<0.05**
****p<0.010**
*****p<0.001**

4.2.2.1 The Relationships Between Overall MSDs Scores and Overall Self-Reported Work Efficiency Among the Industry Workers in a Manufacture Factory

The overall MSDs score was calculated by simply adding the Musculoskeletal Disorders (MSDs) symptoms for every body part for each respondent; for example, if 4 MSDs symptoms were reported by the respondent, and score of 4 will be recorded for that respondent. Besides, the overall self-reported work efficiency was calculated by simply adding the total self-reported work efficiency for every body part with

reported MSDs symptoms. For example, 2 MSDs symptoms and both self-reported work efficiency were reported as 3, and a total of 6 marks is recorded for that respondent. Hence, the significance between the overall MSDs score and overall self-reported work efficiency was p-value < 0.001 ($\rho = 0.620$) after running the Spearman correlation test.

4.2.3 Prevalence of MSDs Symptoms and Presenteeism for Different Body Parts Among the Industry Workers in a Manufacture Factory

Table 4.10 shows the relationships between the prevalence of Musculoskeletal Disorders (MSDs) symptoms and presenteeism for different body parts among the industry workers in a manufacturing factory. The relationships between the prevalence of MSDs symptoms and presenteeism for each body part were significant for every body part (p-value < 0.001), and the workers who reported MSDs symptoms had higher presenteeism compared to those who reported no MSDs symptoms. Workers with reported MSDs symptoms usually have presenteeism of working with discomfort and pain in the respective body parts.

In the Mann-Whitney U test, the "U" value is a statistic that quantifies the difference between two independent groups by assessing the likelihood that the two samples come from the same population based on the ranks of observations (Wall Emerson, 2023). In a Mann-Whitney U test, a U value of 0 indicates that all values in one sample are more significant than all values in the other sample, suggesting a very strong difference between the two groups and a strong rejection of the null hypothesis (Wall Emerson, 2023). The presenteeism of the worker can be categorized into voluntary and involuntary (Drake, 2020). Voluntary presenteeism is when the worker works to keep their muscle and joints moving to let them forget the body pain; involuntary presenteeism is when the workers are forced to not take sick leave due to financial issues and are too busy to get the work done (Drake, 2020). According to past studies, they found that financial concern is the major work-related factor that has a great influence on the presenteeism of workers (Drake, 2020).

Table 4.10: The relationships between the prevalence of MSDs symptoms and presenteeism for different body parts among the industry workers in a manufacture factory (n=60)

Body parts	Mann-Whitney U	Mean Rank		p-value[a]
		Yes	No	
Neck	0.000	45.00	15.00	**< 0.001*****
Right Shoulder	0.000	46.00	16.00	**< 0.001*****
Left Shoulder	0.000	50.50	20.50	**< 0.001*****
Upper back	0.000	50.50	20.50	**< 0.001*****
Right Upper Arm	0.000	54.50	24.50	**< 0.001*****
Left Upper Arm	0.000	55.00	25.00	**< 0.001*****
Lower Back	0.000	45.50	15.50	**< 0.001*****
Right Forearm	0.000	55.00	25.00	**< 0.001*****
Left Forearm	0.000	56.00	26.00	**< 0.001*****
Right Wrist	0.000	52.50	22.50	**< 0.001*****
Left Wrist	0.000	53.50	23.50	**< 0.001*****
Hip/Buttock	0.000	54.50	24.50	**< 0.001*****
Right Thigh	0.000	55.50	25.50	**< 0.001*****
Left Thigh	0.000	56.00	26.00	**< 0.001*****
Right Knee	0.000	55.00	25.00	**< 0.001*****
Left Knee	0.000	54.50	24.50	**< 0.001*****
Right Lower Leg	0.000	51.00	21.00	**< 0.001*****
Left Lower Leg	21.500	50.74	22.50	**< 0.001*****
Right Foot	32.000	45.81	17.97	**< 0.001*****
Left Foot	36.000	47.00	19.50	**< 0.001*****

[a]Analysis performed using Mann-Whitney U test
***p<0.05**
****p<0.010**
*****p<0.001**

4.3 The Relationships Between Significant Individual and Work-Related Risk Factors of Musculoskeletal Disorders (MSDs) Symptoms Among the Workers with Monotonous Repetitive Work in a HVAC Manufacture Factory

4.3.1 The Relationships Between Prevalence of MSDs Symptoms at Different Body Parts and Individual Risk Factors Among the Industry Workers in a Manufacture Factory

Table 4.11 shows the binary logistic regression between the prevalence of Musculoskeletal Disorders (MSDs) symptoms at different body parts and individual risk factors among the industry workers in a manufacturing factory. Among the individual risk factors (gender, smoking status, and past injuries) with the prevalence of MSDs for different body parts, gender and past injuries showed was significant association with the prevalence of MSDs for different body parts. For gender, the prevalence of right foot shows a significance ($p = 0.035$, OR = 5.296) with the gender of the workers. For past injuries, Multiple prevalence of the different body parts have showed significance with the past injuries of the workers which including right shoulder ($p = 0.010$, OR = 6.561), right upper arm ($p = 0.007$, OR = 39.714), lower back ($p = 0.001$, OR = 52.298), right forearm ($p = 0.019$, OR = 24.555), right wrist ($p = 0.001$, OR = 47.618), right knee ($p = 0.006$, OR = 16.780), right lower leg ($p = 0.011$, OR = 19.459), right foot ($p = 0.001$, OR = 43.886), and left foot ($p = 0.046$, OR = 0.739). However, among all the body parts, the prevalence of the right foot showed more significance with the gender ($p = 0.035$) and past injuries ($p = 0.001$). The result of high Odd Ratio (OR) and low (0) 95% Confidence Level (CI) indicates that the separation among the variables is strong; for example, one of the corresponding variables always responds to one outcome, which is “Yes” for both prevalence of MSDs symptoms and past injuries (Althomali *et al*., 2021). Besides, a small sample size can lead to a large standard error due to too few cases in certain groups and not enough power (Althomali *et al*., 2021).

According to the past studies, the prevalence of the MSDs symptoms is difference among the gender of male and female, and the female workers was found significantly higher prevalence of MSDs symptoms than male workers at neck,

shoulders, wrist/hands, upper back, low back, and ‘any body region’ (Vingård *et al*, 2000). The explanation is that females have lower physical capabilities and smaller dimensions and body sizes compared to males; hence, female workers will suffer higher workloads even performing the same work as male workers (Vingård *et al*., 2000). In a study that investigated the physical and psychological work risk factors and their interaction for low back symptoms, 77% of the male workers were carrying out heavy physical work and 62% of the female workers were handling light physical work including manual handling such as hand tasks, so the prevalence of MSDs symptoms among male and female can be different due to the gender segregation in the workforce (Vingård *et al*, 2000). However, this study found that gender is associated with the prevalence of right foot among male and female workers, which can be explained due to the prolonged standing and lack of microbreaks from the sociodemographic data collected. Besides, the smoking status shows no significant relationship with the MSDs symptoms prevalence among the manufacturing industry workers.

Furthermore, a past study found that there was a strong correlation between smoking habits and MSDs complaints among construction workers due to the large coverage of smokers among those workers (ZulArdi and Sari, 2023). However, there was no significant relationship between smoking habit and MSDs complaints in another study focused on firefighters, as the number of smokers is relatively low to moderate among the firefighters (ZulArdi and Sari, 2023). Hence, no significance between smoking status and MSDs symptoms prevalence among the manufacturing industry workers can be explained as most of the workers (78.3%) were found to have never smoked before.

