UNIVERSITI PUTRA MALAYSIA

RISK FACTORS ASSOCIATED WITH MUSCULOSKELETAL DISORDER (MSD) AMONG FACTORY WORKERS IN NILAI, NEGERI SEMBILAN.

CHEN TECK HSIN

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ABSTRACT

RISK FACTORS ASSOCIATED WITH MUSCULOSKELETAL DISORDER (MSD) AMONG FACTORY WORKERS IN NILAI, NEGERI SEMBILAN.

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Introduction: According to Centers for Disease Control and Prevention, Musculoskeletal Disorders (MSD) are diseases and discomfort which are caused by, or are related with injuries of muscles, tendons, joints, nerves, cartilage and spinal discs (CDC, 2022). The prevalence of Musculoskeletal Disorder (MSD) was relatively high in the modern society, which the recent analysis of Global Burden of Disease (GBD) from World Health Organisation (WHO) showed that around 1.71 billion people around the globe have musculoskeletal conditions (WHO, 2021). Musculoskeletal Disorder (MSD) are usually associated with work activities as causal factor. According to Department of Occupational Safety and Health, Malaysia (2021), occupational musculoskeletal disorders cases were 126 cases (3.2%) out of all 3890 occupational disease cases being reported in the year of 2017, which takes place as the second highest occupational disease amongst all. This situation indeed confirmed that musculoskeletal disorders (MSD) are a relatively common occupational disease among workers at the workplace. Thus, it is important for us to learn and discern the common symptoms and causes of Musculoskeletal Disorder (MSD) in order to prevent the workers to become a victim of it. **Objective**: To determine the association between the work-related and individual-related risk factors with prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan. **Methodology**: The study design used for this research is cross-sectional study. The study location is located at Coca-Cola Far East Limited, Nilai, Negeri Sembilan during 1st August 2022 till 30th September 2022. 119 factory workers who aged between 18-60 years old and are full time workers were selected respondents. A set of self-administered questionnaire and Cornell Musculoskeletal Disorder Questionnaire (CMDQ) were distributed to obtain information from the respondents. **Result & Discussion:** Overall prevalence of MSD symptoms is high (91.4%) among the factory workers. The body part with highest prevalence of MSD is lower back (57.1%), followed by shoulders (55.2%) and upper back (50.5%). Majority of the factory workers are from age group of 30-39 years old (62.86%), followed by 40-49 years old (20.95%) and 18-29 years old (16.19%). Pearson's Chi-Square test shown that age, gender, awkward posture and static and sustained posture had significant association with the development of MSD among the factory workers. The p-value for age is 0.030 ($p<0.05$), gender is 0.006 ($p<0.01$), awkward posture is 0.001 ($p<0.01$) and p-value for static and sustained posture is <0.001 ($p<0.01$). Multiple Logistic Regression result showed that male factory workers are 2.51 times (95% CI 1.791 – 3.540) more likely to develop MSD. Awkward posture can also increase the likelihood of factory workers to develop MSD at 8.090 times (95% CI 2.805 – 22.045). Lastly, static and sustained posture can increase the likelihood of developing MSD to 3.274 times (95% CI 2.134 – 4.741). **Conclusion**: The study outcome indicated that the prevalence of MSD was high (91.4%) among the factory workers. The significant risk factors that are associated with MSD are age, gender, awkward posture and static and sustained posture.

Keywords: *musculoskeletal disorder, work-related risk factors, individual-related risk factors, occupational health*

ABSTRAK

FAKTOR RISIKO YANG BERKAITAN DENGAN GANGGUAN OTOT-SENDI (MSD) DI KALANGAN PEKERJA KILANG DI NILAI, NEGERI SEMBILAN.

CHEN TECK HSIN

Pengenalan: Menurut Pusat Kawalan Penyakit, Gangguan Otot-Sendi (MSD) adalah penyakit dan ketidakselesaan yang disebabkan oleh atau berkaitan dengan kecederaan otot, tendon, sendi, saraf, cartilage dan cakera spinal (CDC, 2022). Kejadian Gangguan Otot-Sendi (MSD) cukup tinggi dalam masyarakat moden, yang ditunjukkan oleh analisis Beban Global Penyakit (GBD) dari Pertubuhan Kesihatan Sedunia (WHO) yang menunjukkan bahawa sekitar 1.71 bilion orang di seluruh dunia mempunyai keadaan otot-sendi (WHO, 2021). Gangguan Otot-Sendi (MSD) biasanya berkaitan dengan aktiviti kerja sebagai faktor punca. Menurut Jabatan Keselamatan dan Kesihatan Pekerjaan, Malaysia (2021), kes gangguan otot-sendi kerja adalah 126 kes (3.2%) dari kes semua 3890 kes penyakit kerja yang dilaporkan pada tahun 2017, yang menjadi penyakit kerja kedua tertinggi di kalangan semua. Keadaan ini memang mengesahkan bahawa gangguan otot-sendi (MSD) adalah penyakit kerja yang agak biasa di kalangan pekerja di tempat kerja. Oleh itu, adalah penting bagi kita untuk belajar dan memahami gejala dan punca biasa Gangguan Otot-Sendi (MSD) untuk mengelakkan pekerja menjadi mangsa. **Objektif**: Untuk menentukan hubungan antara faktor risiko kerja dan individu dengan kejadian Gangguan Otot-Sendi (MSD) di kalangan pekerja kilang di Nilai, Negeri Sembilan. **Metodologi**: Reka bentuk kajian yang digunakan untuk kajian ini adalah kajian bersepadu. Lokasi kajian terletak di Coca-Cola Far East Limited, Nilai, Negeri Sembilan semasa 1 Ogos 2022 hingga 30 September 2022. 119 pekerja kilang yang berusia antara 18-60 tahun dan pekerja sepenuh masa dipilih sebagai responden. Satu set soal selidik yang diautomasikan dan Cornell Musculoskeletal Disorder Questionnaire (CMDQ) didistribusikan untuk mendapatkan maklumat dari responden. **Keputusan & Perbincangan**: Kejadian MSD secara keseluruhan adalah tinggi (91.4%) di kalangan pekerja kilang. Bahagian badan dengan kejadian MSD tertinggi adalah belakang bawah (57.1%), diikuti bahu (55.2%) dan belakang atas (50.5%). Kebanyakan pekerja kilang berusia dalam kumpulan umur 30-39 tahun (62.86%), diikuti oleh 40-49 tahun (20.95%) dan 18-29 tahun (16.19%). Ujian Chi-Square Pearson menunjukkan bahawa umur, jantina, postur yang kurang sesuai dan postur statik dan berterusan mempunyai hubungan yang signifikan dengan perkembangan MSD di kalangan pekerja kilang. Nilai p untuk umur adalah 0.030 ($p < 0.05$), jantina adalah 0.006 ($p < 0.01$), postur yang kurang sesuai adalah 0.001 ($p < 0.01$) dan nilai p untuk postur statik dan berterusan adalah <0.001 ($p < 0.01$). Keputusan Regresi Logistik Berbilang menunjukkan bahawa pekerja kilang lelaki 2.51 kali (95% CI 1.791 - 3.540) lebih cenderung untuk mengalami MSD. Postur yang kurang sesuai juga boleh meningkatkan kemungkinan pekerja kilang untuk mengalami MSD sebanyak 8.090 kali (95% CI 2.805 - 22.045). Terakhir, postur statik dan berterusan boleh meningkatkan kemungkinan untuk mengalami MSD sebanyak 3.274 kali (95% CI 2.134 - 4.741). **Kesimpulan**: Hasil kajian menunjukkan bahawa kejadian MSD tinggi (91.4%) di kalangan pekerja kilang. Faktor risiko yang signifikan yang berkaitan dengan MSD adalah umur, jantina, postur yang kurang sesuai dan postur statik dan berterusan.

Kata kunci: *gangguan otot-sendi, faktor risiko berkaitan kerja, faktor risiko berkaitan individu, kesihatan kerja.*

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CMDQ	Cornell Musculoskeletal Discomfort Questionnaire
DOSH	Department of Occupational Safety and Health
MSD	Musculoskeletal Disorder
OSHA	Occupational Safety and Health Act
PPE	Personal Protective Equipment
SPSS	Statistical Package for the Social Sciences
UEMSD	Upper Extremities Musculoskeletal Disorder
WHO	World Health Organization
WMSD	Work-related musculoskeletal disorder
UPM	Universiti Putra Malaysia

CHAPTER 1

INTRODUCTION

1.1 Research Background

According to Centers for Disease Control and Prevention, Musculoskeletal Disorders (MSD) are diseases and discomfort which are caused by, or are related with injuries of muscles, tendons, joints, nerves, cartilage and spinal discs (CDC, 2022). According to Guidelines on Ergonomics Risk Assessment at Workplace 2017, musculoskeletal disorders are disorders that affect the affect human musculoskeletal health, whereby the common affected soft tissues are muscle, ligament, tendons, nerves, spinal disc and bursa sacs (Guidelines on Ergonomics Risk Assessment at Workplace, 2017). Musculoskeletal Disorders (MSD) such as low back pain, arthritis and sarcopenia are some of the common disorders or conditions faced by many individuals at present days. To elaborate, the prevalence of Musculoskeletal Disorder (MSD) was relatively high in the modern society, which the recent analysis of Global Burden of Disease (GBD) from World Health Organisation (WHO) showed that around 1.71 billion people around the globe have musculoskeletal conditions (WHO, 2021). Musculoskeletal Disease (MSD) are commonly characterized by localised and persistent pain, limitation in mobility and reduction of agility in conducting work. This condition can be attributable to injuries on our joints, bones, muscles, spine and multiple body areas or systems (WHO, 2021). Musculoskeletal Disorder (MSD) are usually associated with work activities as causal factor. According to Department of Occupational Safety and Health, Malaysia (2021), occupational musculoskeletal disorders cases were 126 cases (3.2%) out of all 3890 occupational disease cases being reported in the year of 2017, which takes place as the second highest occupational disease amongst all. This situation indeed confirmed that musculoskeletal disorders (MSD) are a relatively common occupational disease among workers at the workplace. Thus, it is important for us to learn and discern the common symptoms and causes of Musculoskeletal Disorder (MSD) in order to prevent the workers to become a victim of it.

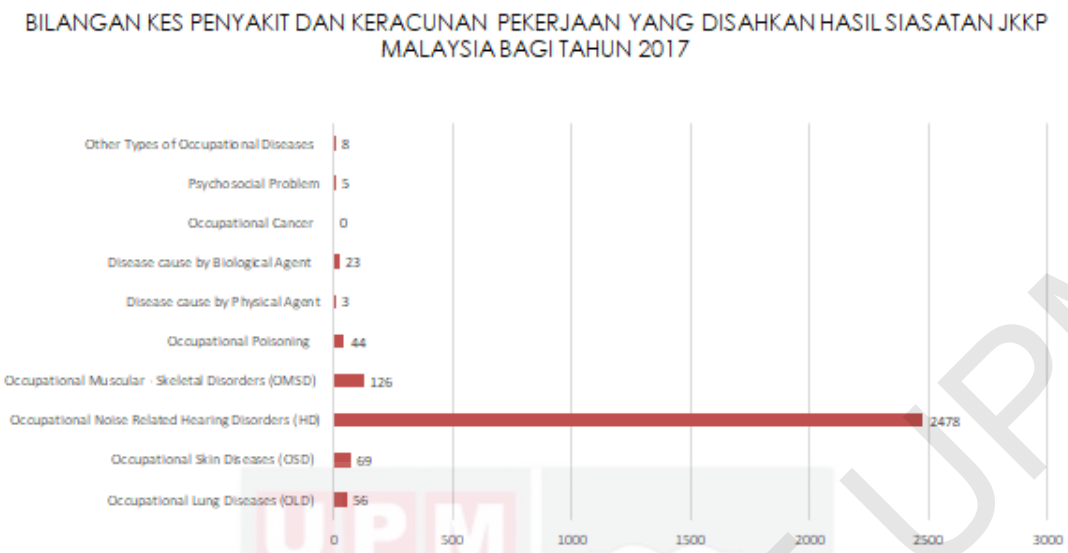

Figure 1.1: Figure of occupational disease in year 2017.

