PREVALENCE OF MUSCULOSKELETAL DISORDERS, THE ASSOCIATING FACTORS, AND ERGONOMIC RISK ASSESSMENT AMONG MEDICAL LABORATORY TECHNOLOGISTS AT THE NATIONAL INSTITUTES OF HEALTH, MALAYSIA – A CROSS-SECTIONAL STUDY

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Dedication

First of all, I am thankful to my wife, Horiah Zahidah Intizam, for her unwavering support and encouragement in completing my this postgraduate course, playing a vital role in taking care of our lovely children whilst I am focusing on my studies. To my children, Ammar Alfateh, Ilman Alhakim, Haura Nusairah, and Hannah Humaira, thank you for being the joy and laughter during my master's journey. To my late mother, Noorhashimah Mohamed Noordin, who funded my studies, I would like to dedicate this achievement to you, my greatest cheerleader, in the world and hereafter. May your love and care towards me bring happiness to you in heaven.

Abstract

Background: Musculoskeletal disorders (MSDs) are one of the most highly reported occupational-related diseases in the world. Workers exposed to ergonomic hazards are likely to suffer from musculoskeletal complaints due to MSDs. This condition impacts their productivity and quality of life. Medical laboratory technologists (MLTs) are often exposed to various ergonomic risks, such as awkward posture, repetitive motions, and prolonged static positions throughout their daily work tasks, making them highly susceptible to MSDs.

Objective: To determine the prevalence and associating factors of musculoskeletal disorders among medical laboratory technologists at the National Institutes of Health, Malaysia.

Methods: This was a cross-sectional study design utilising census sampling method among medical laboratory technologists working in the National Institutes of Health Malaysia. Socio-demographic, predisposing factors, and MSDs symptoms were collected via a self-administered questionnaire, adapting the Extended Nordic Musculoskeletal Discomfort Questionnaire (NMQ-E). MSDs were perceived as presence of discomfort in any of the body regions for the past 12 months. Ergonomic risk assessment was conducted in each laboratory centre using the Rapid Entire Body Assessment (REBA). Data were analysed for the prevalence rate of MSDs, the relationship of whole-body postural risk level and job task-related scores, and to determine the associating factors contributing to MSDs.

Results: A total of 115 MLTs, with female predominance, participated in this study. The prevalence rate of MSDs among them was 63.5% (n = 73), with complaints of discomfort over the neck (37.8%, n = 43), lower back (30.4%, n = 35), and shoulders (28.7%, n = 33) being the most affected body regions. REBA risk levels were mostly low risk (84.3%). There were no high-risk scores recorded. A history of orthopaedic illness (OR 10.77, 95% CI: 1.33-87.00) and a lower education level (OR 0.27, 95% CI: 0.10-0.78) were significantly associated with MSDs after adjusting for age and gender.

Conclusions: This study highlights a high prevalence of MSDs among medical laboratory technologists, particularly in the neck, lower back, and shoulder regions. Albeit most of the work tasks were deemed low ergonomic risk based on REBA scores, history of orthopaedic illnesses, and higher education level, they reported higher odds of MSDs. These findings underscore the importance of incorporating targeted ergonomic interventions and training programmes to mitigate musculoskeletal health issues in laboratory settings.

Keywords: Ergonomics, Laboratory workers, Rapid Entire Body Assessment, Occupational Health, Risk Assessment.

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APPROVAL SHEET NO.1

I, the main supervisor to **Imanul Hassan bin Abdul Shukor** hereby certify that the dissertation report revisions have been made based on the recommendations by the Research Project Examination Committee on **19-08-2025**.



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APPROVAL SHEET NO.2

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DECLARATION

I hereby declare that the research report is based on my original work except for quotations and citations which have been duly acknowledged, and I have not used Artificial Intelligence (AI) to generate the content. I also declare that it has not been previously or concurrently submitted for any other degree at IMU University or any other institution.



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LIST OF ABBREVIATIONS

Abbreviation	Definition
AUC	Area Under Curve
ART	Assessment of Repetitive Task
ETP	Ergonomic Trained Person
IMR	Institute for Medical Research
MSDs	Musculoskeletal Disorders
MLTs	Medical Laboratory Technologists
REBA	Rapid Entire Body Assessment
NIH	National Institutes of Health
NMQ-E	Nordic Musculoskeletal Questionnaire – Extended
OR	Odds Ratio
ROC	Receiver under Operating Characteristics
RULA	Rapid Upper Limb Assessment
WMSDs	Work-related Musculoskeletal Disorders