Furthermore, the article studies on factory workers with the work-related injuries and musculoskeletal disorders in a major city of China (2012), shows 23.4% of the workers experienced more than one injury at body parts in the period of past 12 months and past injuries history is commonly observed can increase the chances of the MSDs symptoms prevalence and eventually lead to future injuries to the workers. In a controlled trial assessing an educational program designed to prevent lower back injuries, researchers found that 75 (20.8%) out of 360 postal workers who had initially suffered lower back injuries experienced reinjury after returning to work. This result

indicated that the reinjury rate was significantly higher compared to workers who had not experienced a primary injury (Daltroy *et al*., 1997)

Table 4.11: Binary logistic regression between the prevalence of MSDs symptoms at different body parts and individual risk factors among the industry workers in a manufacture factory (n=60)

Body parts	Gender			Smoking Status			Past Injuries		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Neck	1.915	0.553 – 6.632	0.305	0.733	0.338 – 1.591	0.433	3886783819.1	0.000	0.998
Right Shoulder	1.015	0.303 – 3.393	0.981	0.752	0.432 – 1.310	0.314	6.561	1.577 – 27.292	**0.010****
Left Shoulder	0.987	0.284 – 3.431	0.983	0.678	0.330 – 1.394	0.291	4360703906.1	0.000	0.999
Upper back	2.515	0.572 – 11.057	0.222	0.683	0.241 – 1.938	0.474	9826196911.1	0.000	0.999
Right Upper Arm	4.335	0.693 – 27.133	0.117	0.715	0.180 – 2.841	0.634	39.714	2.745 – 574.460	**0.007****
Left Upper Arm	3.251	0.681 – 15.332	0.140	0.604	0.150 – 2.432	0.478	12755000574.0	0.000	1.000
Lower Back	1.896	0.458 – 7.844	0.377	0.762	0.369 – 1.573	0.462	52.398	5.602 – 490.079	**<0.001*****
Right Forearm	0.735	0.157 – 3.440	0.695	0.665	0.296 – 1.492	0.322	24.555	1.691 – 356.470	**0.019***
Left Forearm	0.720	0.167 – 3.103	0.659	0.000	0.000	0.998	0.000	0.000	0.000
Right Wrist	1.635	0.345 – 8.237	0.551	0.719	0.355 – 1.456	0.359	47.618	5.534 – 409.727	**<0.001*****
Left Wrist	1.697	0.380 – 7.574	0.488	1.570	0.890 – 2.768	0.119	5.199	0.608 – 44.436	0.132
Hip/Buttock	6.210	0.531 – 72.633	0.146	1.545	0.644 – 3.706	0.330	30506997085.0	0.000	0.999
Right Thigh	1.595	0.305 – 8.356	0.580	1.068	0.520 – 2.194	0.857	12080535730.0	0.000	0.999
Left Thigh	1.082	0.228 – 5.142	0.921	0.513	0.123 – 2.149	0.361	8737585481.5	0.000	1.000
Right Knee	1.620	0.287 – 9.141	0.585	1.285	0.672 – 2.458	0.448	16.780	2.222 – 126.745	**0.006****
Left Knee	0.610	0.148 – 2.507	0.493	0.540	0.194 – 1.505	0.239	7673505503.5	0.000	1.000
Right Lower Leg	0.438	0.111 – 1.723	0.237	0.694	0.355 – 1.357	0.286	19.459	1.969 – 192.298	**0.011***
Left Lower Leg	0.748	0.219 – 2.554	0.643	0.439	0.150 – 1.287	0.134	2934824867.3	0.000	1.000
Right Foot	5.296	1.123 – 24.975	**0.035***	0.800	0.343 – 1.864	0.605	43.886	4.373 – 440.457	**0.001*****
Left Foot	2.020	0.596 – 6.843	0.259	0.571	0.242 – 1.347	0.201	0.739	1.036 – 91.518	**0.046***

***p<0.05**
****p<0.010**
*****p<0.001**

4.3.2 The Relationships Between Prevalence of MSDs Symptoms at Different Body Parts and Work-Related Risk Factors Among the Industry Workers in a Manufacture Factory

Table 4.12 shows the binary logistic regression between the prevalence of Musculoskeletal Disorders (MSDs) symptoms and work-related risk factors among the industry workers in a manufacturing factory. There are three work-related risk factors, which are working years, daily working duration, and frequency of microbreaks. The relationships between these three work-related risk factors with the prevalence of MSDs for different body parts were found to be significant for the right forearm, left forearm, and right wrist. The relationships between daily working duration and prevalence of right and left forearms were significant, with p-value = 0.036 (OR = 0.212) and p-value = 0.006 (OR = 0.062), respectively. Besides, the frequency of microbreaks is found to be significant with the prevalence of MSDs for the right wrist, with the p-value of 0.040 (OR = 0.363). The 95% CI for these body parts was the right forearm (0.050 – 0.904), left forearm (0.008 – 0.456), and right wrist (0.138 – 0.956), which show an inversely proportional relationship with the daily working duration and frequency of microbreaks. For the daily work duration, most of the workers work for 9 hours per day, which is the second rank among all options, hence leading to the result of inversely proportional. Besides, the frequency of microbreaks, the fewer microbreaks taken by the workers can lead to the prevalence of MSDs symptoms.

The working years were found to have no significant relationship with the MSDs symptoms among the workers. The past study targeting laundry workers shows there was no relationship between working years and MSDs symptoms, with a p-value of 0.385, which is larger than 0.05 (Lahdji and Anggraheny, 2019). This is likely due to the limited time available to work in a laundry facility and the process of adapting to the workplace (Lahdji and Anggraheny, 2019). Effective adaptation can have positive effects, such as reducing stress and enhancing work productivity (Lahdji and Anggraheny, 2019). Previous studies have shown that construction workers in Taiwan who worked more than 8 hours per day faced a greater risk of developing work-related musculoskeletal disorders (WMSDs) compared to those who worked 8 hours or less (Gede and Ni, 2024). The study suggests that extended work hours may lead to increased workloads, higher stress levels, and reduced rest, all of which can contribute

to physical and mental fatigue, potentially triggering or worsening the WMSDs among the workers (Gede and Ni, 2024). In this study, most of the workers work for more than 8 hours per day and long duration of manual handling of repetitive motion exposure, hence, the daily working duration is significantly related to the prevalence of MSDs symptoms in the Right and Left forearms of the workers.

Due to workplace exercises interrupting work activities, they are often referred to as "short active breaks" or "micro-breaks" (Vitoulas *et al*., 2022). These breaks are intended to reduce stress on the musculoskeletal system, particularly the muscles and joints, which are caused by work-related factors, and to help correct awkward or unnatural postures (Vitoulas *et al*., 2022). However, micro-breaks are beneficial not only physically but also psychologically, which address issues such as fear of movement, depression, and anxiety (Vitoulas *et al*., 2022). Most of the workers take only 1-2 microbreaks throughout their long working duration, as shown in this study, therefore, the MSDs symptoms prevalence at the right wrist shows a significant relationship with the frequency of microbreaks taken by the workers as the lesser the microbreak takes, the higher the prevalence of MSDs symptoms.