Musculoskeletal Disorder (MSD) is one of the major causes of sickness and disability among the occupational populations (Burdorf & van der Beek, 1999). Among some of the common Musculoskeletal Disorder (MSD) that are troubling the occupational populations are upper limb musculoskeletal disorders, such as rotator cuff tendonitis, epicondylitis, and carpal tunnel syndrome (Mani & Gerr, 2000). Besides, work related Musculoskeletal Disorders (WMSD) can also bring effect to elbows, arms, shoulders, wrists, back, hands, leg and feet, which can lead to symptoms including tenderness, aches, pains, stiffness, swellings, muscle spas, as well as lower and upper back pain (Kawade et al, 2022). As a result, in order to prevent the occurrence of Musculoskeletal Disorders (MSD), we must be able to recognise and assess the potential risk factors for Musculoskeletal Disorders (MSD) so that we can intervene early. It is common that development Musculoskeletal Disorders (MSD) at workplace are associated with heavy physical work, smoking activity, high body mass index, high psychosocial work demands and existence of co-morbidities (da Costa & Vieira, 2009). To top on that, evidence shows that overexertion was the leading cause of Work-Related Musculoskeletal Disorders (WMSDs) in construction, with back injuries accounting for more than 40% of WMSDs among construction workers (Wang et al., 2016). Needless to say, these disorders can cause discomfort and in worse condition, causing physical disability among the workers. As evidence to support the statement, a study from Roux (2005) shows that Musculoskeletal Disorders (MSD) have a significant negative impact on the physical domain of quality of life.

1.2 Problem Statement

Manufacturing industries grow at a fast pace in Malaysia, where the manufacturing sales grew 15.3% in March 2021, the highest among the past 44 months, where the Transportation Equipment & Other Manufactures Products (34.2%), Electrical & Electronics Products (17.0%), and Food, Beverages & Tobacco Products (17.0%) all contributed to the growth in sales value in March 2021 (DOSM, 2022). Also, according to the statistic reported by Department of Statistics Malaysia Official Portal. (2022), the number of workers involved in the manufacturing industries are up to 2,233,545 people.

Factory workers are of high susceptibility to be diagnosed with Musculoskeletal Disorder (MSD). To further elaborate, according to Yu et al. (2012), 8.3 percent of all workers who took part in the study mentioned that they had suffered an acute traumatic injury in the preceding year. The incidence rate based on events was 119.6 per 1000 person-years and approximately half of frontline workers said they had suffered from MSDs in the previous year. Also, according to a research, Musculoskeletal Disorders (MSD) are the leading cause of occupational disorders and disability in developing nations, and they are strongly linked to socioeconomic burdens on individuals, organisations, and society as a whole (Aghilinejad et al., 2012). Data collected also shown that the the industrial industry had the most incidences of occupational sickness and poisoning in 2017, with 3349 cases (86.1%), followed by the mining sectors, which had 117 instances (3.01%), and the public service sectors, which had 116 cases (2.98%) (DOSH, 2021).

Figure 1.2: Figure of Analysis of Occupational Disease and Poisoning by sector.

Musculoskeletal Disorder (MSD) can cause chronic pain among the patients, causing their daily lives to be affected and daily activities to be restricted. In the year 2017, musculoskeletal diseases had resulted in 121.3 thousand fatalities and 138.7 million Disability-Adjusted Life Years (DALYs) globally (Safiri et al., 2021). In addition to that, Musculoskeletal Disorders (MSD) can also be related to mental health decline and deterioration in body functions (WHO, 2021).

According to a study, MSDs were prevalent in a large percentage of the workers (76.97%) in Malaysia, where the neck had the highest prevalence of MSDs in the last twelve months (49.3%), followed by the hand/wrist (48.0%), and the shoulder (46.7%) (Nur et al., 2014). Another study in Malaysia also shown that the prevalence of musculoskeletal disorders among semiconductor women workers was high, and there was a significant link between work-related musculoskeletal pain and long periods of time spent in certain postures and activities (Chandrasakaran., 2003). Latest study shows that the highest prevalence of work-related musculoskeletal disorders among workers in food manufacturing factories in Hulu Langat, Selangor, Malaysia within the past 12 months was ankles/feet (46.2%), followed by wrist/hands (45.6%), elbow (40.9%), shoulders (31.1%), lower back (28%), neck (25%), knee (20.5%), hips/thighs (15.2%) and the lowest was the upper back (10.6%) (Ahmad et al., 2021). Thus, by looking at the high prevalence of MSD among factory workers in Malaysia, there is indeed a need to conduct research and study on the related field to help us understand more on the risk factors as we can effectively prevent the increase of MSD cases among factory workers in our country.

1.3 Study Justification

This study is designed to study the prevalence of Musculoskeletal Disorders (MSD) and associated risk factors among the workers at Coca-Cola Far East Limited, Nilai. Musculoskeletal Disorders (MSD) are caused by disorders or damages on the tendons, ligaments, muscles, nerves and blood vessels, which can lead to restriction of movement on human body and injury to the musculoskeletal system. Musculoskeletal Disorders (MSD) are commonly associated with work-related risk factors and the regular work-related Musculoskeletal Disorders (MSD) includes Carpal Tunnel Syndrome (CTS), Epicondylitis, tendinitis and Rotator cuff injuries (United States Department of Labor, 2012).

The overall prevalence of Musculoskeletal Disorder (MSD) among factory workers in Malaysia is high. To elaborate, study had shown that musculoskeletal complaints were found in 79.6% of Malaysian worker at a printing manufacturing company, where the workers reported lower back (48.0 %), shoulders (44..4%), knees (32.8%), and neck (29.6%) (Foong et al., 2014). Another research also found that the occurrence of musculoskeletal discomfort has become a serious concern for industrial organisations in Malaysia, which rely heavily on manual labour (Hazana Abdullah et al., 2018). Moreover, a study in Malaysia also discovered that 30 of the 36 participants had developed Work-Related Musculoskeletal Disorders (WMSDs), particularly in the shoulder, wrists, and lower back and the risk of WMDs has been detected in the unloading, pressing, and winding processes (Yahya & Zahid, 2018).

Furthermore, it is a known fact that Musculoskeletal Disorders (MSD) can cause significant complications on the physical, financial and mental health of an individual, as it lowers job productivity, increase frequency of medical visits, raise the medical compensation cost for the organisations and lower quality of life of an individual (Hendi et al., 2021). Therefore, another intention of this study is to provide sufficient and quality data to assist the relevant authorities in planning future intervention programmes in hopes to effectively control the incidence of Musculoskeletal Disorders (MSD) among factory workers. By utilising the data collected from this study, relevant authorities or government bodies could improve their corresponding treatments programmes, facilities, intervention programmes and community health program management accordingly. This could cause the threshold of pain and disability among the factory workers to be shifted, causing lesser factory workers to have to suffer from Musculoskeletal Disorders (MSD) in the future.

1.4 Research Question

This study raises a number of issues, where each issue was formulated to address the corresponding research variables and objectives. The following are the primary issues that will be addressed in this study:

i. Is there any association between the prevalence of Musculoskeletal Disorders (MSD) with work-related factors?
ii. Is there any association between the prevalence of Musculoskeletal Disorders (MSD) with individual-related factors?

1.5 Research Objectives

The main objective of this research is to determine the association between the work-related and individual-related risk factors with prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan.

The specific objectives of this study are as follow:

i. To identify the prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan.
ii. To determine the association between the prevalence of Musculoskeletal Disorders (MSD) with individual-related factors.
iii. To determine the association between the prevalence of Musculoskeletal Disorders (MSD) with work-related factors.

1.6 Research Hypothesis

i. There is a significant association between prevalence of Musculoskeletal Disorders (MSD) with all work-related factors.
ii. There is a significant association between prevalence of Musculoskeletal Disorders (MSD) with all individual-related factors.

1.7 Study Variables

i. **Independent variable**: Work-related factors (Awkward Posture, Forceful Exertion, Repetitive Motion, Static and Sustained Posture, Contact Stress, Vibration) and individual-related factors (Age, Gender, Body Mass Index).

ii. **Dependent variable**: Prevalence of Musculoskeletal Disorders (MSD) among factory workers in Coca-Cola Far East Limited, Nilai, Negeri Sembilan.

1.8 Definition of Terms

Research Title: **Risk Factors** Associated with **Musculoskeletal Disorders (MSD)** among **Factory Workers** in Nilai, Negeri Sembilan.

i. Term: **Risk Factors.**

- **Conceptual definition:** Risk factors are the something or causative elements that makes an individual more likely to develop a disease (NCI Dictionary of Cancer Terms, 2022).
- **Operational definition:** Risk factors are the factors that are associated with the increased probability of certain outcomes, where in this scenario are work-related risk factors (Awkward Posture, Forceful Exertion, Repetitive Motion, Static and Sustained Posture, Contact Stress, Vibration) and individual-related factors (Age, Gender, BMI), which will be identified in the self-administered questionnaire.

ii. Term: **Musculoskeletal Disorder (MSD).**

- **Conceptual definition:** Musculoskeletal Disorders (MSD) are disorders that affect the muscles, nerves, tendons, joints, cartilage, and spinal discs of human body (CDC, 2022).
- **Operational definition:** Musculoskeletal Disorders (MSD) are identified by using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). The respondents will respond to the questions on the questionnaire and respondents that have subjected to one or more trouble in any body parts will be identified as having Musculoskeletal Disorders (MSD).

1.9 Conceptual Framework

The interest of this study was to determine the risk factors of MSD among factory workers. The risk factors can be divided into four categories, which are environmental, psychosocial, individual-related and work-related risk factors. The common environmental risk factors of MSD were extreme temperature, lighting, noise and indoor air quality. Furthermore, the common psychosocial risk factors of MSD include depression, maladaptive pain responses and impact on work capacity and quality. However, this research will not be focussed on the environmental and psychosocial risk factors but only the individual and work-related risk factors as these two factors were not included in the scope of interest of this study. On the contrary, individual-related risk factors and work-related risk factors were studied and association were investigated to determine the association of the risk factors within the two groups, namely individual-related risk factors and work-related risk factors group with the development of MSD among the factory workers. The individual-related risk factors that were studied in this research include age, gender and Body Mass Index (BMI), while the work-related risk factors that were investigated in this research were awkward posture, forceful exertion, repetitive motion, static and sustained posture, contact stress and vibration.