CHAPTER 1: INTRODUCTION

1.1 Work-related Musculoskeletal Disorders (MSDs)

Musculoskeletal disorders (MSDs) are a prevalent health issue worldwide, affecting people in both work and daily life. According to the World Health Organisation (WHO), MSDs are characterised by impairments in the muscles, bones, joints, and surrounding connective tissues, leading to temporary or permanent dysfunction in mobility, reducing working ability, and hindering social participation. MSDs manifest in the form of musculoskeletal pain, which is the most common form of non-cancerous pain (1). In general, MSDs can be associated with genetic, congenital, or acquired pathological processes (2). Musculoskeletal complaints that arise from work-related activities are classified as work-related MSDs (WMSDs) (3). These conditions commonly affect workers exposed to ergonomic hazards such as awkward postures, repetitive movements, and prolonged static positions. According to Liu et al in 2022, occupational risk exhibits the highest contribution to MSDs, with numerous study findings on the prevalence of MSDs among laboratory workers at around 70% to 80% (3). Failure to address this issue may result in increased sickness absenteeism, lower productivity, and poor quality of life. Employers may not always prioritise ergonomic assessments, and employees are driven by financial rewards, oftentimes taking up overtime tasks and working vigorously for maximal work output, exercising unsafe behaviour such as continuous long working hours without breaks, maximal exertion on manual handling, and pushing the body limits to its breaking point, inevitably leading to poor ergonomic practices. These phenomena will increase the probability of MSDs.

1.2 Medical laboratory technologists in healthcare

This brings the focus to the occupation of medical laboratory technologists (MLT). In the context of the Malaysian healthcare system, the MLT's role in conducting screening and diagnostic tests is essential in guiding medical practitioners in outlining appropriate treatment plans based on clinical practice guidelines. The driving force of these laboratories is the medical laboratory technologists (MLT), who diligently work within the limited laboratory workspace throughout their shifts to perform both routine and urgent laboratory work tasks. A limited workspace refers to environments where space constraints affect workflow, efficiency, and safety. These compact laboratories expose the MLT to various ergonomic hazards such as repetitive movements, prolonged static postures, and awkward body positions (4). These hazards may cause musculoskeletal discomfort to MLT, leading to incidences of MSDs.

1.3 Problem statement

In the Malaysian workforce, musculoskeletal disorders (MSDs) rank among the top three occupational health concerns highlighted in existing literature (5). However, research on ergonomic risk assessment among MLTs remains limited, as most local studies have predominantly focused on occupations involving manual handling tasks, such as nursing, construction work, housekeeping, and farming. The understanding of MSD prevalence and its associated risk factors among MLTs in Malaysia remains limited, highlighting a knowledge gap that could benefit from further research and intervention. The Occupational Safety and Health (Amendment) Act 2022 in Malaysia mandates all employers to conduct workplace risk assessments, with enforcement taking place in June 2024. This involves evaluating the risks to safety and health posed by workplace hazards and establishing the necessary risk control strategies (5). This study on ergonomic risk assessment is timely and provides a starting point

for the healthcare sector, particularly MLTs in Malaysia, to align effectively with the requirements of the amended Act.

However, there is limited understanding of the prevalence of MSDs and their associating factors among medical laboratory workers in the Malaysian population. Therefore, this study aimed to determine the prevalence of MSDs, their associating factors, along with ergonomic risk assessments among MLTs in a research institute in Malaysia.

1.4 Significance of the study

As musculoskeletal disorder limits the functional capability of medical laboratory workers, they cause a direct impact on the public healthcare system due to a decrease in productivity at work, sickness absenteeism, and an increase in medical costs. As MLTs are exposed to various ergonomic hazards in their daily tasks, this study evaluated ergonomic risk assessment according to risk levels to highlight the magnitude of ergonomic insufficiencies in their working laboratory settings. Hence, this study could aid in minimising those direct impacts towards the public healthcare system, evaluate ergonomic risks, and mitigate appropriate corrective and preventive actions in reducing the incidence of MSDs.

Under the newly amended OSHA Act 2022, the outcome of this study would facilitate stakeholders, especially employers, in ensuring, as far as practicable, ergonomic practices in performing medical laboratory tasks, especially in NIH laboratories (6). Work task modification in significantly high ergonomic risk tasks will be highlighted and could be brought to the attention of the laboratory supervisors to ensure ergonomic best practices are applied to every laboratory worker, especially the MLTs. It is also important to ensure that non-modifying factors that are vulnerable to MSDs will be given special attention for preventive measures according to ergonomic principles.

1.5 Research questions

Listed below are the research questions for this study:

1. What is the prevalence of MSDs among medical laboratory technologists (MLTs) in medical laboratory settings?
2. What are the whole-body postural risk levels and job task-related risk among these MLTs?
3. What is the association between sociodemographic factors, predisposing factors, ergonomic risk levels and MSDs among these MLTs?