Table 4.12: Binary logistic regression between the prevalence of MSDs symptoms at different body parts and work-related risk factors among the industry workers in a manufacture factory (n=60)

Body parts	Working years			Daily working duration			Frequency of microbreak		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Neck	0.697	0.371 – 1.309	0.261	0.580	0.236 – 1.426	0.236	0.964	0.456 – 2.035	0.923
Right Shoulder	0.759	0.403 – 1.070	0.393	0.380	0.135 – 1.070	0.067	0.908	0.426 – 1.934	0.802
Left Shoulder	1.416	0.749 – 2.680	0.285	0.861	0.343 – 2.159	0.749	0.726	0.327 – 1.614	0.433
Upper back	1.364	0.712 – 2.612	0.350	0.807	0.325 – 2.007	0.644	0.532	0.231 – 1.228	0.139
Right Upper Arm	0.675	0.281 – 1.618	0.378	0.517	0.165 – 1.625	0.259	0.809	0.302 – 2.168	0.674
Left Upper Arm	0.579	0.215 – 1.561	0.280	0.336	0.085 – 1.322	0.119	1.391	0.488 – 3.962	0.537
Lower Back	0.910	0.489 – 1.693	0.765	1.694	0.697 – 4.114	0.244	1.536	0.718 – 3.285	0.269
Right Forearm	0.413	0.125 – 1.364	0.147	0.212	0.050 – 0.904	**0.036***	0.647	0.198 – 2.110	0.470
Left Forearm	0.600	0.169 – 2.137	0.431	0.062	0.008 – 0.456	**0.006****	1.851	0.490 – 6.986	0.364
Right Wrist	0.935	0.454 – 1.928	0.856	0.763	0.298 – 1.951	0.572	0.363	0.138 – 0.956	**0.040***
Left Wrist	1.047	0.517 – 2.122	0.899	0.955	0.352 – 2.589	0.928	0.940	0.395 – 2.237	0.890
Hip/Buttock	1.308	0.635 – 2.695	0.467	1.105	0.360 – 3.393	0.861	1.339	0.542 – 3.304	0.527
Right Thigh	0.328	0.097 – 1.111	0.073	0.959	0.335 – 2.745	0.938	1.311	0.451 – 3.806	0.619
Left Thigh	0.584	0.207 – 1.650	0.310	1.030	0.343 – 3.093	0.957	1.128	0.389 – 3.268	0.824
Right Knee	0.686	0.281 – 1.679	0.409	1.057	0.355 – 3.148	0.921	1.679	0.633 – 4.450	0.298
Left Knee	0.886	0.396 – 1.983	0.769	1.126	0.359 – 3.530	0.839	2.293	0.873 – 6.027	0.092
Right Lower Leg	0.733	0.361 – 1.491	0.392	0.553	0.197 – 1.550	0.260	1.352	0.596 – 3.065	0.471
Left Lower Leg	0.725	0.342 – 1.536	0.401	0.398	0.122 – 1.298	0.127	1.393	0.588 – 3.301	0.451
Right Foot	0.820	0.433 – 1.555	0.544	2.426	0.867 – 6.787	0.091	0.724	0.334 – 1.569	0.413
Left Foot	0.869	0.457 – 1.651	0.668	2.090	0.816 – 5.358	0.125	0.948	0.441 – 2.035	0.890

***p<0.05**
****p<0.010**
*****p<0.001**

CHAPTER 5

CONCLUSION

5.1 Research Conclusion

All objectives in this study were achieved, and this study indicates that there were significant relationships between the prevalence of Musculoskeletal Disorders (MSDs) symptoms and work productivity among the industry workers in a manufacturing factory. The prevalence of MSDs symptoms was 93.3% among the assembly line workers. The most prevalence of MSDs symptoms at all body parts were neck (51.7%), lower back (50.0%), right shoulder (48.3%), right foot (45.0%), and left foot (40.0%). The work productivity studied under this research included absenteeism, presenteeism, and self-reported work efficiency. No significant relationship between the overall prevalence of MSDs symptoms and absenteeism was found ($p = 0.129$). However, the relationship between the prevalence of MSDs symptoms and absenteeism for each body shows significance at the right forearm ($p = 0.028$, OR = 4.375), left forearm ($p = 0.004$, OR = 9.250), right lower leg ($p = 0.019$, OR = 4.263), and right lower leg ($p = 0.006$, OR = 6.050). The relationship between the prevalence of MSDs symptoms and presenteeism for each body part was significant for every body part ($p < 0.001$), and the workers who reported MSDs symptoms had higher presenteeism compared to those who reported no MSDs symptoms. For each body part, the prevalence of MSD symptoms was significantly associated with self-reported work efficiency ($p < 0.001$).

Among the individual risk factors (gender, smoking status, and past injuries) with the prevalence of MSDs symptoms for different body parts, gender and past injuries show there were significant associations with the prevalence of MSDs

symptoms for different body parts ($p < 0.05$). Among all the body parts, the prevalence of the right foot showed more significance with the gender ($p = 0.035$) and past injuries ($p = 0.001$). For work-related risk factors with the prevalence of MSDs symptoms for different body parts, the relationship between daily working duration was significantly associated with the prevalence of MSDs at right ($p = 0.036$; OR = 0.212) and left forearm ($p = 0.006$; OR = 0.062). Besides, the frequency of microbreaks was found to be significantly associated with the prevalence of MSDs symptoms for the right wrist, with the p-value of 0.040 (OR = 0.363).

5.2 Strengths and Limitations of the Study

This study demonstrates several methodological strengths that enhance the validity and reliability of its findings in this study. In order to reduce the selection bias and confounding factors control, clear inclusion and exclusion criteria were applied. Specifically, office workers, maintenance staff, and pregnant workers were excluded due to their differing job tasks and exposure to risk factors, ensuring a more homogenous and representative sample of industrial production workers. The study also employed a frequent follow-up schedule for questionnaire distribution and collection, which helped maximize response rates and reduce the likelihood of missing data. Furthermore, the use of the standardized and widely validated Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) strengthens the reliability of self-reported symptom data, contributing to the overall robustness of the study outcomes.

There were several limitations found in this study that could be studied and focused on in future research exploring the relationship between the prevalence of musculoskeletal disorders (MSDs) symptoms and work productivity among industrial workers in manufacturing settings. These limitations can be categorized into three key stages, including the preparation stage, data collection stage, and data analysis stage. In the preparation stage, lack of research to identify additional risk factors that may influence both MSD symptom prevalence and productivity. Potential factors such as psychological distress, physical working conditions, and organizational culture, especially awareness of ergonomics, should be considered, as they could significantly

affect study outcomes. Regarding data collection, improvements can be made by considering workers' educational backgrounds and technological literacy. Initially, the questionnaire was available in both paper and digital formats via Google Forms. However, some workers had difficulty writing or using digital tools, including scanning QR codes. Therefore, standardizing the data collection method is crucial for consistency, with paper forms being the preferred option due to their accessibility for the majority of workers.

Clear communication and step-by-step guidance throughout the data collection process are also essential to ensure accurate and complete responses. In this study, a lack of guidance and time constraints, such as production demands, resulted in incomplete and insufficient data. Future studies should coordinate with management and line leaders to schedule appropriate briefing sessions, allowing adequate time for explanation and assistance during data collection. During the data analysis stage, the study encountered issues with statistical power due to a limited sample size. This led to inflated odds ratios and confidence intervals that included zero, reducing the reliability of the results. Future research should conduct a thorough review of similar studies to determine the appropriate sample size and ensure more accurate, reliable outcomes.