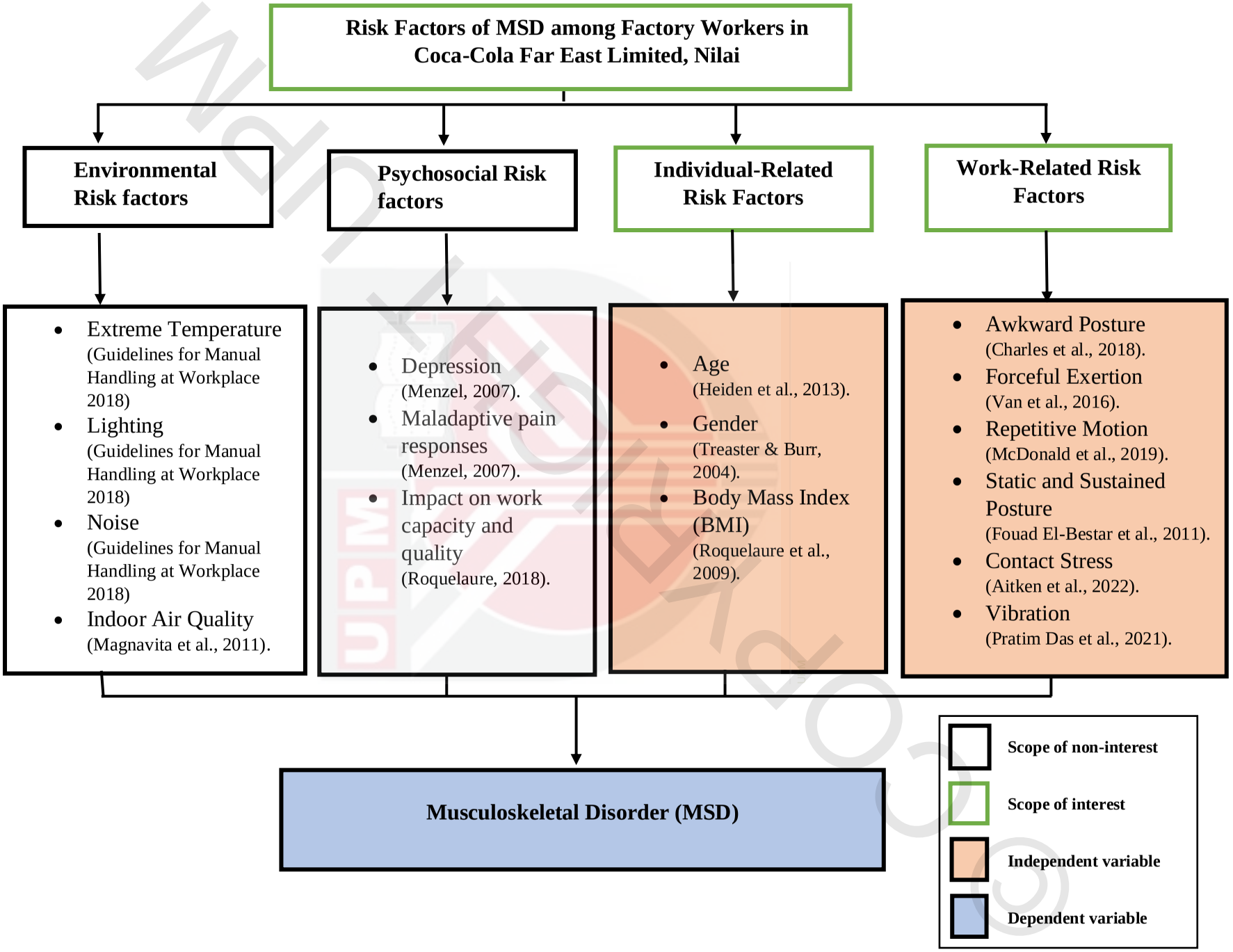

Figure 1.3: Conceptual Framework

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discuss about the overview of Musculoskeletal Disorder (MSD) and its associated risk factors. The findings and results from other researchers' studies that are in relation with Musculoskeletal Disorder (MSD) were read and explained in detail. Literature review was to be done so that recommendations from previous research could be identified, which helps in reducing mistakes and able to ensure the current study can be conducted successfully. It is also important to conduct literature review on studies that are closely related to our research, so that we can prevent conducting similar research as it indeed is an act that wastes resources and time. In this chapter, the following topics will be reviewed and discussed, namely Musculoskeletal Disorders (MSD), work-related risk factors associated with MSD such as awkward posture, forceful exertion, repetitive motion, static and sustained posture, contact, stress, vibration and lastly individual related risk factors associated with MSD which are age, gender and BMI.

2.2 Musculoskeletal Disorders (MSD)

Musculoskeletal Disorder (MSD) are disease that affect the bones, joints, muscles, and connective tissues (National Academies of Sciences, Engineering, and Medicine et al., 2020). Musculoskeletal Disorder (MSD) are usually associated with pain (persistent) which limits the mobility, dexterity, general level of functioning and a people's capacity to work (WHO, 2021). Musculoskeletal Disorders (MSD) are disorders cause by physiological reaction to an incident or exposure to over bodily reaction and the common examples of MSD are back pain, sprains, strains, carpal tunnel syndrome and hernia (CDC, 2020).

In year 2017, there were 336.5 million cases of various Musculoskeletal diseases, with an age-standardized point prevalence estimate of 4151.1 per 100 000 (Safiri et al., 2020). This indicates that the Despite the fact that the prevalence of most musculoskeletal diseases and chronic pain increases with age, chronic pain is also commonly associated with work as a risk

factor. Research had showed that workers generally experienced mild musculoskeletal pain in numerous body locations, with the lower back region being the most affected, followed by the neck, upper back, and knee regions (Gaikwad, 2022). Because of the pain and exhaustion caused by Musculoskeletal Disorder (MSD), the workers were forced to change their physical and social activities as well as employment options. According to the Global Burden of Disease 2010 Study, musculoskeletal disorders are the fourth leading cause of disability worldwide, accounting for 21.3 percent of years lived with disability (Bervoets et al., 2015). This result indeed indicates that MSD could have a significant impact on workers' overall health.

The common effects of work-related Musculoskeletal Disorders (MSD) can be observed on lower back, neck, and upper and lower extremities of the employees (Hossain et al., 2018). Soft tissue disorders that affect the neck area, shoulders, arms, wrists, hands, and fingers are referred as UEMSDs, while Carpal tunnel syndrome, epicondylitis, neck tension syndrome, tendinitis, tenosynovitis, thoracic outlet syndrome, and white finger are all common diagnoses of UEMSDs. On the other hand, back injury is of the highest prevalence injured body parts amongst all (22% of 1 million injuries). While the common cause of back injury is overexertion, activities such as kneeling or squatting, climbing stairs or ladders, heavy lifting, walking and standing are believed to be the origin of lower limb injuries (Gasibat et al., 2017).

Musculoskeletal Disorders (MSD) were commonly treated with non-steroidal anti-inflammatory drugs (NSAIDs). According to a recent study, nonsteroidal anti-inflammatory medicines (NSAIDs) were the common treatment used to treat Musculoskeletal Disorders (MSD), which 42.0 percent of patients prefers nonsteroidal anti-inflammatory medicines (NSAIDs) over analgesics, muscle relaxants, and disease-modifying antirheumatic therapies (DMARDs) (Guevara-Pacheco et al., 2016). Besides, massage therapy is also one of the treatment solutions to relief the chronic pain or pain flare of Musculoskeletal Disorders (MSD). Massage therapy has become a widely accepted treatment for musculoskeletal diseases due to its appeal for pain alleviation and body function improvement. To elaborate, massage treatment was used by 87 percent of individuals with problems of the arm, neck, and or shoulder (Bervoets et al., 2015).

Malaysia has seen an upward trend in Musculoskeletal Disorder (MSD) in recent years, particularly in the manufacturing sector (Shamsudin Mohd Zubairy et al., 2017). According to statistics reported in Social Security Organisation (SOCSO) annual report, the number of Occupational Musculoskeletal Disorders being reported in year of 2018 were 1151 while the

number of reported Occupational Musculoskeletal Disorder cases had increased to 1369 in the year 2019, with 218 cases increment in a year's time (SOCSO, 2019). To elaborate, a study had suggested that the prevalence of musculoskeletal disorders among semiconductor women workers in Malaysia was high, and there was a definite link between work-related musculoskeletal pain and long periods of time spent in certain postures and activities at the workplace, where the most cases of MSD were reported regarding back discomfort (57.8%), followed by lower leg discomfort (48.4%), shoulder discomfort (44.8%), upper leg discomfort (38.8%) and lastly neck discomfort (29.7%) (Chee & Rampal, 2004). Another study also suggested that almost a third of the workers in an automotive manufacturing company had reported that they were experiencing upper and lower backs discomfort, in particularly 41 workers (8.2%) reported extremely uncomfortable at lower back area, 33 workers (6.6%) reported extremely uncomfortable at feet or ankle and 25 workers (5.0%) reported extremely uncomfortable at knee area (Deros, 2010). Another finding revealed that factory employees in Malaysia had a high prevalence rate of musculoskeletal disorder (45.4%). Among the most prevalent MSD among workers is at shoulder (21.8%), followed by lower back (18.7%), upper back (14%), and neck region (13.6%) (Lim & Vinodhkumar, 2019). According to Foong et al., (2014), musculoskeletal disorders were found in 79.6% of production line workers in a printing manufacturing company in Malaysia. Among the highest prevalence of MSD at this factory was lower back pain (48.0 %), shoulders discomfort (44.4 %), knees discomfort (32.8 %), and neck discomfort (29.6 %).

2.3 Risk Factors of Musculoskeletal Disorders (MSD)

2.3.1 Work-Related Risk Factors

The work-related risk factors of Musculoskeletal Disorders (MSD) being discussed in this study comprise of six main components, namely awkward posture, forceful exertion, repetitive motion, static and sustained posture, contact stress and vibration.

2.3.1.1 Awkward Posture

According to Centers for Disease Control and Prevention's (CDC), one of the main risk factors of Musculoskeletal Disorder (MSD) is working in an awkward or unnatural position for

a prolonged period of time, for example crawling and kneeling (CDC, 2022). In a systematic review, it had proven that exposure to vibration and awkward working postures, and various other physical variables were linked to MSDs of the shoulder and neck. This is because the awkward posture might increase the physical stress on our body tissue yet increasing its load tolerance. For instance, when the hand and arm are in an awkward overhead position, such as when hanging a light fixture from the ceiling, the stress on the shoulder is significantly raised, and blood flow in the hand–arm system is significantly reduced. Hence, due to the increased physical load and reduced blood circulation on the affected tissue, awkward position can significantly increase the risk of developing MSD (Charles et al., 2018). In a recent study, data also suggested that awkward posture is significantly associated with MSD ($\chi 2 = 65.37$, $p < 0.001$), as workers in assembly line of an automotive industry suggested that high Rapid Upper Limb Assessment (RULA) result will have 69 times (OR=69.38, 95% CI 14.51-331.73) higher odds of workers complaining suffering from MSD (Anita et al., 2014). Another study had also suggested that the adjusted odds ratio associated between Upper Extremities Musculoskeletal Disorder (UEMSD) and awkward posture of wrist is 2.37 (95% CI: 1.28–4.37) (Pullopdissakul et al., 2013).

2.3.1.2 Forceful Exertion

Forceful exertion is physical force that is required to carried out tasks such as lifting heavy objects and maintaining control over equipment. The prolonged exposure to forceful exertion and insufficient recovery time is one of the causes that can lead to musculoskeletal disorders (Ergonomics | Environmental, Health and Safety Services | Virginia Tech, 2022). To elaborate, a study had showed that lower back pain was more common in participants who worked with forceful exertion (AOR=2.45, 95 percent CI: 1.683.59) than in subjects who did not work with forceful exertion (Van et al., 2016). Besides, another study also portray significance between Upper Extremities Musculoskeletal Disorder (UEMSD) and usage of wrist with high force at odds ratio of 1.78 (95% CI: 1.06–2.99) (Pullopdissakul et al., 2013). This situation can be explained by research conducted by Nimbarte (2014), where study had shown that the sternocleidomastoid muscle activity will increase as the lifting weight and heights increase until the peak activity occurring at the overhead height for the heavy weight (75 % strength) condition is reached. Hence, it is proven that work-related lifting and forceful exertions can cause WMSDs on the neck or cervical spine of the workers (Nimbarte, 2014).

According to recent research, it is found that posture and forceful exertion are of high significance that have contributed to pain on neck and wrist region on automotive industry workers, where the association between pain on neck and wrist region with posture risk factor is ($\beta = 0.218$, $p = 0.005$) and force risk factor is ($\beta = 0.107$, $p = 0.044$) respectively (Assunção et al., 2021). According to Guideline for Manual Handling at Workplace 2018, it is indicated that tasks that require high amount of force can lead muscles fatigue in a shorter period of time. At the same time, it also can cause irritation, inflammation, strains, and tears of muscles, tendons, and other tissues due to usage of high forces during completion of work tasks (DOSH, 2017).

2.3.1.3 Repetitive Motion

Repetitive motion is work tasks that are being carried out in repetitive nature, which are usually being controlled by production targets over a specific time period and work process (DOSH, 2017). Study had shown that high frequency of repetitive work tasks is the main factor that caused the high prevalence (40%) of MSD among the maintenance worker at an offshore facility in Norway (Kalteh et al., 2018). This is because the musculoskeletal system can be easily overworked by activities that require force, repeated motion, and extended posture maintenance (Aptel et al., 2002). A research had proven that muscle fatigue, loss of strength and increase of perceived fatigue were associated with repetitive work tasks as the result of the experiment had shown that participants showed significant signs of loss of strength, increased perceived fatigue and increased muscle fatigue ($p < 0.05$) (McDonald et al., 2019). Another study also had showed result of that the prevalence of neck or shoulder pain was significantly higher (7.0%) among the participants that carried out repetitive work as compared to the control group (3.8%). The same study also found out that there is an association of neck or shoulder pain with high repetitiveness (prevalence ratio 1.8, 95% confidence interval 1.1-2.9) and with high repetitiveness and high force (2.3, 1.4-4.0) (Hviid Andersen et al., 2002). Lastly, it has been proven that when excessive task repetition is paired with other risk variables such as high force and/or uncomfortable postures, work-related MSDs can develop (DOSH, 2017).

2.3.1.4 Static and Sustained Posture

The definition of static and sustained posture is work tasks that involve little or no movement, and it can increase the risk of developing Work-Related Musculoskeletal Disorder (WMSD) (DOSH, 2017). This is because isometric contraction of the muscles occurs during a static muscular effort, and the muscles' length remains unaltered, resulting in increased tension and vascular compression. As a consequence of that, blood flow declines, implying a reduction in oxygen and nutritional contribution, and ischemia develops. Thus, lactic acid will start building up in muscles, causing muscular aches and weariness (Anghel et al., 2007). A study that was carried out among the workers in the Telecommunications Company at Mansoura City had shown that physical exposure to static posture over a long time can significantly increase the risk of developing MSD (OR: 6.9; 95% CI: 0.83–57.9) (Fouad El-Bestar et al., 2011). Another research had also suggested that prolonged sitting and anthropometric mismatch were shown to be the most common occupational factors linked to musculoskeletal discomfort, as proven by the result where the neck, back, shoulder, and knee/thigh areas had the highest 12-month prevalence rates, ranging from 35 % to 60 %, and bus-driving, which is the occupational risk factor that include sustained posture was responsible for nearly 90 % of the musculoskeletal discomfort (Szeto & Lam, 2007).