1.6 Research objectives

The general objective of this study is to determine the prevalence and associating factors of WMSDs among MLTs.

The specific objectives of this study are:

1. To determine the prevalence of MSDs among medical MLTs in medical laboratory settings.
2. To assess whole-body postural risk levels and job task-related risk among these MLTs.
3. To determine the association between sociodemographic factors, predisposing factors, ergonomic risk levels, and MSDs among MLTs.

1.7 Research hypothesis

The research hypothesis is:

1. Null hypothesis (H_0): There is no significant association between sociodemographic factors, predisposing factors, ergonomic risk levels and MSDs among the MLTs in medical laboratory settings.

2. Alternative hypothesis (H_1): There is a significant association between sociodemographic factors, predisposing factors, ergonomic risk levels and MSDs among the MLTs in medical laboratory settings.

1.8 Conceptual framework of study

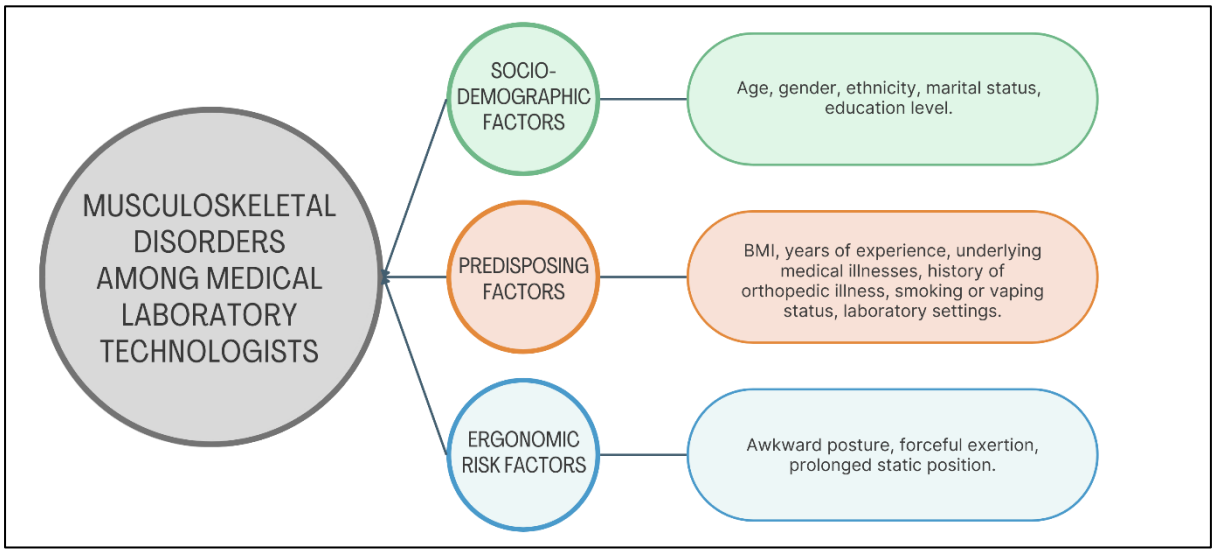

Figure 1.1. The conceptual framework of this study.

Based on the conceptual framework in Figure 1.1, three main factors contribute to the occurrence of musculoskeletal disorders: socio-demographic factors, predisposing factors, and ergonomic risk factors.

Socio-demographic factors refer to the identity of an individual, encompassing age, gender, ethnicity, and marital status. Ageing causes degenerative changes in the musculoskeletal system, leading to an increase in susceptibility to MSDs (7). Females have significant hormonal changes, especially at the verge of the menopausal stage, leading to the demineralisation of the bones and various musculoskeletal degenerative changes (8). Due to the variability of genetic profiles between ethnic groups, ethnicity may contribute as a decisive factor in musculoskeletal health (9). Marital status may also have an effect on musculoskeletal health, as a marriage

contract may be the source of psychological resilience due to strong family support, it could also reciprocally be the cause of psychological fragility due to an unharmonious marriage. Workers with better education tend to have a better health conscience, often take musculoskeletal health more seriously.

The predisposing factors are psychological or situational characteristics that influence an individual's tendency or motivation to engage in a particular behaviour (10). These factors are years of working experience, body mass index (BMI), smoking or vaping behaviour, history of medical or orthopaedic conditions, and type of laboratory centre. Due to wear and tear of the body's musculoskeletal system, an increase in the number of years of working experience may have a cumulative stress on the muscles and bones of the worker. Moreover, workers with higher BMI tend to have higher cumulative musculoskeletal stress as the body needs to adapt not only to the workplace hazards, but also to their excessive body weight. Medical conditions, such as diabetes, hypertension, and rheumatic diseases, are more prone to MSDs due to their effect on the musculoskeletal system. A previous history of orthopaedic illness increases the likelihood of MSDs, as the physical structure of the muscles and bones has been previously compromised. Smoking and vaping behaviours decrease the density of bone mineral, as they interfere with calcium absorption. Bone healing takes a longer time due to impaired blood flow and oxygen delivery to the bones. Moreover, smokers are prone to musculoskeletal pain due to systemic inflammation caused by tobacco consumption. Lastly, job tasks are different throughout each laboratory centre, thus, it is one of the predisposing factors to be considered in the study of MSDs.