5.3 Recommendations

5.3.1 Recommendation for Future Studies

Several recommendations can be made for future research based on the limitations identified in this study to explore the relationship between the prevalence of Musculoskeletal Disorders (MSD) symptoms and work productivity among industrial workers. Firstly, during the preparation stage, future studies should conduct more extensive preliminary research to identify a broader range of potential risk factors, including psychological distress, physical working environment, and organizational culture, such as ergonomic awareness, that may significantly influence both MSDs symptoms and productivity outcomes. In the data collection stage, it is crucial to

consider the education level and digital literacy of participants. Given the challenges experienced with electronic questionnaires, future studies should prioritize the use of paper-based forms and provide clear, simple instructions to ensure inclusivity and consistency in responses. Moreover, enhancing communication and providing step-by-step guidance through proper coordination with management and supervisors can improve the completeness and reliability of the collected data. Lastly, to strengthen the statistical analysis, future research should aim for a larger and more representative sample size. Referring to existing literature to calculate the minimum required sample size beforehand will help improve the study's statistical power and reduce the likelihood of obtaining distorted measures such as extremely large odds ratios or zero confidence intervals.

5.3.2 Recommendation for Workers and Company

The prevalence of Musculoskeletal Disorders (MSDs) symptoms among the assembly line workers can be reduced by the proactive action taken by the company including conduct the medical surveillance for the high risk of repetitive motion working line such as assembly line in this study to identify the early signage of the MSDs symptoms among the workers and control measures needed to be carry out following the hierarchy of control: Elimination, Substitution, Engineering, and Administrative control measures. It is recommended that a comprehensive ergonomic intervention program be implemented. This should begin with a thorough assessment of workstation design, tool usability, and repetitive task patterns to identify ergonomic risk factors contributing to MSDs. Adjustments such as height-adjustable workstations, ergonomic seating, and improved tool grips can help minimize physical strain. In addition, job rotation strategies should be introduced to reduce repetitive motion injuries by varying physical demands across tasks. Providing regular training on proper posture, lifting techniques, and early symptom reporting is essential to promote worker awareness and self-care. Investing in these ergonomic improvements not only enhances worker health and comfort but also leads to improved morale, reduced absenteeism, and ultimately, higher productivity on the assembly line. Management should monitor the impact of these changes through health surveillance and

productivity metrics to ensure continuous improvement. By integrating the hierarchy of control into the working process, the repetitive motion related hazards posed to the workers in the workplace will be reduced, more than that, this will increase the confidence level from the workers to the safety and health management of the company and increase their morale to work which help to maintain and increase their work productivity..

REFERENCES

Afsharian, A., Dollard, M. F., Glozier, N., Morris, R. W., Bailey, T. S., Nguyen, H., and Crispin, C., 2023. Work-related psychosocial and physical paths to future musculoskeletal disorders (MSDs). Safety Science, 164. Available at: <https://doi.org/10.1016/j.ssci.2023.106177> [Accessed 21 August 2024]

Albeeli, A., Bahri Mohd Tamrin, S., Yee Guan, N., and Karuppiah, K., 2020. Musculoskeletal disorders and their association with self-reported productivity: a cross-sectional study among public office-workers in Putrajaya, malaysia. Malaysian Journal of Medicine and Health Sciences, 16(4), pp. 2636–9346. [Accessed 21 August 2024]

Ali, N.F. and Roslan, A.N.N., 2024. Ergonomic risk factors (erfs) and prevalence of work-related musculoskeletal disorders (wrmds) among solvent manufacturing workers in shah alam, selangor. Malaysian Journal of Medicine and Health Sciences. [e-journal] 20(5), pp. 99-105. Available at: <doi:10.47836/mjmhs20.5.14> [Accessed 14 April 2025]

Althomali, O.W., Amin, J., Alghamdi, W. and Shaik, D.H., 2021. Prevalence and factors associated with musculoskeletal disorders among secondary schoolteachers in hail, saudi arabia: a cross-sectional survey. International Journal of Environmental Research and Public Health. [e-journal] 18(12), p. 6632. Available at: <doi:https://doi.org/10.3390/ijerph18126632.> [Accessed 18 April 2025]

Amin, N.A., Nordin, R., Fatt, Q.K., Noah, R.M., and Oxley, J., 2014. Relationship between psychosocial risk factors and work-related musculoskeletal disorders among public hospital nurses in malaysia. Annals of Occupational and Environmental Medicine. [e-journal] 26(1). Available at: <doi:https://doi.org/10.1186/s40557-014-0023-2.> [Accessed 17 April 2025]

Anita, A.R., Yazdani, A., Hayati, K.S., and Adon, M.Y., 2014. Association between awkward posture and musculoskeletal disorders (msd) among assembly line workers in an automotive industry. Malaysian Journal of Medicine and Health Sciences. [e-journal] 10(1), pp. 23-28. Available at: <https://www.researchgate.net/publication/269107479_Association_between_Awkward_Posture_and_Musculoskeletal_Disorders_MSD_among_Assembly_Line_Workers_in_an_Automotive_Industry> [Accessed 17 April 2025]

Antle, D.M., Vézina, N., Messing, K. and Côté, J.N., 2013. Development of discomfort and vascular and muscular changes during a prolonged standing task.

Occupational Ergonomics. [e-journal] 11(1), pp. 21–33. Available at: <doi:https://doi.org/10.3233/oer-130205.> [Accessed 11 April 2025]

Baber, C., and Young, M. S., 2022. Making ergonomics accountable: Reliability, validity, and utility in ergonomics methods. Applied Ergonomics, 98. [online] Available at: <https://doi.org/10.1016/j.apergo.2021.103583> [Accessed 21 August 2024]

Berndt, A. E., 2020. Sampling methods. Journal of Human Lactation, 36(2), pp. 224–226. [online] Available at: <https://doi.org/10.1177/0890334420906850> [Accessed 20 August 2024]

Blessing Oribhabor, C., and Anyanwu, C. A., n.d. Research sampling and sample size determination: a practical application. [Accessed 20 August 2024]

Brunner, B., Igic, I., Keller, A.C. and Wieser, S., 2019. Who gains the most from improving working conditions? health-related absenteeism and presenteeism due to stress at work. The European Journal of Health Economics, [online] 20(8), pp. 1165–1180. Available at: <doi:https://doi.org/10.1007/s10198-019-01084-9.> [Accessed 18 April 2025]

Centers for Disease Control and Prevention, n.d. Epi info. [online] Available at: <https://www.cdc.gov/epiinfo/index.html> [Accessed 20 August 2024]

Crawford, J. O., 2007. The nordic musculoskeletal questionnaire. Occupational Medicine, 57(4), pp. 300–301. [online] Available at: <https://doi.org/10.1093/occmed/kqm036> [Accessed 21 August 2024]

Daltroy, L.H., Iversen, M.D., Larson, M.G., Lew, R., Wright, E., Ryan, J., Zwerling, C., Fossel, A.H. and Liang, M.H., 1997. A controlled trial of an educational program to prevent low back injuries. New England Journal of Medicine. [e-journal] 337(5), pp. 322–328. Available at: <doi:https://doi.org/10.1056/nejm199707313370507.> [Accessed 11 April 2025]

Daneshmandi, H., Choobineh, A. R., Ghaem, H., Alhamd, M., and Fakherpour, A., 2017. The effect of musculoskeletal problems on fatigue and productivity of office personnel: a cross-sectional study. J PREV MED HYG, 58, pp. 252–258.