2.3.1.5 Contact Stress

According to DOSH, (2017) there are two types of contact stress, namely internal and external contact stress. When a tendon, nerve, or blood artery is stretched or curved around a bone or tendon, internal stress happens. When a part of the human body rubs against a component of the tools, equipment, loads, or workstation, external contact stress arises. A research had shown that electronic assembly workers are typically affected by Upper Extremities Musculoskeletal Disorder (UEMSD) and one of the causal factor is contact stress on wrist and finger of the workers, as proven by the result where the adjusted odds ratio between UEMSD and contact stress at wrists is 1.75 (95% CI: 1.02–3.00) and on finger is 1.86 (95% CI: 1.04–3.34) respectively (Pullopdissakul et al., 2013). This signifies that contact stress are significant and is one of the causal factors that can lead to MSD. Furthermore, another study had also shown that there is a correlation between development of chondromalacia grade with

chronic stress-time exposure over both a 1 MPa damage threshold and a 2 MPa-years (R 2 = 0.423, p 0.001) (Aitken et al., 2022).

2.3.1.6 Vibration

Vibrations imparted to the human body by operating equipment are known as human body vibrations. Vibrations can be both beneficial and harmful, where the harmful vibrations usually will lead to MSD (Pratim Das et al., 2021). Vibration can cause a distinct occupational condition known as vibration syndrome, but it is also recognised as a main risk factor for work-related musculoskeletal disorder (WMSDs) (Gauthier et al., 2012). There are mainly two types of vibration, namely localized vibration and whole-body vibration, where localized vibration is vibration that is experienced by only a specific part of the body while whole-body vibration is vibration that is experienced by people who operate heavy equipment, such as bus and truck drivers (DOSH, 2017). A study had shown that whole-body vibration is the leading cause of musculoskeletal illnesses and joint discomfort, and at the same time it can gradually reduce a person's motor ability (Pratim Das et al., 2021). Apart from whole-body vibration, another study also showed that localized vibration can also lead to MSD. According to Mbutshu et al. (2014), the millers who worked more than 8 hours per day had a higher rate of hand-arm musculoskeletal symptoms than those who worked less than 8 hours per day (27.3 % vs. 3.4 %, respectively; p = 0.027) and data also shown that the risk of developing hand-arm MSD is 1.6 times higher in millers who did not use protective device that reduce vibration (OR = 1.64; 95% CI: 1.81–2.58).

2.3.2 Individual-Related Risk Factors

The individual-related risk factors of Musculoskeletal Disorders (MSD) being discussed in this study comprise of three main components, namely age, gender and body mass index (BMI).

2.3.2.1 Age

Age is a risk factor that could contribute to Musculoskeletal Disorder (MSD), as proven by research that stated that although foremen and office employees showed a greater age-adjusted prevalence of MSD than construction workers, the overall prevalence rates increases progressively with age in general (Holmström & Engholm, 2003). Also, another research had proven that at least one upper-extremity musculoskeletal disorder was reported out of 472 workers. Both genders, namely male and female showed result of increased risk of upper-extremity musculoskeletal diseases as the age increases (P 0.001, odds ratio [OR] $\leqslant$4.9 in men and $\leqslant$5.0 in women) (Roquelaure et al., 2009). Another study suggested that significant differences were found in the prevalence of MSD between old age-group and young/middle age-group and significant difference was also found between middle age-group and young age-group for shoulder related MSD (Heiden et al., 2013).

2.3.2.2 Gender

Gender can also become a risk factor that contributes to Musculoskeletal Disorder (MSD), where women generally have a higher susceptibility to develop MSD at workplace as compared to men. To explain the statement, a study had mentioned that after confounders, namely age and work factors are being controlled, data suggests that women have significantly higher prevalences of developing Upper Extremities Musculoskeletal Disorders (UEMSDs) when compares to men (Treaster & Burr, 2004). Another study also showed that females were more likely to have abnormalities on musculoskeletal system, where results indicated that age-adjusted prevalence odds ratio (POR) is 2.3 (95 percent CI 1.3–3.8) for neck/shoulders, 2.4 (1.4–4.0) for elbows/hands, neck/shoulder 1.9 (1.1–3.6), elbows/hands 4.1 (1.2–9.3) (Nordander et al., 2007). According to the findings, women rice farmers also experienced significantly (p 0.001) more discomfort than men rice farmers as a result of performing numerous household duties, which increased their discomfort in various body parts (Das, 2015). However, there are also study that suggested no significant difference between gender with MSD, as according to Coury et al. (2002), there was no significant difference in symptoms between male and female workers when compared within the same age group or employment duration.

2.3.2.3 Body Mass Index (BMI)

The BMI is calculated by dividing a person's weight in kilogrammes by the square of their height in metres. BMI is a simple and economical method of determining weight categories such as underweight, healthy weight, overweight, and obesity (CDC, 2022). Obesity frequently emerges as a prominent and potentially risk factor in the onset and progression of musculoskeletal diseases of the hip, knee, ankle, foot, and shoulder, despite the multifactorial complexity of musculoskeletal disease (Wearing et al., 2006). Besides, a research finding also suggested that obesity was linked to upper-extremity musculoskeletal diseases in men (OR 2.2, P = 0.014) (Roquelaure et al., 2009). Another research that was carried out to investigate the effect on BMI, workload, complaints and work fatigue of musculoskeletal disorders on nurse performance in Sawerigading, Hospital Palopo showed that the effect of the body mass index on job tiredness and its impact on nurse hospitalisation performance was 0.124 in the multivariate study (Yamin et al., 2020). Lastly, there is also study found that obesity was linked to the onset of musculoskeletal symptoms (OR 1.37, 95 percent CI: 1.05-1.79) and was negatively linked to symptom recovery (OR 0.76, 95 percent CI: 0.59-0.97) (Viester et al., 2013).

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will explain on the overall research methodology, which includes study design, study location, study duration, study sample, study instrument, quality control, statistical analysis and ethical consideration. Each component will be in purpose of answering the research objectives and at the same time align with the research interest, which is to determine the Risk Factors associated with Musculoskeletal Disorder (MSD) among factory workers in Nilai, Negeri Sembilan.

3.2 Study Design

The study design used for this research is cross-sectional study. The objective of this cross-sectional study is to determine the prevalence of musculoskeletal diseases (MSDs) and the associated risk factors among factory workers in Nilai, Negeri Sembilan.

The independent variables of this study are work-related risk factors, namely awkward posture, forceful exertion, repetitive movement, static and sustained posture, contact stress and vibration as well as individual-related risk factors, which are age, gender and BMI. The dependent variable of this study is the prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan.

Two questionnaires, namely Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) and a set of self-administered questionnaire will be used to collect data required for the research. The data collected by Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) will be utilized to determine the prevalence of Musculoskeletal Disorders (MSD) among the workers, while data collected by self-administered questionnaire will be used to determine the possible risk factors of MSD, namely the work-related risk factors and individual-related risk factors as discussed. Following that, descriptive analysis is used to identify the overall prevalence of Musculoskeletal Disorders (MSD) and sociodemographic distribution of the

factory workers. Then, Pearson's chi-square test will be used to determine the association between Musculoskeletal Disorders (MSD) with work-related and individual-related risk factors that are being studied. Lastly, multivariate analysis, namely multiple logistic regression will be conducted to determine the significance of the risk factors that contribute to prevalence of Musculoskeletal Disorders (MSD) factory workers in Nilai, Negeri Sembilan.

3.3 Study Location

The study location is located at Nilai, Negeri Sembilan. Only one factory is selected, which is Coca-Cola Far East Limited, Nilai, Negeri Sembilan. This is because Coca-Cola Far East Limited, Nilai, Negeri Sembilan is able to fulfil the required sample population of this study, which is 119, while the factory Coca-Cola Far East Limited, Nilai, Negeri Sembilan itself consists of approximately 370 factory workers. Secondly, the factory also has a relatively multicultural socio-demographic distribution among its workers. This enables us to conduct a more comprehensive and accurate study as we can avoid racial biasness.

Figure 3.1: Map Coca-Cola Far East Limited, Nilai, Negeri Sembilan.

3.4 Study Duration

The duration of study will be from 1st August 2022 till 30th September 2022.

3.5 Study Population

Factory workers of different ethnicity, educational level, working experience, gender, age, body weight and height were randomly selected using stratified random selection as study population. Office workers and other non-production related staffs in the factory are excluded from this study.

3.6 Study Sample

The study samples were selected from each production lines and warehouse at the Coca-Cola Far East Limited, Nilai, Negeri Sembilan, namely from production line 1 to 7 and warehouse. Workers that do not fulfil the inclusion criteria or are of characteristics of exclusion criteria were being excluded from the selection. Then, the ratio for number of workers at each production lines were being calculated. The respondents that fulfil the selection criteria were selected from each production lines, according to the ratio that were calculated beforehand, until total sample of 119 factory workers were achieved.

3.6.1 Sampling Frame

The sampling frame of this study is factory workers who work at the 7 production lines and warehouse indicated in Coca-Cola Far East Limited, Nilai, Negeri Sembilan. Then, the sampling population will be selected from the name list provided by the management of Coca-Cola Far East Limited, Nilai, Selangor according to the inclusive and exclusive criteria stated. The figure 4 below demonstrates the position of the 7 production lines and warehouse where the study samples were selected from.

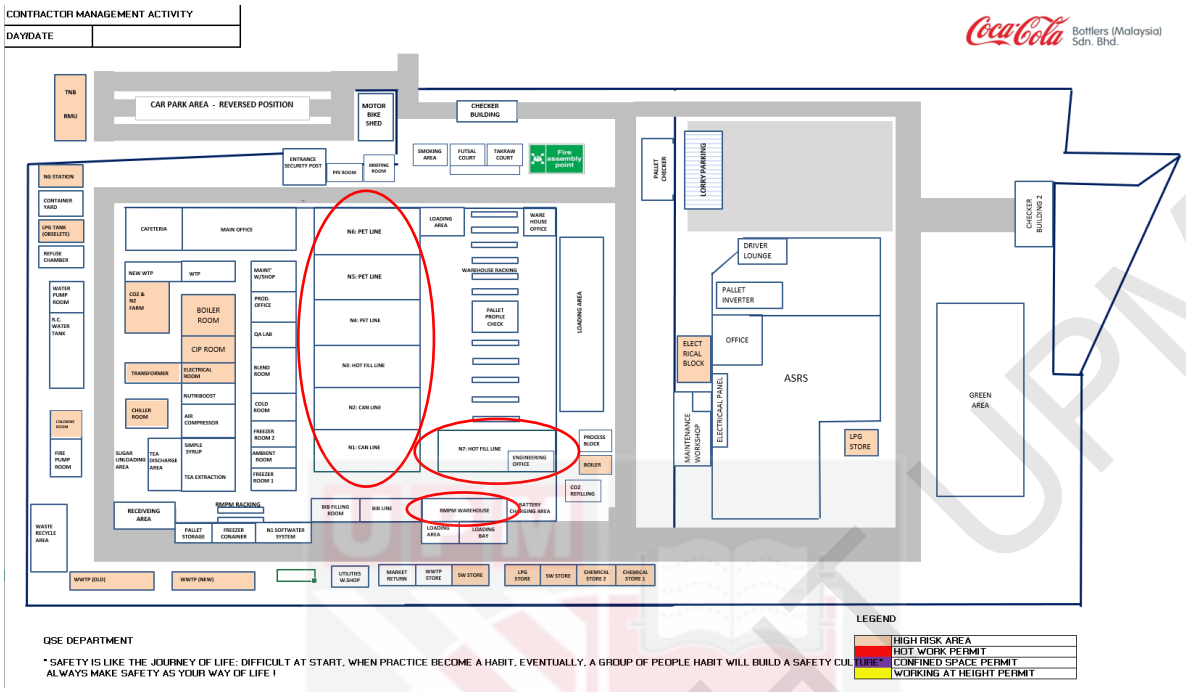

Figure 3.2: Floor Plan of Coca-Cola Far East Limited Sdn. Bhd.