Ergonomic risk factors include awkward postures, forceful exertions, prolonged static positions, and grip quality in load handling tasks, known as coupling. Awkward postures are unnatural positions of the body and body parts, usually as a result of the demands of work.

These postures lead to increased workload in certain muscles, which subsequently leads to musculoskeletal stress. Forceful exertions are excessive forces generated by the musculoskeletal system of the worker to perform certain job demands. Chronic forceful exertions lead to muscle fatigue and increase the likelihood of MSDs. Certain job demands, particularly in the context of medical laboratory technologists, require static postures in performing meticulous tasks, such as using the microscope, entering laboratory results into the computer, and conducting pipetting tasks with thousands of wells. In addition, grip quality while using certain equipment is also an important factor in the susceptibility to having MSDs.

1.9 Definition of terms

Work-related MSDs (WMSDs) are disorders of the muscles, joints, bones, cartilages, and connective tissues that are caused by performing work-related tasks. It is usually exhibited during or after the duration of performing work tasks (11).

Ergonomic risk factors are elements of a work task that increase the likelihood of developing MSDs due to various factors at work (12). Ergonomic risk assessment is the process of evaluating ergonomic risks in a specific work task by visual observation (4). The magnitude of the ergonomic risk can be quantified by utilising Rapid Entire Body Assessment (REBA) for a whole body assessment of ergonomic risk (13).

Medical laboratory technologists (MLTs) are qualified persons who graduated from an accredited university or institution. In this study, the MLTs have undergone a public service department interview and have been selected by the Government of Malaysia to function as medical laboratory workers performing medical laboratory work in Malaysia's healthcare system (14). There are also MLTs working in various private sectors in Malaysia.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Musculoskeletal disorders (MSDs) are any type of discomfort, until the extent to irreversible or disabling injury affecting the muscles, motor organs, tendons, cartilages, bones, nerves, and ligaments (15). MSDs were the leading disease causing disability globally, and ranked fifth in overall diseases in disability-adjusted life-years (DALYs) in 2017 (16). People with MSDs tend to have psychological disorders, aggravated by continuous bodily pain and unstable mood (17). A systematic review with meta-analysis on MSDs showed that persons with MSD conditions have a higher risk of chronic diseases (RR 1.17, 95% confidence interval 1.13-1.22) (18). This study focuses on musculoskeletal disorders that are associated with workplace activities.

2.2 Global overview of MSDs

Musculoskeletal disorders that arise due to physical activities in the workplace are known as work-related musculoskeletal disorders (WMSDs). According to a systematic review by Greggi et al. in 2024, four main occupational groups were synthesised among the working population: healthcare, farming, industrial, and computer sectors (11). Each of these four groups has different ergonomic risk factors and MSD ailments. The commonly affected workers with various degrees of pathological conditions were in the industrial sector, as the work tasks are the most physically demanding nature of work. On the contrary, computer workers mostly have ailments around the neck, upper limbs, and shoulders. In the healthcare sector, osteopenia in doctors and hand osteoarthritis in dentists were the common diseases of the musculoskeletal system that were reported in the review (11).

2.3 Prevalence of MSDs in medical laboratory workers worldwide

Through a systematic literature review carried out, there were 10 available studies on MSDs among medical laboratory workers. In 2020, a study in Saudi Arabia among medical laboratory workers found that 82% had experienced musculoskeletal discomfort in the previous 12 months of work, highlighting lower back pain as the most prevalent site of pain (19). Another study on a similar population conducted in India showed a 73.3% prevalence rate of musculoskeletal disorders among MLTs (20). After synthesising these available studies, a total of 2,417 participants were involved, with 1,779 of them having MSDs. Thus, the pooled prevalence rate was 73.6%. Table 2.1 below shows every proportion of musculoskeletal disorders among medical laboratory workers retrieved via three online scientific databases, which were Scopus, Embase, and PubMed.

Table 2.1. Summary of available MSDs studies among medical laboratory workers.