Department of Occupational Safety and Health, 2003b. Guidelines on occupational vibration. [online] Available at: <https://dosh.gov.my/perundangan/garis-panduan/ergonomik/> [Accessed 21 August 2024]

Department of Occupational Safety and Health, 2017. Guidelines on ergonomics risk assessment at the workplace. [online] Available at: <https://dosh.gov.my/perundangan/garis-panduan/ergonomik/> [Accessed 19 August 2024]

Department of Occupational Safety and Health, 2018. Guidelines for manual handling at the workplace. [online] Available at:

<https://dosh.gov.my/perundangan/garis-panduan/ergonomik/> [Accessed 21 August 2024]

Department of Occupational Safety and Health, 2024a. Guidelines on occupational safety and health for standing at work. [online] Available at: <https://dosh.gov.my/perundangan/garis-panduan/ergonomik/> [Accessed 21 August 2024]

Department of Occupational Safety and Health, 2024b. Guidelines on occupational safety and health for seating at work. [online] Available at: <https://dosh.gov.my/perundangan/garis-panduan/ergonomik/> [Accessed 21 August 2024]

Department of Occupational Safety and Health, 2024c. Guidelines on occupational safety and health for working with display screen equipment. [online] Available at: <https://dosh.gov.my/perundangan/garis-panduan/ergonomik/> [Accessed 21 August 2024]

Department of Occupational Safety and Health, n.d. Ergonomic. [online] Available at: <https://dosh.gov.my/perundangan/garis-panduan/ergonomik/> [Accessed 16 April 2025]

Dong, Y., Jiang, P., Jin, X., Jiang, N., Huang, W., Peng, Y., Shen, Y., He, L., Forsman, M. and Yang, L., 2022. Association between long-term static postures exposure and musculoskeletal disorders among university employees: A viewpoint of inflammatory pathways. [e-journal] Available at: <10. doi:https://doi.org/10.3389/fpubh.2022.1055374.> [Accessed 17 April 2025]

Drake, C., Gibb, A., Chow, V., and Jones, W., 2020. Presenteeism related to musculoskeletal disorders in uk construction. Loughborough University. [e-journal] [Accessed 14 April 2025]

Elif Altundaş Hatman, Ferit Serkan Öngel, Melike Erkoç Yavuz and Nuran Gülenç, 2023. Work-related diseases and risk factors associated with work-related musculoskeletal disorders among unionized metal industry workers: a cross-sectional study. *International Journal of Occupational Safety and Ergonomics*. [e-journal] 30(1), pp. 194–204. Available at: <doi:https://doi.org/10.1080/10803548.2023.2284538.> [Accessed 23 April 2025]

Escorpizo, R., 2008. Understanding work productivity and its application to work-related musculoskeletal disorders. International Journal of Industrial Ergonomics, 38(3–4), pp. 291–297. Available at: <https://doi.org/10.1016/j.ergon.2007.10.018> [Accessed 21 August 2024]

Fahim, N., and Negida, A. 2018. Sample size calculation guide - part 1: how to calculate the sample size. ADVANCED JOURNAL OF EMERGENCY MEDICINE, 2(4), pp. 50. [online] Available at: < https://doi.org/10.22114/ajem.v0i0.101> [Accessed 20 August 2024]

Foong, M., Adon, M., Rafee B and A.A. Azuhairi, 2014. Prevalence of musculoskeletal symptoms among production line workers in a printing manufacturing company, malaysia. International Journal of Public Health and Clinical Sciences. [e-journal] 1(1), pp. 109–117. [Accessed 12 April 2025]

Gede, W. and Ni, 2024. Prevalence of work-related musculoskeletal disorders among laundry workers in north sulawesi province, indonesia. International Journal of Occupational Safety and Health. [e-journal] 14(2), pp. 237–246. Available at: <doi:https://doi.org/10.3126/ijosh.v14i2.60842.> [Accessed 12 April 2025]

Govaerts, R., Tassignon, B., Ghillebert, J., Serrien, B., De Bock, S., Ampe, T., El Makrini, I., Vanderborght, B., Meeusen, R., and De Pauw, K., 2021. Prevalence and incidence of work-related musculoskeletal disorders in secondary industries of 21st century europe: a systematic review and meta-analysis. BMC Musculoskeletal Disorders, 22(1). [online] Available at: <https://doi.org/10.1186/s12891-021-04615-9> [Accessed 19 August 2024]

Hagberg, M., Tornqvist, E. W., and Toomingas, A., 2002. Self-reported reduced productivity due to musculoskeletal symptoms: associations with workplace and individual factors among white-collar computer users. Journal of Occupational Rehabilitation, 12(3). [Accessed 19 August 2024]

Harun, W., Che, A. and Noh, M., 2025. Evaluation of work-related musculoskeletal disorders (wmsds) among manual assembly workers in the medical device manufacturing industry. Journal of Physics Conference Series. [e-journal] 2933(1), pp. 012023–012023. Available at: <doi:https://doi.org/10.1088/1742-6596/2933/1/012023.> [Accessed 12 April 2025]

Havet, N., and Penot, A., 2022. Trends in exposures to physically demanding working conditions in france in 2003, 2010, and 2017. European Journal of Public Health, 32(1), pp. 73–79. [online] Available at: <https://doi.org/10.1093/eurpub/ckab195> [Accessed 21 August 2024]

Heidarimoghadam, R., Mohammadfam, I., Babamiri, M., Soltanian, A. R., Khotanlou, H., and Sohrabi, M. S., 2022. What do the different ergonomic interventions accomplish in the workplace?. International Journal of Occupational Safety and Ergonomics, 28(1), pp. 600–624. Available at: <https://doi.org/10.1080/10803548.2020.1811521> [Accessed 21 August 2024]

Hembecker, P.K., C. Reis, D., Konrath, A.C., A. Gontijo, L. and D. Merino, E.A., 2017. Investigation of musculoskeletal symptoms in a manufacturing company in brazil: a cross-sectional study. Brazilian Journal of Physical Therapy. [e-journal] 21(3), pp. 175–183. Available at: <doi:https://doi.org/10.1016/j.bjpt.2017.03.014.> [Accessed 13 April 2025]

Jansen, K., Luik, M., Reinvee, M., Viljasoo, V., Ereline, J., Gapeyeva, H., and Pääsuke, M., 2012. Musculoskeletal discomfort in production assembly workers. Acta Kinesiologiae Universitatis Tartuensis, 18, pp. 102. [online] Available at: <https://doi.org/10.12697/akut.2012.18.11> [Accessed 20 August 2024]

Kesmodel, U. S., 2018. Cross-sectional studies – what are they good for? Acta Obstetricia et Gynecologica Scandinavica, 97(4), pp. 388–393. [online] Available at: <https://doi.org/10.1111/aogs.13331> [Accessed 20 August 2024]

Lahdji, A. and Anggraheny, H.D., 2019. Effect of age, work period, and work duration on musculoskeletal disorders in laundry workers. Advances in Health Sciences Research. [e-journal] 24. [Accessed 14 April 2025]

Latko, W.A., Armstrong, T.J., Franzblau, A., Ulin, S.S., Werner, R.A. and Albers, J.W., 1999. Cross-sectional study of the relationship between repetitive work and the prevalence of upper limb musculoskeletal disorders. American Journal of Industrial Medicine [e-journal] 36(2), pp. 248–259. Available at: <doi:https://doi.org/10.1002/(sici)1097-0274(199908)36:2%3C248::aid-ajim4%3E3.0.co;2-q.> [Accessed 17 April 2025]

Lee, J.-G., Kim, G.H., Jung, S.W., Kim, S.W., Lee, J.-H., and Lee, K.-J., 2018. The association between long working hours and work-related musculoskeletal symptoms of korean wage workers: data from the fourth korean working conditions survey (a cross-sectional study). Annals of Occupational and Environmental Medicine [e-journal] 30(1). Available at: <doi:https://doi.org/10.1186/s40557-018-0278-0.> [Accessed 17 April 2025]