3.6.2 Sampling Unit

The factory workers from production line 1 to 7 and warehouse at Coca-Cola Far East Limited, Nilai, Negeri Sembilan were the sampling unit. The following are the inclusion criteria and exclusion criteria of the study population.

Inclusive criteria: Male and female factory workers who are aged between 18-60 years old and are full time workers that work at the company for at least one year and above.

Exclusive criteria: Workers who had a past medical history of musculoskeletal disease, injuries or had undergone surgeries for less than one year.

3.6.3 Sampling Method

The respondents were selected using stratified random sampling, where the respondents were randomly selected according to each respective group, namely Production lines 1 to 7 and warehouse. Firstly, all the workers that does not fulfil the inclusion criteria are being excluded from the study. Then, the workers that meet the exclusion criteria will also be excluded from the study. After excluded the workers that does not fulfil the selection criteria, ratio of workers from each production line and warehouse at Coca-Cola Far East Limited, Nilai, Negeri Sembilan were calculated. The respondents were then be randomly selected from each 7 production lines and warehouse, where the number of respondents selected from each production line were strictly accordance to the ratio that were being calculated. The respondents were selected from each production line according to the manner as per discussed until all 119 respondents were attained.

3.6.4 Sample Size

The sample size was calculated to according to standard of 95% confidence interval and 5% of margin of error. The following is the formula used to calculate sample size for this study (Daniel, 1999).

$$n = \frac{NZ^2P(1-P)}{d^2(N-1) + Z^2\,P(1-P)}$$

Where:

n = Sample size,

N = Sample size of previous study

Z = Z statistic for a level of confidence,

P = Expected prevalence or proportion (in proportion of 1; if 80%, P = 0.8)

D = Precision (in proportion of one; if 5%, d=0.05)

Objectives	Calculation	Prevalence from previous study	Total Sample Size
To identify the prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan.	**The sample size was determined by using the following formula (Daniel, 1999).** $n = \frac{NZ^2P(1-P)}{d^2(N-1) + Z^2\,P(1-P)}$ $n = \frac{132 \times 1.96^2 \times 0.462(1-0.462)}{0.05^2(132-1) + [1.96^2 \times 0.462(1-0.462)]}$ $n = \frac{126.0406}{1.2824}$ $n = 98.2849$ $n \simeq 99\ respondents$ **To include non-response rate of 20% in order to reach total response rate at least 80%:** $n = 99 + (99 \times 20\%)$ $n = 118.8$ $n \simeq 119\ respondents$	Reference value is from (Ahmad et al., 2021). Sample size = 132 Prevalence = 46.2%	N = 119

3.7 Study Instrument

3.7.1 Self-Administered Questionnaire

A self-administered questionnaire that is designed in Bahasa Melayu that is modified from study of Tamrin et al., (2012) were distributed to the 119 selected participants. The self-administered questionnaire consists of two main parts, namely part A and part B.

In part A of the questionnaire, it consists of 19 questions, where their name, date of birth, age, height, weight, gender, religion, marital status, educational level, income, years of working, type of employment, pre-diagnosis on MSD, medical history, declaration of smoker, declaration on part-time jobs and time of work in the company and working hours daily were collected. The responses collected in this section of the questionnaire were used to determine the individual-related risk factors of MSD, namely age, gender and BMI.

In part B of the questionnaire, it consists of 7 questions, where their working conditions, such as declaration on frequency of lifting work, repetitive work, standing or maintaining awkward posture, siting for a long period of time and exposure to vibration will be collected. Then, the responses collected were used to determine the work-related risk factors on MSD. The work-related risk factors that were investigated are awkward posture, forceful exertion, repetitive motion, static and sustained pressure, contact stress as well as vibration.

3.7.2 Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)

Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) that had been re-interpreted into Bahasa Melayu by Shariat et al., (2016) will be used to determine the prevalence of Musculoskeletal Disorders (MSD) among the factory workers. The CMDQ is a standardised questionnaire, that allow us to identify the discomfort score on 20 body parts, including neck, right shoulder, left shoulder, upper back, lower back, right upper arm, left upper arm, right forearm, left forearm, right wrist, left wrist, hip/buttocks, right thigh, left thigh, right knee, left knee, right lower leg, left lower leg, right foot and left foot of the factory workers. The questionnaire consists of 3 sections

for each body part, where each section is used to determine the severity of MSD at each respective body part. In this study, the weightage of severity will not be studied but only the prevalence of cases of MSD will be determined and studied. At each section out of the 3 main sections, only one answered is required to be answered. Then, with any response that indicated pain or discomfort at any of the body parts will be considered to be suffered from MSD. Then, with the result obtained, it is analysed together with the self-administered questionnaire to fulfil the research objectives.

3.7.3 Statistical Package IBM® SPSS® Statistics version 28

Statistical Package IBM® SPSS® Statistics version 28 were used to analyse the collected data. The result collected by self-administered questionnaire will be coded to presence of work-related risk factors and individual-related risk factors at the workplace while, data collected by Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) will be coded to prevalence of Musculoskeletal Disorder (MSD) into the Statistical Package IBM® SPSS® Statistics version 28. Then, Pearson's Chi-Square analysis were conducted to look for association between prevalence of MSD among the factory workers with each respective risk factors. Then, a multivariate analysis, namely multiple logistic regression analysis was also conducted to determine all the possible risk factors that could contribute to the prevalence of MSD among the factory workers.

3.8 Quality Control

The self-administered questionnaire together with Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) had undergo a pre-testing to 10% of the target population as to confirm the reliability and validity of the questionnaire. The questionnaire underwent content validity testing by experts to ensure that it effectively measured the topic being investigated. Face and construct validity were also assessed for the questionnaire. The questionnaire was revised based on feedback from workers, and a test-retest reliability was conducted to ensure its quality. The final version of the questionnaire used in the study was based on the corrected pilot version. After the pre-test, the self-administered questionnaire's reliability was determined using the Cronbach's Alpha test, which the result was 0.750, while for CMDQ the result was 0.821.

3.9 Statistical Analysis

All the data collected were analysed by using Statistical Package IBM® SPSS® Statistics version 26. The statistical analysis used are as below:

Specific Objectives	Statistical Analysis
To identify the prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan.	Descriptive analysis
To identify the socio-demographic distribution of factory workers in Nilai, Negeri Sembilan.	Descriptive analysis
To determine the association between the prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan with work-related risk factors.	Pearson's Chi-Square Test
To determine the association between the prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan with individual-related risk factors.	Pearson's Chi-Square Test
To determine the association between prevalence of Musculoskeletal Disorders (MSD) among factory workers in Nilai, Negeri Sembilan with work-related and individual-related risk factors.	Multiple Logistic Regression

Table 3.1: Table of types of statistical analysis used.

3.10 Ethical Consideration

It is one of the requirements that researcher must obtain approval from the ethic committee of the University council before initiating a study or research. After obtaining approval from University Ethics Committee Involving Human Subjects of Universiti Putra Malaysia (JKEUPM), with reference number of JKEUPM-2022-398, data collection and research project were initiated. The study was conducted with two sets of questionnaire, namely self-administered questionnaire and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). A written consent form was issued on the first page of the questionnaire as shown in Appendix 1, to obtain the signature of the respondents to signify that they understood and agree with the terms of the research. All personal and confidential data of the participants must be strictly protected and only the researchers can have access to it.

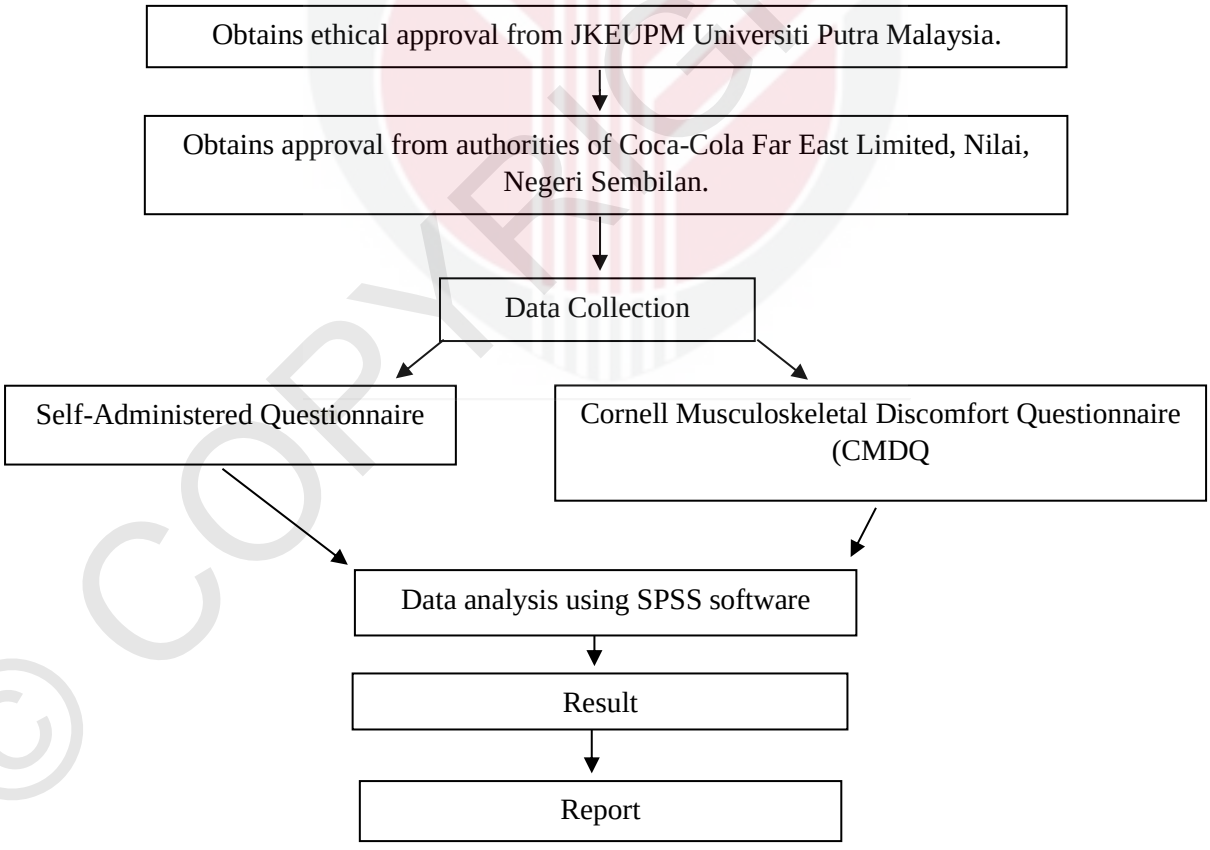

Figure 3.3: Research Flowchart

CHAPTER 4

RESULTS

4.1 Prevalence of Musculoskeletal Disorder (MSD) symptoms among Factory Workers

The first objective of the study is to determine prevalence of Musculoskeletal Disorder (MSD) symptoms among the factory workers in Nilai, Negeri Sembilan. The prevalence of MSD was recorded using Cornell Musculoskeletal Disorder Questionnaire (CMDQ) and any body parts that experienced discomfort, the result will be recorded as present of MSD symptoms at that particular body part. The body part with highest prevalence of MSD is lower back (57.1%), followed by shoulders (55.2%) and upper back (50.5%). There are 96 factory workers experienced MSD symptoms on at least or more than one body part. Therefore, the overall prevalence of MSD symptoms is high (91.4%) among the factory workers. Table 4.1 summarizes the outcome of the prevalence of MSD symptoms among the factory workers in Nilai, Negeri Sembilan.