Study (Author, year)	The number of participants had WMSDs (n)	Number of participants (N)	Percentage (%)
Herman, 1995 (21)	157	253	62.1
Jacobsen, 1996 (22)	452	731	61.8
Kalavar, 1996 (23)	71	78	91.0
Thompson, 2003 (24)	207	244	84.8
Maulik, 2014 (20)	44	60	73.3
Sadeghian, 2014 (25)	113	156	72.4
AlNekhilan, 2020 (19)	239	292	81.8
Lopez-Gonzalez, 2021 (26)	306	362	84.5
Patrao, 2022 (27)	84	120	70.0
Shah, 2023 (28)	106	121	87.6
Total	1779	2417	73.6

2.4 MSDs in the Malaysian medical laboratory workforce

In the Malaysian context, the literature on MSDs among medical laboratory workers is scarce, with only a single study published, with reported prevalence of MSDs of the neck (91.8%), followed by the shoulders (87.5%) and lower back (85.7%) (4). The study highlighted that awkward posture was the main ergonomic risk factor in their routine work tasks, with a high-risk level recorded by utilising the Rapid Upper Limb Assessment (RULA), an ergonomic risk assessment tool that focuses on upper limb movements (29).

2.5 Socio-demographic factors of MSDs

Socio-demographic factors include a variety of personal and social characteristics, such as age, gender, occupation, educational status, ethnicity, and marital status. These variables had a significant association with MSDs, and each variable is described below.

2.5.1 Age

One of the factors associated with the occurrence of MSDs is age. According to a study among medical laboratory workers in Ethiopia, workers aged 36 and above had higher odds of MSDs (AOR 1.51, 95% CI: 1.02-6.01) (30). A local study on medical laboratory workers showed a significant correlation between the frequency of MSDs and age (4). However, a study in Saudi Arabia showed no significant differences among age groups ($p = 0.338$) (31). With vast literature linking age with the occurrence of MSDs, thus, age is considered to be an independent variable of theoretical importance.

2.5.2 Gender

According to a study conducted in Ethiopia, females had higher odds of MSDs among medical laboratory workers (AOR 1.89, 95% CI: 1.09-5.04) (30). Moreover, among Malaysian medical laboratory workers, female gender also had a significant correlation with the frequency of

MSDs (4). In contrary, there was no significant relationship between gender and MSDs in a study among medical laboratory workers in Saudi Arabia (p = 0.43) (31). Due to numerous literature highlighting females with higher tendency of MSDs, this variable is also considered as an independent variable with theoretical importance, alongside age.

2.5.3 Ethnicity

In a cross-sectional study among supermarket cashiers in Malaysia, MSDs, particularly the upper back region, were associated with Malay ethnicity (p-value = 0.0042) (32). However, findings from an urban population in Seremban, Malaysia, showed that Indians were more prone to MSDs (33). On the contrary, there was no available literature discussing ethnicity as the predictor of MSDs in the context of medical laboratory workers.

2.5.4 Marital status

According to a cross-sectional study among cashiers in Ethiopia, it was found that married cashiers had a higher prevalence of MSDs compared to their unmarried counterparts (AOR 2.12, 95% CI: 1.26, 3.56) (34). In contrast, a study on Iranian nurses showed there was no significant association between marital status and MSDs (35). However, there was no available evidence on marital status with MSDs in medical laboratory workers.

2.5.5 Level of education

Hansen et al. in 2023 discovered that a higher education level was associated with lower odds of musculoskeletal pain (OR 0.56, 95% CI: 0.41, 0.74) among the Danish elderly population (36). A study among nurses in Malaysia found that a lower education level was a significant risk factor for MSDs (37). However, there was no available evidence on the relationship between education level and MSDs in medical laboratory workers.

2.6 Predisposing factors of MSDs

The predisposing factors are psychological or situational characteristics that influence an individual's tendency or motivation to engage in a particular behaviour (10). These variables are the determinants of health, particularly with MSDs, and each of the variable were described below.

2.6.1 Body mass index (BMI)

A study in Saudi Arabia among medical laboratory workers showed that there was no significant association between BMI and MSDs (31). However, among the working population conducted in the Netherlands, workers with an obese BMI had higher odds of MSDs (OR 1.37, 95% CI: 1.05-1.79) with an inverse relation to symptom recovery (OR 0.76, 95% CI: 0.59-0.97) (38). In addition, a study in Portugal among manufacturing workers found that overweight and obese workers had significantly higher odds of having MSDs (OR 2.129, 95% CI: 1.108, 4.091) (39). Higher BMI among nurses was also associated with a higher incidence of MSDs (37).

2.6.2 Years of experience

In a study conducted among medical laboratory workers in the African country of Ethiopia, there was significantly higher odds of MSDs among workers with more than 15 years of experience (AOR 4.13, 95% CI: 1.52-10.81) and among workers in between 10 to 15 years of experience (AOR 3.99, 95% CI 1.60-9.40) compared to workers with less than 10 years of experience (30). This finding was supported by another study among Saudi Arabian medical laboratory workers, with a significant relationship between years of experience and MSDs ($p = 0.024$) (31). Thus, length of working experience was generally correlated with higher odds of MSDs.