Leite, W.K. dos S., Araújo, A.J. da S., Norte da Silva, J.M., Gontijo, L.A., Vieira, E.M. de A., Lopes de Souza, E., Colaço, G.A. and Bueno da Silva, L., 2019. Risk factors for work-related musculoskeletal disorders among workers in the footwear industry: a cross-sectional study. *International Journal of Occupational Safety and Ergonomics*. [e-journal] 27(2), pp. 393–409. Available at: <doi:https://doi.org/10.1080/10803548.2019.1579966.> [Accessed 23 April 2025]

Lin, S. C., Lin, L. L., Liu, C. J., Fang, C. K., and Lin, M. H., 2020. Exploring the factors affecting musculoskeletal disorders among hospital nurses. PLOS ONE, 15(4). [online] Available at: <https://doi.org/10.1371/journal.pone.0231319> [Accessed 21 August 2024]

Maakip, I., Keegel, T. and Oakman, J., 2015. Workstyle and Musculoskeletal discomfort (msd): exploring the influence of work culture in malaysia. Journal of Occupational Rehabilitation. [e-journal] 25(4), pp. 696–706. Available at: <doi:https://doi.org/10.1007/s10926-015-9577-2.> [Accessed 13 April 2025]

Maestas, N. A., Mullen, K. J., and Rennane, S., 2021. Absenteeism and presenteeism among american workers. Journal of Disability Policy Studies, 32(1), pp. 13–23. [online] Available at: <https://doi.org/10.1177/1044207320933211> [Accessed 21 August 2024]

Mahdavi, N., Dianat, I., Heidarimoghadam, R., Khotanlou, H., and Faradmal, J., 2020. A review of work environment risk factors influencing muscle fatigue. International Journal of Industrial Ergonomics, 80. Available at: <https://doi.org/10.1016/j.ergon.2020.103028> [Accessed 21 August 2024]

Malaysia Investment Development Authority, 2022. Key highlights of the manufacturing sector in 2022. [online] Available at: <https://www.mida.gov.my/industries/manufacturing/> [Accessed 19 August 2024]

National Heart, Lung, and Blood Institute, n.d. BMI Calculator (Metric). [online] Available at: <https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi-m.htm> [Accessed 11 April 2025]

National Institute of Occupational Safety and Health, 2014. Work-related musculoskeletal disorders among assembly workers in malaysia. Journal of Occupational Safety and Health. 11(1), pp. 33-18. [Accessed 13 April 2025]

Ng, Y. G., Bahri, S., Tamrin, M., Yik, W. M., Syah, I., Yusoff, M., and Mori, I., 2014. The prevalence of musculoskeletal disorders and association with productivity loss: a preliminary study among labour-intensive manual harvesting activities in oil palm plantation. Industrial Health. [e-journal] 52, pp. 78–85. [Accessed 13 April 2025]

Ng, Y. M., Voo, P. and Maakip, I., 2019. Psychosocial factors, depression, and musculoskeletal disorders among teachers. BMC Public Health [online] 19(1). Available at: <doi:https://doi.org/10.1186/s12889-019-6553-3.> [Accessed 17 April 2025]

Nur, N. M., Zawiah, S., Dawal, M., and Dahari, M., 2014. The prevalence of work-related musculoskeletal disorders among workers performing industrial repetitive tasks in the automotive manufacturing companies. University of Malaya. [e-journal] [Accessed 17 April 2025]

Omidi, M., Jalilian, M., Kazemi, M., Kamalvandi, M., Jamshidzad, M., and Kurd, N., 2017. Using of cornell measuring tool (cornell musculoskeletal discomfort questionnaires) for assessment of the musculoskeletal disorders among Ilam teaching hospitals nurses: a cross-sectional study in 2016. Annals of Tropical Medicine and Public Health, 10(6), pp.1729. [online] Available at: <https://doi.org/10.4103/atmph.atmph_619_17> [Accessed 21 August 2024]

Oo, T.W., 2021. Work-related musculoskeletal disorders, psychosocial factors, work productivity, and work ability among garment factory workers in myanmar. Chulalongkorn University Theses and Dissertations (Chula ETD). [e-journal] 4894. Available at: <https://digital.car.chula.ac.th/chulaetd/4894?utm_source=digital.car.chula.ac.th%2Fchulaetd%2F4894&utm_medium=PDF&utm_campaign=PDFCoverPages> [Accessed 14 April 2025]

Ou, Y. K., Liu, Y., Chang, Y. P., and Lee, B. O., 2021. Relationship between musculoskeletal disorders and work performance of nursing staff: a comparison of hospital nursing departments. International Journal of Environmental Research and Public Health, 18(13). [online] Available at: <https://doi.org/10.3390/ijerph18137085> [Accessed 21 August 2024]

Quiroz-Flores, J.C., Abásolo-Núñez, B., Suárez-Miñano, D. and Nallusamy, S., 2023. Minimization of personnel absenteeism with the application of proposed ergonomic model in a plastics manufacturing industry. Applied Sciences. [online] 13(13), p. 7858. Available at: <doi:https://doi.org/10.3390/app13137858.> [Accessed 13 April 2025]

Razak, M.S., Karuppiah, K., Mohd. Tamrin, S.B., and Mohammad Yusof, N.A.D., 2014. Occupational safety and health in commodity agriculture: case studies from a malaysian agricultural perspective. [e-journal] [Accessed 14 April 2025]

Rohani, J. M., Mohd-Zainal, A., Johari, M. F., Sirat, R. M., Zein, R. M., and Rahman, I. A., 2016. Analysis of compensation cost related to musculoskeletal disorders (msds) against younger and older malaysian manufacturing workers. International Conference on Industrial Engineering and Operations Management, pp. 1699–1702. [Accessed 14 April 2025]

Sarkar, K., Dev, S., Das, T., Chakrabarty, S. and Gangopadhyay, S., 2016. Examination of postures and frequency of musculoskeletal disorders among manual workers in calcutta, india. International Journal of Occupational and Environmental Health [online] 22(2), pp. 151–158. Available at: <doi:https://doi.org/10.1080/10773525.2016.1189682.> [Accessed 17 April 2025]

Shariat, A., Tamrin, S., Arumugam, M., and Ramasamy, R., 2016. The bahasa melayu version of cornell musculoskeletal discomfort questionnaire (cmdq): reliability and validity study in malaysia. IOS Press, 54(1), pp. 171-178. [online] Available at: <DOI: 10.3233/WOR-162269> [Accessed 21 August 2024]

Sormunen, E., Remes, J., Hassi, J., Pienimaki, T., and Rintamaki, H., 2009. Factors associated with self-estimated work ability and musculoskeletal symptoms among male and female workers in cooled food-processing facilities. Industrial Health. [e-journal] 47(4), p. 454. Available at: <doi:https://doi.org/10.2486/indhealth.47.454.> [Accessed 15 April 2025]

Summers, K., Jinnett, K., and Bevan, S., 2015. Musculoskeletal disorders, workforce health, and productivity in the united states. The work foundation. [online] Available at: <www.theworkfoundation.com> [Accessed 21 August 2024]

Tangchareonsamut, J., Wongrathanandha, C., Khamsee, S. and Aekplakorn, W., 2021. Association of work performance with absenteeism and presenteeism among support workers in a medical school hospital, Thailand. Journal of Health Research. [e-journal] Available at: <doi:https://doi.org/10.1108/jhr-01-2021-0045.> [Accessed 18 April 2025]