Table 4.1: The prevalence of MSD symptoms at any body parts among factory workers at Nilai, Negeri Sembilan (N=105)

Body Parts with MSD Symptoms	Frequency n	Percentage %
Neck		
Yes	50	47.5%
No	55	52.4%
Shoulders		
Yes	**58**	**55.2%**
No	47	44.8%
Upper Back		
Yes	**53**	**50.5%**
No	52	49.5%
Upper Arm		
Yes	29	27.6%
No	76	72.4%

Table 4.1: Continue (N=105)

Body Parts with MSD Symptoms	Frequency n	Percentage %
Lower Back		
Yes	**60**	**57.1%**
No	45	42.9%
Forearm		
Yes	25	23.8%
No	80	76.2%
Wrist		
Yes	45	42.9%
No	60	57.1%
Hip/Buttocks		
Yes	28	26.7%
No	77	73.3%
Thigh		
Yes	15	14.3%
No	90	85.7%
Knee		
Yes	30	28.6%
No	75	71.4%
Lower Leg		
Yes	23	21.9%
No	82	78.1%
Foot		
Yes	32	30.5%
No	73	69.5%
Overall MSD Symptoms		
Yes	**96**	**91.4%**
No	9	8.6%

4.2 Individual-Related Risk Factors of MSD among Factory Workers

The second objective is to identify the socio-demographic distribution of factory workers in Nilai, Negeri Sembilan. The socio-demographic distribution of this study includes 3 individual-related risk factors of Musculoskeletal Disorder (MSD), which are age, gender and Body Mass Index (BMI). Overall, the majority of the factory workers are from age group of 30-39 years old (62.86%), followed by 40-49 years old (20.95%) and 18-29 years old (16.19%). Majority of factory workers are of age 35, as the mean age of the factory workers are 34.68 (± 6.204). Most of the factory workers are male in the factory, which there are 96 male (91.43%) and only 9 female (8.57%) in this study. Most of the factory workers also have a normal BMI, which the mean BMI of the study is 26.82 (± 6.742), which is within the normal range for BMI. Table 4.2 summarizes the outcome of the individual-related risk factors of MSD among the factory workers.

Table 4.2: The individual-related risk factors of MSD among factory workers at Nilai, Negeri Sembilan (N=105)

Characteristics	Frequency n	Mean ± S.D.	Percentage %
Age			
18-29 years old	17	34.68 ± 6.204	16.19%
30-39 years old	66		62.86%
40-49 years old	22		20.95%
>50 years old	0		0%
Gender			
Male	96	-	91.43%
Female	9		8.57%
Body Mass Index (BMI)			
Underweight	3	26.82 ± 6.742	2.86%
Normal	48		45.71%
Overweight	25		23.81%
Obesity	29		27.62%

4.3 Work-Related Risk Factors of MSD among Factory Workers

Work-related risk factors of Musculoskeletal Disorder (MSD) in this study includes awkward posture, forceful exertion, repetitive motion, static and sustained posture, contact stress and vibration. The highest prevalence for work-related risk factor is forceful exertion (91.4%), where most of the factory workers are required to lifting up things during work. Static and sustained posture also has high prevalence among the factory workers (82.9%). Almost half of the factory workers experienced both risk of awkward posture (51.4%) and repetitive motion (50.5%) during work. Table 4.3 summarizes the outcome of the work-related risk factors of MSD among the factory workers.

Table 4.3: The work-related risk factors of MSD among factory workers at Nilai, Negeri Sembilan (N=105)

Characteristics	Frequency n	Percentage %
Awkward Posture		
Yes	**54**	**51.4%**
No	51	48.6%
Forceful Exertion		
Yes	**96**	**91.4%**
No	9	8.6%
Repetitive Motion		
Yes	**53**	**50.5%**
No	52	49.5%
Static and Sustained Posture		
Yes	**87**	**82.9%**
No	18	17.1%
Contact Stress		
Yes	8	7.5%
No	97	92.4%
Vibration		
Yes	9	8.6%
No	96	91.4%

4.4 Association of Individual-Related Risk Factors with Prevalence of MSD among Factory Workers

The third objective is to determine the association between prevalence of Musculoskeletal Disorder (MSD) among the factory workers with individual-related risk factors. Pearson's Chi-square Test was done to associate between the prevalence of MSD among the factory workers with individual-related risk factors. Pearson's Chi-Square test shown that age and gender had significant association with the development of MSD among the factory workers. The p-value for age is 0.030 ($p<0.05$) and p-value for gender is 0.006 ($p<0.01$). Table 4.4 summarizes the outcome of association between individual-related risk factors with prevalence of MSD among the factory workers.

Table 4.4: Pearson's Chi-Square Test for association between work-related risk factors with prevalence of MSD among factory workers at Nilai, Negeri Sembilan (N=105)

Variables	Prevalence of MSD n (%)		Frequency n (%)	X^2 (p-value)
	Yes	No		
Age				
18-29	13 (76.5%)	4 (23.5%)	17 (16.2%)	7.000
30-39	61 (92.4%)	5 (7.6%)	66 (62.9%)	**(0.030)***
40-49	22 (100%)	0	22 (20.9%)	
Gender				
Male	90 (93.8%)	6 (6.2%)	96 (91.4%)	7.702
Female	6 (66.7%)	3 (33.3%)	9 (8.6%)	**(0.006)****
BMI				
Underweight	7 (77.8%)	2 (22.2%)	9 (8.6%)	
Normal	63 (94.0%)	4 (6.0%)	67 (63.8%)	4.617
Overweight	17 (85.0%)	3 (15.0%)	20 (19.0%)	(0.202)
Obesity	9 (100%)	0	9 (8.6%)	

* Significant level at $p<0.05$

** Significant level at $p<0.01$

4.5 Association of Work-Related Risk Factors with Prevalence of MSD among Factory Workers

The fourth objective is to determine the association between prevalence of Musculoskeletal Disorder (MSD) among the factory workers with work-related risk factors. Pearson's Chi-square Test was done to associate between the prevalence of MSD among the factory workers with work-related risk factors. Pearson's Chi-Square test shown that awkward posture and static and sustained posture had significant association with the development of MSD among the factory workers. The p-value for awkward posture is 0.001 ($p<0.01$) and p-value for static and sustained posture is <0.001 ($p<0.01$). Table 4.5 summarizes the outcome of association between work-related risk factors with prevalence of MSD among the factory workers.

Table 4.5: Pearson's Chi-Square Test for association between work-related risk factors with prevalence of MSD among factory workers at Nilai, Negeri Sembilan (N=105)

Variables	Prevalence of MSD n (%)		Frequency n (%)	X^2 (p-value)
	Yes	No		
Awkward Posture				
Yes	54 (100%)	0	54 (51.4%)	10.423
No	42 (82.4%)	9 (17.6%)	51 (48.6%)	**(0.001)***
Forceful Exertion				
Yes	89 (92.7%)	7 (7.3%)	96 (91.4%)	2.341
No	7 (77.8%)	2 (22.2%)	9 (8.6%)	(0.126)
Repetitive Motion				
Yes	50 (94.3%)	3 (5.7%)	53 (50.5%)	1.157
No	46 (88.5%)	6 (11.5%)	52 (49.5%)	(0.282)
Static and Sustained Posture				
Yes	84 (96.6%)	3 (3.4%)	87 (82.9%)	16.997
No	12 (66.7%)	6 (33.3%)	18 (17.1%)	**(<0.001)***
Contact Stress				
Yes	8 (100%)	0	8 (7.6%)	0.812
No	88 (90.7%)	9 (9.3%)	97 (92.4%)	(0.368)

Table 4.5: Continue (N=105)

Variables	Prevalence of MSD n (%)		Frequency n (%)	X^2 (p-value)
	Yes	No		
Vibration				
Yes	9 (100%)	0	9 (8.6%)	0.923
No	87 (90.6%)	9 (9.4%)	96 (91.4%)	(0.337)

*Significant level at p<0.01

4.6 Association of Work-Related Risk Factors and Individual-Related Risk Factors with Prevalence of MSD among Factory Workers

The last objective is to determine the association between prevalence of Musculoskeletal Disorders (MSD) among factory workers with work-related and individual-related risk factors. Multiple Logistic Regression is used to analyse for age, gender, awkward posture together with static and sustained posture. The result showed that male factory workers are 2.51 times (95% CI 1.791 – 3.540) more likely to develop MSD, while awkward posture can increase the likelihood of factory workers to develop MSD at 8.090 times (95% CI 2.805 – 22.045). Static and sustained posture can also increase the likelihood of developing MSD to 3.274 times (95% CI 2.134 – 4.741).

Table 4.6: Multiple Logistic Regression Analysis (N=105)

Variables	Odds Ratio	95% Confidence Interval		p-value
		Lower	Upper	
Age	0.570	0.357	0.830	0.597
Gender	2.510	1.791	3.540	**0.009****
Awkward Posture	8.090	2.805	22.045	**<0.001****
Static & Sustained Posture	3.274	2.134	4.741	**0.006****

**Significant level at p<0.01

CHAPTER 5

DISCUSSION

5.1 Prevalence of Musculoskeletal Disorder (MSD) among Factory Workers

The first objective of the study is to determine the prevalence of MSD among factory workers in Nilai, Negeri Sembilan. The prevalence of MSD among the factory workers is 91.4% which the high prevalence can be compared with a study that found majority of workers (87.1%) had MSD symptoms (Choobineh et al., 2009). The prevalence of both the studies were high and almost at the same rate, which explained that the findings of this study was logical. Another study by Choobineh et al. (2007) also found that majority of the rubber factory workers (73.6%) suffered from musculoskeletal discomfort in the past 12 months.

Besides overall MSD symptoms at any body part, this study also recorded the MSD symptoms that occurred at 12 body parts according to Cornell Musculoskeletal Disorder Quesionnaire (CMDQ). The 12 body parts that were included in the study are neck, shoulders, upper back, upper arm, lower back, forearm, wrist, hip, thigh, knee, lower leg and foot. In this study, the findings shown that low back pain has the highest prevalence among the factory workers (57.1%), followed by symptoms of MSD at shoulders (55.2%) and neck (50.5%). This result can be explained by the nature of work of the factory workers that mostly were involved in production line and warehouse section. The factory workers from production line are required to sit or stand in front of the machineries or computer to ensure the production line operates smoothly. On the other hand, the warehouse workers were required to operate forklift and were operating the forklift for a long period of time sitting on the forklift. Hence, it is believed that prolonged sitting or standing can lead to lower back pain among the factory workers. A study suggested that low back pain was highly associated with lack of physical activities (Abraha et al., 2018).

There are some studies that reported similar results, which suggested lower back pain, shoulder pain and neck pain has the highest prevalence among the MSD symptoms that occurred at other body parts. Study by Acaröz Candan et al. (2019) had reported similar findings to this study, which the highest prevalence of Work-Related Musculoskeletal Disorder (WMSD) was at lower back (61.4%), followed by, neck (57.9%), shoulder (53.6%) and upper back (45.6%). Study by Chandrasakaran A. (2003), found that the most affected body parts for

workers in semiconductor industry was pain in the back (57.8%), lower leg (48.4%) and shoulder (44.8%), which the result is similar to the findings of this study that also suggested back pain and shoulder as the main affected area for MSD. Another research also found that the most common WMSDs were seen in the back (60%), shoulder/neck (54%), neck (51%), shoulder (50%), lower back (47%), and wrist (42%) (Govaerts et al., 2021).

5.2 Individual-Related Risk Factors of MSD among the Factory Workers

The second objective of this study is to identify socio-demographic distribution of the factory workers in Nilai, Negeri Sembilan. In this study, age, gender and Body Mass Index (BMI) of the factory workers were analysed. The data of age, gender and BMI for 105 factory workers were collected and analysed. The mean age for the factory workers is 34.68 (± 6.204) which means most of the factory workers are middle-aged adults. The factory workers are mostly male (91.43%) because it is believed that mostly male will be more willingly to work as factory worker as the nature of work is more tiring and require more physical strength. Most of the factory workers have a normal BMI, where the mean BMI among the factory workers is 26.82 (± 6.742). Owing to the fact that most of the workers are male, the mean BMI of 26.82 (± 6.742) is considered within normal range for male.

The reason age, gender and BMI was selected to be analysed is because these factors are believed can affect and cause MSD to the factory workers aside from work-related risk factors, which are more to ergonomics and manual handling causative factors of MSD. Study among Female Readymade Garments Workers in Bangladesh found that risk of developing MSD was significantly higher at age group of 25–30 years old [aPR = 1.16, 95% CI: 1.01–1.33] and age group with $\geq$ 31 years old [aPR = 1.21, 95% CI: 1.04–1.1.39] (Nabi et al., 2021). This finding suggested that age has significant effect on development of MSD among the factory workers. Hence, this study had taken in age as one of the possible individual-related risk factors of MSD to be analysed. Gender can also affect the outcome and development of MSD among the factory workers. Study by Treaster D. E. (2011), suggested that even after controlling confounders such as age or employment characteristics, the research findings still imply that women had much greater prevalence than males for several forms of Upper Extremities Musculoskeletal Disorders (UEMSD). Furthermore, Body Mass Index (BMI) is also one of the important individual-related risk factors that can cause development of MSD

among factory workers. The study of found that with higher BMI, the risk of lower extremity musculoskeletal disorders were also increased (Jin et al., 2022). Another research also shown that BMI was found to be strongly associated with lower back and left shoulder complaints among workers in glass artware industries (Rathore et al., 2020).