2.6.3 Underlying medical illnesses

In a study among Ethiopian laboratory workers, the presence of chronic medical illness had no significant relationship with MSDs (30). However, according to a large cohort study conducted in Brazil, depression [Prevalence Ratio (PR): 2.55 (95% CI: 2.35–2.77), $p < 0.001$], and sleep disorders [PR: 2.32 (95% CI: 2.17–2.48), $p < 0.001$] had a significant association with MSDs (40). In addition, mental illnesses such as personality disorders and depression made a significant contribution to the incidence of MSDs among nurses in China (41).

2.6.4 Previous history of orthopaedic illness

In a study among healthcare providers in Ethiopia, workers with a history of orthopaedic illness had significantly higher odds of developing MSDs (aOR 6.85; 95% CI: 1.91-22.7) (42). Otherwise, there was no other available evidence on the relationship between previous orthopaedic illness and MSDs specifically among medical laboratory workers.

2.6.5 Smoking or vaping status

There was no available literature on the effect of smoking and vaping behaviours on the occurrence of MSDs among medical laboratory workers. However, a study among bus drivers in India showed that tobacco use was a significant predictor of MSDs (43). Literature is scarce on the association of smoking or vaping with the occurrence of MSDs.

2.7 Ergonomic risk factors

Rapid Entire Body Assessment (REBA) is a thorough full-body assessment tool to evaluate ergonomic risks, developed in 2000 by Hignett and McAtamney (13). REBA provides an easy and rapid assessment of various ergonomic hazards, focusing on whole body posture while executing a specified task. In addition, other factors such as the load or force exerted by the body and the quality of grip (coupling) in performing the task were also taken into account for

the final REBA scoring (13). REBA is suitable for the application of risk assessment in various occupational settings, including the healthcare sector (44).

In the literature, REBA has been utilised in a study among medical laboratory workers in India, with a significant association between REBA scores and the type of work tasks ($p < 0.05$). Types of laboratory, such as biochemistry, microbiology, and pathology, were also statistically significant with REBA scores ($p < 0.05$) (27).

2.8 Conceptual framework

Based on previous studies within the last five years on MSDs among medical laboratory workers, there were seven studies focusing on various aspects of predictors of MSDs. Ergonomic risk factors, such as awkward posture and repetitive actions of pippeting, microscope use, along with prolonged static position in the process of data entry into a computerised system, were the main risk factors of MSDs described by all seven studies (19,27,28,30,31,45,46). Most of the body regions affected were the neck and shoulders, due to the exposure of various ergonomic risk factors. In addition, poor workstation design was among the ergonomic risk factors depicted by the studies from Estonia and Ethiopia (30,46).

One of the associated factors analysed was the socio-demographic factors, elicited by Fikre et al. in 2024 (30). Age and gender were the significant predictors with three times higher odds of having MSDs. Additionally, predisposing factors such as smoking behaviour, physical activity, alcohol use, and chronic medical conditions were also part of the conceptual framework of the same study (30).

Another aspect of interest in the predictors of MSDs among laboratory workers was the psychosocial risk factors, investigated by the studies in Saudi Arabia, Estonia, and the United

States (28,31,46). These psychosocial risks were due to the extraordinary workload, pressure from completing the work tasks before deadlines, and inadequate staffing.

Poor implementation of occupational health and safety policies was one of the framework the of MSDs occurrence in a study by Aldhabi et al. in 2025 (31). Lack of compliance with ergonomic principles affects the prevalence of MSDs among Ethiopian medical laboratory workers (30).