Van Eerd, D., Irvin, E., Le Pouésard, M., Butt, A., and Nasir, K., 2022. Workplace musculoskeletal disorder prevention practices and experiences. The Journal of Health Care Organization, Provision, and Financing, 59, pp. 1–13. [online] Available at: <https://doi.org/10.1177/00469580221092132> [Accessed 21 August 2024]

Varghese, E., Jaggi, S., Gills, R., and Jayasankar, J., n.d. Ibm spss statistics: an overview. In ICAR- Central Marine Fisheries Research Institute, pp. 62–82. [online] Available at: <https://www.cmfri.org.in/> [Accessed 20 August 2024]

Vingård, E., Alfredsson, L., Hagberg, M., Kilbom, Å., Theorell, T., Waldenström, M., Hjelm, E.W., Wiktorin, C. and Hogstedt, C., 2000. To what extent do current and past physical and psychosocial occupational factors explain care-seeking for low back pain in a working population? Spine. [e-journal] 25(4), pp. 493–500. Available at: <doi:https://doi.org/10.1097/00007632-200002150-00017.> [Accessed 11 April 2025]

Vitoulas, S., Konstantis, V., Drizi, I., Vrouva, S., Koumantakis, G.A. and Sakellari, V., 2022. The effect of physiotherapy interventions in the workplace through active micro-break activities for employees with standing and sedentary work. Healthcare. [e-journal] 10(10), p. 2073. Available at: <doi:https://doi.org/10.3390/healthcare10102073.> [Accessed 12 April 2025]

Wall Emerson, R., 2023. Mann-whitney u test and t-test. Journal of Visual Impairment & Blindness. [e-journal] 117(1), pp. 99–100. Available at: <doi:https://doi.org/10.1177/0145482x221150592.> [Accessed 11 April 2025]

Wang, T., Zhao, Y.-L., Hao, L.-X. and Jia, J.-G., 2019. Prevalence of musculoskeletal symptoms among industrial employees in a modern industrial region in beijing, china. Chinese Medical Journal. [e-journal] 132(7), pp. 789–797. Available at: <doi:https://doi.org/10.1097/cm9.0000000000000165.> [Accessed 13 April 2025]

Wardhono, A., and Lestari, Y., 2023. The understanding of research ethics reviewers on ethical clearance review process: a case study. International Joint Conference on Arts and Humanities 2023, pp. 417–425. [online] Available at: <https://doi.org/10.2991/978-2-38476-152-4_40> [Accessed 20 August 2024]

Yua, W., Yu, I.T.S., Li, Z., Wang, X., Sun, T., Lin, H., Wan, S., Qiu, H., and Xie, S., 2012. Work-related injuries and musculoskeletal disorders among factory workers in a major city of china. Accident Analysis and Prevention. [e-journal] 48, pp. 457-463. Available at: <doi:10.1016/j.aap.2012.03.001> [Accessed 14 April 2025]

Zainal Abidin, N., Mohd Rohani, J., Nadia Nordin, A., Md Zein, R., and Satik anak Ayak, A., 2018. Financial impact and causes of chronic musculoskeletal disease cases in malaysia based on the social security organization of malaysia claims record. International Journal of Engineering & Technology, 7, pp. 23–27. [online] Available at: <www.sciencepubco.com/index.php/IJET> [Accessed 19 August 2024]

Ziam, S., Lakhal, S., Laroche, E., Lane, J., Alderson, M., and Gagné, C., 2023. Musculoskeletal disorder (msd) prevention practices by nurses working in health care settings: facilitators and barriers to implementation. Applied

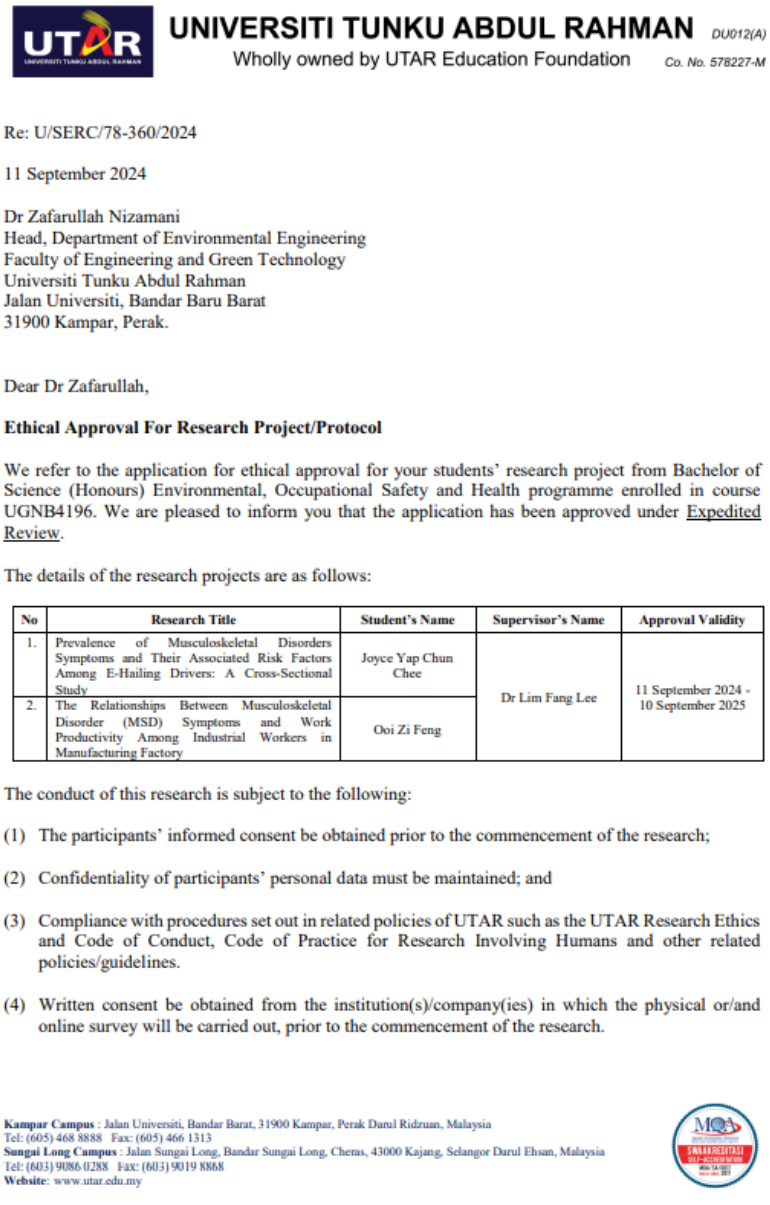
Ergonomics, 106. [online] Available at: <https://doi.org/10.1016/j.apergo.2022.103895> [Accessed 21 August 2024]

Zimbalist, A., Rempel, D., Feng, L. and Harris-Adamson, C. 2022. The association between forceful hand exertions and musculoskeletal disorders of the neck and shoulder: a prospective cohort study of us manufacturing workers. Journal of Occupational and Environmental Medicine [online] 64(10), pp. e613–e621. Available at: <doi:https://doi.org/10.1097/JOM.0000000000002646.> [Accessed 17 April 2025]

ZulArdi, S. and Sari, R.P., 2023. Work posture and smoking habits in relation to musculoskeletal disorders (msds) complaints among construction workers at dewi sinta residence housing project, gunung kidul regency. Periodicals of Occupational Safety and Health. [e-journal] 2(2), pp. 105–112. Available at: <doi:https://doi.org/10.12928/posh.v2i2.9239.> [Accessed 12 April 2025]

APPENDICES

APPENDIX A: Ethical Approval Letter



UNIVERSITI TUNKU ABDUL RAHMAN DU012(A)
Wholly owned by UTAR Education Foundation Co. No. 578227-M

Re: U/SERC/78-360/2024

11 September 2024

Dr Zafarullah Nizamani
Head, Department of Environmental Engineering
Faculty of Engineering and Green Technology
Universiti Tunku Abdul Rahman
Jalan Universiti, Bandar Baru Barat
31900 Kampar, Perak.