5.3 Work-Related Risk Factors of MSD among the Factory Workers

The work-related risk factors for MSD in this study includes awkward posture, forceful exertion, repetitive motion, static and sustained posture, contact stress and vibration. All the work-related risk factors are ergonomics risk factors because the factory workers are mostly involved with manual handling activities and are highly exposed to ergonomics risk factors compared to other risk factors. Among all the work-related risk factors of MSD, forceful exertion had the highest prevalence (91.4%) amongst all. The risk factor with second highest prevalence is static and sustained posture with 82.9% prevalence, followed by awkward posture (51.4%) and repetitive motion (50.5%). Among all the work-related risk factors, contact stress and vibration shown the least prevalence, with only 7.5% and 8.6% respectively.

The work-related risk factors, namely awkward posture, forceful exertion, repetitive motion, static and sustained posture, contact stress and vibration were determined from Guidelines of Ergonomics Risk Assessment at Workplace 2017. These factors were chosen because ergonomics risk factors were the most significant risk factors that lead to MSD among factory workers. Study shown that the main ergonomics issues were awkward postures, manual material handling, and long periods of standing among workers of Sugar-Producing Factory (Choobineh et al., 2009). Another study also had associated ergonomics risk with the development of MSD, which the study found that ratios for trigger finger were awkward finger posture — 2.09 (95% CI: 1.12-3.90) and contact stress on finger — 1.86 (95% CI: 1.04-3.34). Besides, for awkward elbow posture, it can cause medial epicondylitis — 3.14 (95% CI: 1.10-8.95) but found no links between repeated movements and any UEMSD (Pullopdissakul et al., 2013). Study by Yahya et al. (2018) also found that manual handling task, which is the primary task at the assembly production such as awkward postures, excessive force and repetition can lead to WMSDs.

5.4 Association between Individual-Related Risk Factors and Work-Related Risk Factors of MSD among the Factory Workers

The main objective of this study is to determine the association between individual-related risk factors and work-related risk factors of MSD among the factory workers in Nilai, Negeri Sembilan. A self-administered questionnaire was distributed to 105 factory workers in the study location to determine the risk factors that might contribute to the development of MSD among the workers. The risk factors collected were categorized into two parts, which were individual-related risk factors that consists age, gender, BMI and another part was work-related risk factors that consists of awkward posture, forceful exertion, repetitive motion, static and sustained posture, contact stress and vibration. Cornell Musculoskeletal Disorder Questionnaire (CMDQ) was also distributed to the factory workers at the same time to determine the prevalence of MSD among the workers. The result was collected and analysed using Pearson's Chi Square test and Multiple Logistic Regression to determine the risk factors that had significant association with the development of MSD among the factory workers.

5.4.1 Significant Risk Factors

5.4.1.1 Age

The first risk factor that has significant association with development of MSD is age. Pearson's Chi-Square test shown that age had a significant association with development of MSD among the factory workers with a p-value of 0.030 ($p<0.05$). The group with highest frequency with prevalence of MSD was age group of 30-39 years old. This result shown that factory workers that are aged between 30-39 years old are more likely to develop MSD compare to other age groups. The 30-39 years old age group were more likely to develop MSD because this age group is middle-age, where the bodily functions and strengths of the workers that are within this age group were beginning to deteriorate. Furthermore, with deteriorating strength and bodily functions, the factory workers still were required to conduct and operate machineries that poses many ergonomics risk. This can lead to the development MSD to this age group.

Study shown that there was significant association between disorders at both knees with age (p = 0.019) and also correlation between ankle disorders with age (p = 0.039) (Aghili, 2012). Another study reported that in most areas, there were significant differences in the frequencies of MSD between the young/middle age-group and the old age-group, with only shoulder-MSD being the exception (Heiden et al., 2013). Another research also consolidated that the age group can be significantly associated with prevalence of MSD. According to the study, repetitive movements (B = 1.76, p 0.001) and uncomfortable postures (B = 1.30, p = 0.02) were significantly associated with an increased risk of MSD among individuals aged between 36-49 (Oakman et al., 2016). Hence, the age, specifically middle-age group can be one of the factors affecting factory workers causing them to have higher risk to develop MSD.

5.4.1.2 Gender

According to the study, gender shown association with the development of MSD among the factory workers. Pearson's Chi-Square Test shown that there is significant association between gender with MSD symptoms, which the p-value for gender is 0.006 ($p<0.01$). In this study, male shown the highest association with prevalence of MSD. Male factory workers had significantly high prevalence of MSD (93.8%) compared to female (66.7%) when both the genders were compared among their respective gender group. Male factory workers that shown MSD symptoms was 93.8% while male factory workers that did not develop MSD was only 6.2% among the study population. On the other hand, female factory workers that had shown MSD symptoms was 66.7% and female factory workers that did not shown MSD symptoms was 33.3%. In this case, the male factory workers shown a higher likelihood of developing MSD as compared to female.

This study result somehow was not parallel with most of the findings at other researches or studies. A study by Nordander et al. (2007), suggested that females tend to have higher muscle activity in relation to maximal voluntary contractions [(%MVE); m. trapezius: ladies 18 (SD 9.2), males 12 (SD 4.3); forearm extensors: females 39 (SD 11), males 27 (SD 10), right side, 90th percentile]. This result indicated that gender actually was significantly associated with development of MSD. However, female were more likely to develop MSD compared to men among the factory workers. Another study also showed similar findings whereby, the odds ratio (OR) or prevalence ratio (PR) for men ranged from 0.85 to 10.05 for

self-reported UEMSDs and the OR/PR for self-report paired with physical examination, ranged from 0.66 to 11.4. These findings imply that, after including confounders such as age or employment factors, women still had considerably greater prevalence than males for various forms of UEMSDs (Treaster & Burr, 2004).

The main reason that the result of this study did not parallel with most of the findings from other similar study is because the number of male respondents had outnumbered female respondents by a very large amount. The number of male factory workers in this study were 96, which was 91.4% and female workers were 9, which was 8.6% out of all respondents. Hence, the result of the study was affected and biased towards male factory workers due to the large percentage of male factory workers in this study.

5.4.1.3 Awkward Posture

The Pearson's Chi-Square test revealed that awkward posture was one of the factors that is significantly associated with the development of MSD among the factory workers. The p-value for Pearson's Chi-Square test is $p = 0.001$ ($p < 0.01$), which indicated that awkward posture is a significant risk factor that can lead to MSD. This finding was parallel to result of other studies, whereby awkward posture can be a significant risk factor that led to development of MSD.

The result of this study was aligned with most of other similar studies, which also indicated that awkward posture can lead to development of MSD among factory workers. A study found significant association between awkward posture ($\chi 2 = 65.37$, $p < 0.001$) and MSD among assembly line workers in automotive industry (Anita et al., 2014). According to the findings of the study, the musculoskeletal health of brick field workers was severely harmed, especially at lower back (brick carriers: 90%; moulders: 92%; fireman: 75%; stackers: 88%) and neck (brick carriers: 89%; moulders: 88%; fireman: 54%; stackers: 72%) as a result of working in various awkward postures for extended periods of time (Das, 2014). Another study on lower extremity musculoskeletal disorders among manufacturing workers had found that lifting in an uncomfortable position can contribute to higher risk of developing MSD, with Odds Ratio of 2.25 (95% CI 2.04 to 2.47) (Jin et al., 2022). These studies had consolidated the result that awkward posture can increase risk on developing MSD among the factory workers.

According to the observation, the factory workers from this study were exposed to awkward posture of working with back bent forward more than 30 degrees or bent sideways for more than 2 hours cumulatively, per day (Guidelines of Ergonomics Risk Assessment at Workplace 2017). The factory workers who work at the production line were constantly required to check on the machineries and remove any products that create malfunctions or obstruct the production line. Besides, the workers from warehouse department were also required to carry loads or wrapping finished products, which also had exposed to ergonomics risk factor of extensive bending of their back. Hence, the high exposure to awkward posture among the factory workers during work can extensively lead to high prevalence of MSD.

5.4.1.4 Static and Sustained Posture

Significant association were reported between static and sustained posture and the development of MSD symptoms among the factory workers. Pearson's Chi-Square test revealed that static and sustained posture is significantly associated $p = <0.001$ ($p < 0.01$) with prevalence of MSD among the factory workers. This result was also aligned with most of the similar studies that indicate static and sustained posture can increase prevalence of MSD among factory workers.

Study reported that prolonged sitting during the hazelnut selection task among the workers were known as one of the main risk factors for WMSDs (Punnett and Wegman, 2004). Study from Waongenngarm et al. (2016) also shown that prolonged sitting can cause soreness in the neck, shoulder, upper back, lower back, and buttocks as after 1 hour of sitting, the Body Perceived Discomfort levels in the neck, shoulder, upper back, low back, and buttock increased considerably ($t(9) = 11.97$ to 2.69, p 0.05). Another study also suggested that workplace ergonomic exposures were substantially linked with musculoskeletal pain in the neck and shoulders, with an odds ratio (OR) of 3.91 (95% CI 1.11 to 13.7) for sitting work versus standing labour (Schierhout et al., 1995). Besides prolonged sitting, prolonged standing can also increase the risk of developing MSD among the factory workers. A study on musculoskeletal problems among women workers in semiconductor industry in Peninsular Malaysia found that lower-limb pain was significantly associated with standing after logistic regression analysis being conducted (Chee & Rampal, 2004). Another important study also

indicated that the odds ratio (p =.05) of workers who stand for 2-8 hours each day are 29 times more likely to suffer low back discomfort than those who sits (Leilanie Del Prado-Lu, 2004).

The main risk of static and sustained posture experienced by the factory workers were prolonged sitting and prolonged standing. Factory workers from production line were more likely to exposed to prolonged sitting risk factor as they mostly were required to sit in front of computer or control panels to ensure the production line operates without error. On the other hand, the maintenance workers with nature of work that required to stand and repair machineries were more likely to be exposed to risk of prolonged standing. However, for factory workers from the warehouse department, they were more likely to be exposed to prolonged siting risk factor because their work tasks were to be carried out on forklifts. This means they were more prone to sitting on forklifts for a long period of time during work. Though workers from different departments had different work tasks and were exposed to different types of static and sustained posture risk factors, most workers somehow were still experienced with at least one type of static and sustained posture risk factor. Hence, due to the high exposure to static and sustained posture, the prevalence of MSD was high among the factory workers.

5.4.1.5 Multiple Logistic Regression Analysis

Multiple Logistic Regression was used to analyse for age, gender, awkward posture together with static and sustained posture as these risk factors were found to have significant association with the development of MSD among factory workers via result from Pearson's Chi-Square Analysis. The result showed that only gender together with static and sustained posture were the only risk factors that were significant. According to the result of Multiple Logistic Regression analysis, male factory workers are 2.51 times (95% CI 1.791 – 3.540) more likely to develop MSD than female. Awkward posture can also increase the likelihood of factory workers to develop MSD at 8.090 times (95% CI 2.805 – 22.045). Furthermore, static and sustained posture can also increase the likelihood of developing MSD to 3.274 times (95% CI 2.134 – 4.741) compare to workers without exposure to static and sustained posture during work. This result indicated that combining the analysis of multiple sets of variables, namely work-related risk factors and individual-related risk factors, the most significant risk factors that can lead to the development of MSD among factory workers are gender, awkward posture together with static and sustained posture.

CHAPTER 6

CONCLUSSION AND RECOMMENDATIONS

6.1 Conclusion

This research was carried out to determine the risk factors associated with Musculoskeletal Disorder (MSD) among the factory workers in Nilai, Negeri Selangor. The study outcome indicated that the prevalence of MSD was high (91.4%) among the factory workers. The body part with highest prevalence of MSD is lower back (57.1%), followed by shoulders (55.2%) and upper back (50.5%). According to results of Pearson's Chi-Square test, 2 out of 3 individual-related risk factors that were being studied in this research were significantly associated with development of MSD. The individual-related risk factors were age, $p = 0.030$ ($p<0.05$) and gender $p = 0.006$ ($p<0.01$). On the other hand, 2 out of 6 work-related risk factors that were being studied in this research had shown significant association with the development of MSD among factory workers. Pearson's Chi-Square test shown that awkward posture, $p = 0.001$ ($p<0.01$) and static and sustained posture $p = <0.001$ ($p<0.01$) had significant association with the development of MSD among the factory workers. Furthermore, the result of Multiple Logistic Regression showed that male factory workers are 2.51 times (95% CI 1.791 – 3.540) more likely to develop MSD. Awkward posture can also increase the likelihood of factory workers to develop MSD at 8.090 times (95% CI 2.805 – 22.045). Lastly, static and sustained posture can increase the likelihood of developing MSD to 3.274 times (95% CI 2.134 – 4.741) compared to workers without exposure to static and sustained posture during work.