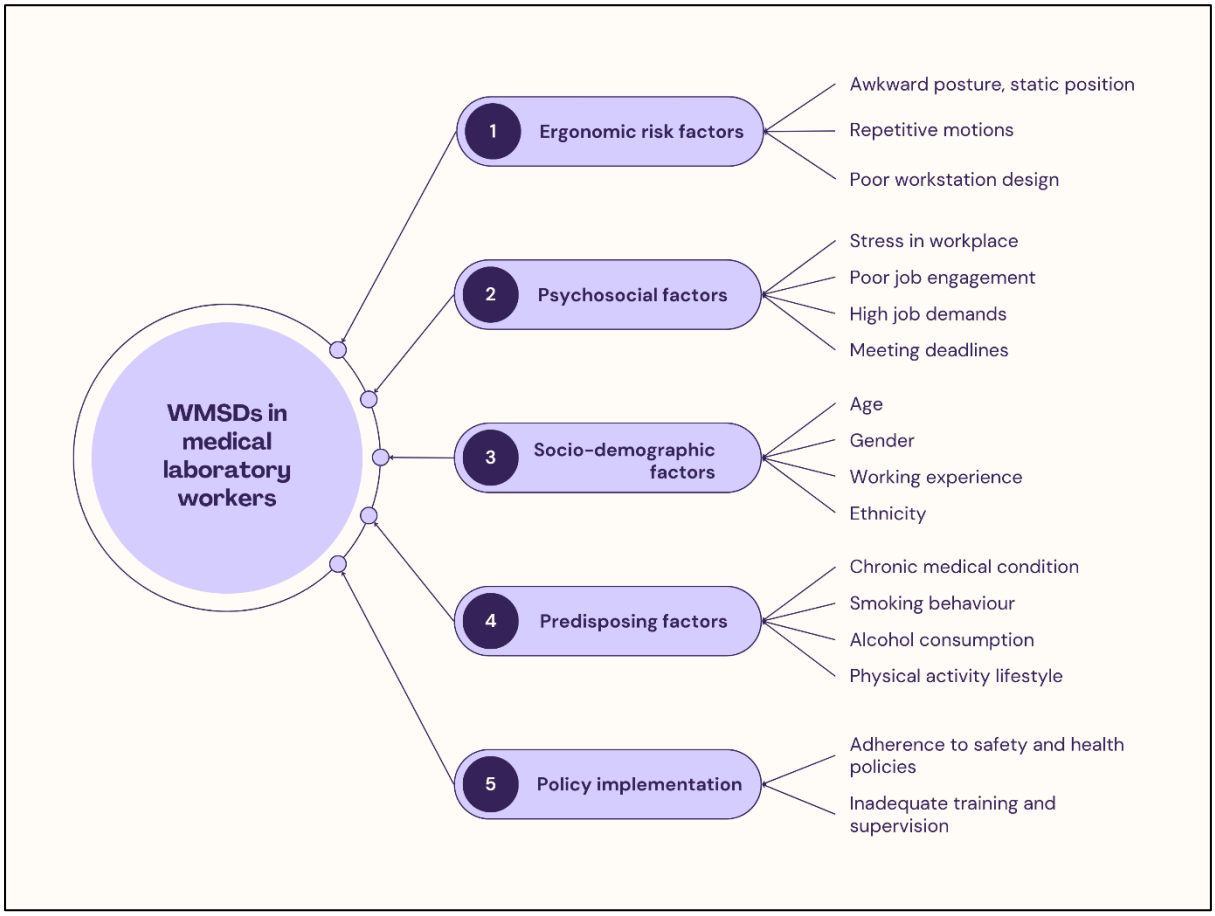

Figure 2.1. The conceptual framework from seven similar studies between 2020 and 2025 (19,27,28,30,31,45,46)**.**

2.9 Summary and literature gaps

Medical laboratory workers are prone to MSDs due to the nature of their work, which exposes them to numerous types of ergonomic risks. A previous local study among medical laboratory workers in Malaysian medical laboratory settings in 2024 only recruited 49 workers (4). Thus,

this study emphasised on larger sample of medical laboratory workers with the utilisation of a more robust ergonomic risk assessment tool (REBA), focusing on every part of the body. In contrast, RULA focuses more on upper body parts and was used in the previous study among laboratory workers in Malaysia (4). Therefore, this study possessed a novelty in utilising the REBA tool in the context of Malaysian medical laboratory workers.

CHAPTER 3: METHODOLOGY

3.1 Research Design

This is a quantitative cross-sectional study, a type of observational study that measures outcomes and exposures of a study population based on one point in time. This type of research design was chosen due to its cost-effectiveness and its appropriateness for a larger sample size compared to other types of observational study designs (47). In this study, data collection was collected using the self-administered questionnaire form, and the ergonomic risk assessments were conducted according to their specific job tasks within their respective laboratory centre.

3.2 Research Location

The study involved medical laboratory centres within the Institute for Medical Research (IMR), National Institutes of Health (NIH), under the purview of the Ministry of Health Malaysia (MOH). The main function of the medical laboratories in NIH was mainly for medical research purposes, along with selected diagnostic capabilities, focusing exclusively on specialised diagnostic tests (48). NIH laboratories were selected as they consisted of multidisciplinary medical laboratory setting, thus multiple laboratory work tasks could be evaluated. There were seven laboratory centres in IMR, and the majority of the laboratory centres were situated in the Setia Alam NIH complex. There was only one laboratory centre, which is the Biomedical and Genomics Research Centre (BGRC) located in the century-old medical laboratory building in Kuala Lumpur (49).