Dear Dr Zafarullah,

Ethical Approval For Research Project/Protocol

We refer to the application for ethical approval for your students' research project from Bachelor of Science (Honours) Environmental, Occupational Safety and Health programme enrolled in course UGNB4196. We are pleased to inform you that the application has been approved under Expedited Review.

The details of the research projects are as follows:

No	Research Title	Student's Name	Supervisor's Name	Approval Validity
1.	Prevalence of Musculoskeletal Disorders Symptoms and Their Associated Risk Factors Among E-Hailing Drivers: A Cross-Sectional Study	Joyce Yap Chun Chee	Dr Lim Fang Lee	11 September 2024 - 10 September 2025
2.	The Relationships Between Musculoskeletal Disorder (MSD) Symptoms and Work Productivity Among Industrial Workers in Manufacturing Factory	Ooi Zi Feng		

The conduct of this research is subject to the following:

(1) The participants' informed consent be obtained prior to the commencement of the research;

(2) Confidentiality of participants' personal data must be maintained; and

(3) Compliance with procedures set out in related policies of UTAR such as the UTAR Research Ethics and Code of Conduct, Code of Practice for Research Involving Humans and other related policies/guidelines.

(4) Written consent be obtained from the institution(s)/company(ies) in which the physical or/and online survey will be carried out, prior to the commencement of the research.

Kampar Campus : Jalan Universiti, Bandar Barat, 31900 Kampar, Perak Darul Ridzuan, Malaysia
Tel: (605) 468 8888 Fax: (605) 466 1313
Sungai Long Campus : Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor Darul Ehsan, Malaysia
Tel: (603) 9086 0288 Fax: (603) 9019 8868
Website: www.utar.edu.my

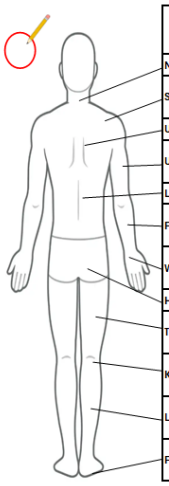
Figure 1: Ethical approval letter

APPENDIX B: Questionnaires

Name:_____ Age:_____ Section/Line:_____ Serial Number:

Please tick in the box(es) if you experienced any:

1. Circle the body part(s) if you have previous injuries:



		2. During the last work week how often did you experience ache, pain, discomfort in:					3. If you experienced ache, pain, discomfort, how uncomfortable was this?			4. If you experienced ache, pain, discomfort, did this interfere with your ability of work?			5. If you experienced ache, pain, discomfort, how much did this affect your work quantity or quality? "0": No Output / Low Quality "5": Normal Output / Normal Quality					
	☑	Never	1-2 times last week	3-4 times last week	Once every day	Several time every day	Slightly Uncomfortable	Moderate Uncomfortable	Very Uncomfortable	Not at all	Slightly interfered	Substantially interfered	0	1	2	3	4	5
Neck		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hip/Buttock		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Foot	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

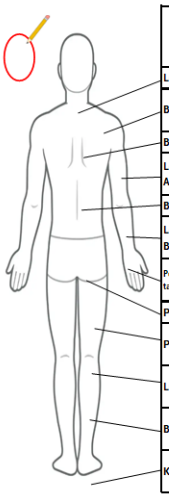
6. Have you take any sick leave in the past month due to the Musculoskeletal Disorders (MSDs) symptoms? ☐ Yes ☐ No

Figure 2: Modified Cornell Discomfort Questionnaire English version

Nama:_____ Umur:_____ Bahagian/Seksyen:_____ No. Siri:

Sila tandakan dalam kotak jika anda mengalami sebarang:

1. Bulatkan bahagian badan jika anda pernah mengalami kecederaan:



		2. Sepanjang minggu bekerja yang lepas, berapa kerapkah anda mengalami kesakitan atau ketidak selesaan di:					3. Jika anda mengalami kesakitan atau ketidak selesaan, bagaimanakah tahapnya?			4. Jika anda mengalami kesakitan atau ketidak selesaan, adakah ia mengganggu kebolehan anda untuk bekerja?			5. Jika anda mengalami kesakitan dan ketidakselesaan, sejauh manakah ia menjejaskan kuantiti atau kualiti kerja anda? "0": Tiada Hasil / Kualiti Rendah "5": Hasil Normal / Kualiti Normal					
	☑	Tidak pernah	1-2 kali minggu lepas	3-4 kali minggu lepas	Sekali setiap hari	Berapa kali setiap hari	Sedikit kurang menyenangkan	Agak tidak menyenangkan	Sangat tidak menyenangkan	Tidak sama sekali	Sedikit mengganggu	Sangat mengganggu	0	1	2	3	4	5
Leher		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bahu	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Belakang Atas		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan Atas	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Belakang Bawah		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan Bawah	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pergelangan tangan	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pinggul/Punggung		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Peha	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lutut	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Betis	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kaki Bawah	(Kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Pernahkah anda mengambil cuti sakit dalam sebulan yang lalu kerana gejala Gangguan Muskuloskeletal? ☐ Ya ☐ Tidak

Figure 3: Modified Cornell Discomfort Questionnaire Bahasa Malaysia version

Section 1a: Sociodemographic information

1)

Name *

Short-answer text

2)

Age *

Short-answer text

3)

Weight (kg) *

Short-answer text

4)

Height (cm) *

Short-answer text

5)

Highest education background *

- ○ Did not attend to formal education institutions
- ○ Primary school
- ○ Secondary school
- ○ Pre-university, technical or vocational school or college (e.g. STPM, UEC, A-level, Foundation, Diploma, et...
- ○ University

6)

Smoking status *

- ○ Yes
- ○ Ex-smoker
- ○ No

7)

Current Medical History *

- ○ None
- ○ Diabetes mellitus
- ○ Thyroid disease
- ○ Arthritis (Joint inflammation)
- ○ Hypertension
- ○ Other...

8)

Frequency of physical activity during leisure time per week (Example of physical activity: sports participation, exercise conditioning or training, and recreational activities)

- None
- 1 - 2 times
- 3 - 4 times
- > 5 times

9)

Duration of physical activity during leisure time per week (hours) *

- None
- < 1 hour
- 1 - 2 hours
- 3 - 4 hours
- > 4 hours

Figure 4 - 6: Sociodemographic information questions

Section 1b: Employment history

1)

Working year(s) in current job position *

- < 1 year
- 1 - 10 years
- 11 - 20 years
- 21 - 30 years
- > 30 years

2)

Daily working duration (hours) including lunch hours *

- 8 hours
- 9 hours
- 10 hours
- > 10 hours

3)

How frequent do you take microbreak other than morning, lunch, and tea break? (Microbreak, Example: 5 minutes break away from work) *

- None
- 1 - 2 times
- 3 - 4 times
- 5 - 6 times
- > 6 times

Figure 7 - 9: Employment history questions