6.2 Study Limitations

There are some limitations to the study that are unavoidable due to study method and time constrains. The information collected were completely based on self-reported result via questionnaires by the factory workers, without being clinical diagnosis or evaluation to verify the actual discomfort level on each respective body parts of the workers. The accuracy of the result could be affected as the workers might have undergone issues of misunderstanding the questions, having difficulties in recalling the actual situation and providing wrong data when

they were in a situation of hurry and wanted to complete the questionnaire as soon as possible. However, the researcher was not able to verify each of the respondents' assertions, all of the information provided by the respondents was judged correct and acceptable. There was also limited number of respondents as the study was only being carried out in one factory due to budget and time constraint. The result of the study might not be representable to the whole population of factory workers in Nilai, Negeri Sembilan. The gender proportion of this study was also imbalanced as the male workers were highly outnumber the female workers. This situation was unavoidable since the gender distribution in the factory was already imbalanced at the first place. Hence, the data and analysis that involved gender as risk factor might have lower accuracy due to the imbalance gender distribution in this study.

6.3 Recommendations

The recommendations that can be suggested for this study are conduct more study on Musculoskeletal Disorder (MSD) related researches to discover more underlying risk factors that could lead to MSD among the factory workers. The study should include Ergonomics Risk Assessment (ERA) methods to determine and verify the risk factors of developing MSD among the factory workers. Environmental risk factors and psychosocial risk factors can be included as risk factors of the study to determine the effect of those factors on the prevalence of MSD among factory workers.

The recommendations that can be suggested to improve workers' musculoskeletal health includes providing proper training for proper sitting posture and educate the factory workers on the risk of MSD. Health screening that includes musculoskeletal health should be conducted to allow the management to constantly monitor the prevalence of MSD among the workers before the level of MSD become out of control. Workers should be taught adequate body mechanics, good work postures, and a self-care programme to promote both performance and recuperation. These recommendations may improve the overall musculoskeletal health among the workers and increase their performance during work. This indeed could reduce loss of manpower and cost of medical compensation for possible uprising MSD cases among the factory workers.

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APPENDICES

APPENDIX I: ETHICAL CLEARANCE

ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS (JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**Risk Factors Associated with Musculoskeletal Disorder (MSD) Among Factory Workers in Nilai, Negeri Sembilan.**
Study Site	:	**Negeri Sembilan.**
JKEUPM Ref No.	:	**JKEUPM-2022-398**
Researcher	:	**Chen Teck Hsin**
Supervisor	:	**Prof. Dr. Shamsul Bahri Bin Haji Mohd Tamrin**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 01/06/2022
2. Respondent's Information Sheet /Consent (English), Version 1 dated 01/06/2022
3. Proposal (English), Version 2 dated 12/08/2022
4. Questionnaire / Interviews (English), Version 1 dated 01/06/2022
5. Questionnaire / Interviews (Malay), Version 1 dated 01/06/2022
6. Curriculum Vitae of:
    a. Prof. Dr. Shamsul Bahri Bin Haji Mohd Tamrin

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.
Decision by JKEUPM:

[X] Approved

[X] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**

[ ] Disapproved

Please note that the approval is **VALID UNTIL 23 AUGUST 2023**

Researchers should comply with the following:

I. Complete a Study Final Report upon study completion (Form 3.2).

II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

III. Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report occurrences of all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs) and Protocol Deviation/ Violation at all JKEUPM approved sites to JKEUPM. SAEs are to be reported within 15 calendar days from awareness of event by investigator. Initial report of SUSARs are to be reported as soon as possible but not later than

APPENDIX II: RESPONDENTS INFORMATION SHEET AND INFORMED CONSENT FORM

JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE :

Risk Factors Associated with Musculoskeletal Disorder (MSD) among Factory Workers in Nilai, Negeri Sembilan.

2. INTRODUCTION:

A study is being conducted to determine the associated risk factors with Musculoskeletal Disorder (MSD) among factory workers in Nilai, Negeri Sembilan. The researcher hopes to discover the relationship between work-related risk factors (Awkward Posture, Forceful Exertion, Repetitive Motion, Static and Sustained Posture, Contact Stress, Vibration) and individual-related factors (Age, Gender, BMI) with development of Musculoskeletal Disorders (MSD) by comparing the prevalence of musculoskeletal discomfort between respondents who declare of being exposed to either or both of the risk factors, namely work-related risk factors and individual-related risk factors. Approximately, 119 numbers of factory workers in Nilai, Negeri Sembilan will take part in the study to fulfill the research requirements.

3. WHAT WILL YOU HAVE TO DO?

Your participation in this survey is voluntary. You may refuse to take part in the research or exit the survey without any penalties. The session will take up to 15 minutes to answer. If you agree to participate, you will be asked to answer four sections which are:-

- Section A (Sociodemographic Data),
- Section B (Cornell Musculoskeletal Discomfort Questionnaire)

Participant that are interested to know about the outcome of the study may provide your email address at the end of the questionnaire.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Person who had a past medical history of musculoskeletal disease, injuries or had undergone surgeries for less than one year.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

By the end of the survey, participants will have the oppurtunity to learn more about their musculoskeletal condition and become more aware on their musculoskeletal health.

(b) TO THE INVESTIGATOR?

By the end of the survey, researcher will have an insight on the risk factors of Musculoskeletal Disorder (MSD) among factory workers in Nilai, Negeri Sembilan.

6. WHAT ARE THE POSSIBLE RISKS?

There are no foreseeable risks involved in this study.

7. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?

Your information will be kept confidential and will not be made publicly available, to the extent permitted by law, and that the identity of the participant will remain anonymous in the event the study results are published. As such, your information will be labelled by number without providing the name while sociodemographic data will still be recorded.

8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

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JKEUPM Ethics Review Panel has approved the study, and may be reached through the following contact for information regarding rights of study participants, including grievances and complaints.

Please initial here if you have read and understood the contents of this page_____

9. CONSENT

I ..... Identity Card No. .....
address.....
.....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature .....
(Respondent)

Signature .....
(Witness)

Date :.....

Name :.....

I/C No. :.....

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date .....

Signature .....
(Researcher)

APPENDIX III: QUESTIONNAIRE

Date/ Tarikh: | | ID No.: | |

UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

QUESTIONNAIRE/*BORANG KAJI SELIDIK*

RESEARCH TITTLE/ *TAJUK KAJIAN*	Risk Factors Associated with Musculoskeletal Disorder (MSD) among Factory Workers in Nilai, Negeri Sembilan. *Faktor-faktor Risiko berkaitan terhadap Gangguan Muskuloskeletal di kalangan Pekerja Kilang di Nilai, Negeri Sembilan.*
RESEARCHER NAME/ *NAMA PENGKAJI*	CHEN TECK HSIN

Instructions/*Arahan*

This questionnaire's questions are divided into three parts:

Soalan soal selidik ini terbahagi kepada tiga bahagian:

Part A: General Information and Ergonomic Risk Factors
Bahagian A: Maklumat umum dan Faktor Risiko Ergonomik

Part B: Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)
Bahagian B: Borang Soal Selidik Otot Rangka Cornell (CMDQ)

Please tick your answer and fill in the blanks for the questions below.
Sila tandakan jawapan anda dan isi jawapan di ruangan yang disediakan untuk soalan dibawah.

BORANG KAJI SELIDIK

BAHAGIAN A: MAKLUMAT RESPONDEN

1. Nama: _____
2. Tarikh Lahir: _____
3. Umur: _____
4. Tinggi: _____ cm
5. Berat: _____kg
6. Jantina:

   ☐ Lelaki ☐ Perempuan
7. Bangsa:

   ☐ Melayu ☐ Cina

   ☐ India

   Lain-lain: _____
8. Agama:

   ☐ Islam ☐ Hindu

   ☐ Buddha ☐ Kristian

   Lain-lain: _____
9. Status perkahwinan:

   ☐ Berkahwin

   ☐ Bercerai ☐ Bujang
10. Tahap Pendidikan: _____

    ☐ Tidak bersekolah ☐ Diploma

    ☐ Sekolah Rendah ☐ SPM

    ☐ STPM ☐ Ijazah

11. Pendapatan Bersih: RM _____

12. Pengalaman bekerja:

☐ Kurang daripada 1 tahun

☐ Lebih daripada 1 tahun

13. Jenis pekerjaan:

☐ Pekerja Sepenuh Masa

☐ Pekerja Sambilan

14. Adakah anda pernah mengalami kecederaan atau kemalangan pada mana-mana anggota badan?

☐ Ya

☐ Tidak

Jika Ya, nyatakan: _____

15. Adakah anda telah disahkan dengan mana-mana penyakit Gangguan Muskuloskeletan Yang Berkaitan Dengan Pekerjaan atau pernah melaui pembedahan?

☐ Ya

☐ Tidak

16. Adakah anda merokok?

☐ Ya

☐ Tidak

(Ya bermaksud sekurang-kurangnya 1 batang atau 20 kotak setahun)

17. Adakah anda melakukan kerja sampingan?

☐ Ya

☐ Tidak

18. Berapa lamakah anda telah bekerja di syarikat ini?

_____

19. Secara purata, berapa jumlah dalam sehari anda bekerja?

_____

1. Which posture did you face when working?
Postur manakah yang anda mengalami semasa bekerja?

		Never/ *Tidak pernah*	Sometime/ *Kadang-kadang*	Frequent/ *Kerap kali*
i.	Bend forward/ *Bongkok ke hadapan*	☐	☐	☐
ii.	Lean back/ *Menyandar*	☐	☐	☐
iii.	Twisting body/ *Memutar Badan*	☐	☐	☐

2. Does your work need you lifting up the things?
Adakah kerja anda memerlukan anda mengangkat benda?

☐ Yes/ *Ya* ☐ No/ *Tidak*

If Yes, tick the appropriate box/ *Jika Ya, tandakan pada petak yang berkenaan*:

i. < 5 kg (10lbs) ☐ Times per day/ *Berapa kali sehari* .....
ii. 5 – 10 kg (10-20lbs) ☐ Times per day/ *Berapa kali sehari* .....
iii. >10 kg (20lbs) ☐ Times per day/ *Berapa kali sehari* .....
iv. >10 kg (20lbs) ☐ Times per day/ *Berapa kali sehari* .....

3. Does your work require repetitive movement, lifting, pushing or pulling for long period that leads to uncomfortabality?/ *Adakah kerja anda memerlukan pergerakan berulangan, mengambil masa lama atau membawa ketidakselesaan apabila mengangkat, menolak ataumenarik beban?*

☐ Yes/ *Ya* ☐ No/*Tidak*

4. Do you stand more than 2 hours continuously?
Adakah anda berdiri lebih daripada 2 jam secara berterusan?

☐ Yes/ *Ya* ☐ No/*Tidak*

5. Do you sit more than 30 minutes continuously?
Adakah anda duduk selama 30 minit secara berterusan?

☐ Yes/ *Ya* ☐ No/*Tidak*

6. Do you hold any tools, equipment or load for more than 30 minutes continuously?
Adakah anda memegang sebarang alatan, peralatan atau beban selama 30 minit secara berterusan?

☐ Yes/ *Ya* ☐ No/*Tidak*

If Yes, describe the pain level caused by holding the tool, equipment or load during work.

Jika Ya, sila terangkan tahap kesakitan yang diakibatkan oleh memegang alat, peralatan atau beban semasa bekerja.

i. No pain / *Tidak sakit* ☐
ii. Moderate/ *Sederhana* ☐ Times per day/ *Berapa kali sehari* ----------
iii. Painful/ *Sakit* ☐ Times per day/ *Berapa kali sehari* ----------
iv. Very Painful/ *Sangat Sakit* ☐ Times per day/ *Berapa kali sehari* ----------

7. Does your work involve exposure to vibration more than 15 minutes continuously?
Adakah kerja anda melibatkan pendedahan kepada getara selama 15 minit secara berterusan?

☐ Yes/ *Ya* ☐ No/*Tidak*

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 lepas	3-4 kali 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)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Belakang atas	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Belakang bawah	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lengan bawah (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pergelangan tangan (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pinggul/Punggung	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Peha (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lutut (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Betis (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kaki (kanan)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(kiri)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