3.3 Population Background

The medical laboratories in the NIH were operated by medical laboratory technologists (MLTs). These MLTs were appointed by the government of Malaysia through the Public Service Department (PSD). PSD is a central government agency responsible for managing

human resources for the civil service, including enforcing policies and administrative affairs. The minimum requirements for appointment as an MLT include being a Malaysian citizen, over 18 years of age, and having completed training at an accredited training centre or university (50).

3.4 Sampling Procedure

Sociodemographic and musculoskeletal discomfort data from MLTs working in NIH were collected via a self-administered questionnaire survey form. Invitation for participation in this study was circulated via official email via the Director of Institute for Medical Research (IMR). A written consent was obtained prior conducting the data collection. The participation in this study was voluntary. The ergonomic risk assessment was conducted by observing the participant's specified work task in his or her particular laboratory unit. Photos of the work tasks were taken for cross-reference and publication purposes. The process of answering the questionnaire and the ergonomic risk assessment was conducted for approximately 20 minutes for each participant.

3.4.1 Target Population

The target population in this study were medical laboratory technologists (MLTs) working in any of the seven (7) medical laboratory centres located at the National Institutes of Health (NIH), Malaysia, during the data collection period from 1st of December 2024, until 30th of April 2025. The MLTs were clustered according to their laboratory centres, each with different work task. Thus, each laboratory centre has different types of ergonomic risk factors with varying magnitude of ergonomic hazard exposure. Table 3.1 below describes the names of the seven laboratory centres, their common job tasks, and their respective ergonomic risks involved.

Table 3.1. Job task-related risk in each laboratory centre.

Laboratory centre	Job task	Ergonomic risks involved
Infectious Diseases Lab (IDRC)	Cell cultures, viral load quantification.	Prolonged standing, static posture.
Nutrition and Metabolic Lab (NMCRC)	Biochemical assays, metabolomics.	Repetitive pipetting, prolonged standing.
Environmental Health Lab (EHRC)	Toxicology analysis, water and air quality testing.	Manual handling, awkward posture.
Allergy and Immunology Lab (AIRC)	Allergen tests, cytokine profiling	Awkward posture, repetitive pipetting.
Cancer Lab (CaRC)	Molecular pathology, DNA and RNA sequencing	Repetitive hand movements, prolonged sitting.
Herbal Medicine Lab (HMRC)	Phytochemical tests, bioassay testing.	Repetitive filtration, awkward posture.
Biomedical and Genomic Lab (BGRC)	Genomic sequencing, gene expression analysis.	Static posture, repetitive hand movements.

3.4.2 Sampling Frame

To enhance internal validity, a homogenous sample population was created by adhering to the inclusion and exclusion criteria (51). This is essential in reducing variability and confounding factors. Moreover, this method improves safety and ethics, as pregnant workers and disabled workers were excluded from this study. In addition, a homogenous sample population increases the precision of results.

The inclusion criteria were:

- All MLTs employed on either a permanent or contractual employment status with the government of Malaysia, working in any of the centres in IMR, and willingly agreed to participate in the study, as per the Declaration of Helsinki in recruiting study participants with their informed consents (52).

Whereas the exclusion criteria were:

- Any MLTs who had worked less than a year at NIH
- Any MLT who was an active participant in any interventional studies involving the musculoskeletal system
- MLTs who did not perform any laboratory work tasks
- MLTs who were pregnant, as pregnancy-related MSDs may result in false-positive results of MSDs **(53)**.

Each participant could withdraw at any time. Additionally, the investigator could withdraw a participant if continuing was deemed detrimental or posed a risk. Withdrawn participants were not replaced.

3.4.3 Sample Size Determination

Calculating the appropriate sample size is a critical step in a research design. This sample size determination is essential in ensuring the study is scientifically valid, ethically justified, and statistically reliable. The equation for calculating sample size is shown below.

$$\text{Finite population: } n' = \frac{n}{1+\frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$$

Where: z is the z score, ε is the margin of error, N is the population size, and $\hat{p}$ is the population proportion (54).

To ensure adequate statistical power, a power of 80% was set in the calculation. To minimise the type II error, which is to avoid false negatives, the beta (β) value of 0.2 was decided. The confidence interval was set at 95% to provide accurate estimates (54).

For the minimum number of participants, sample size calculation helps in preventing oversampling. This may benefit the researcher's time spent researching a given population.

Therefore, based on alpha of 0.05, with the total number of MLTs in NIH is 262, and with 73.6% of population proportion ($\hat{p}$) having MSDs based on 10 previous studies listed in Table 1, the calculated sample size for the minimum sample required was 140.

3.2.4 Sampling technique

The sampling technique was a census sampling approach, with an invitation to participate in the study advertised via the Director of IMR, and each Head of Centre was approached for the recruitment of each MLT in their respective centres. Only those who consented to participate were recruited in the final sample. Census sampling invites all eligible study population to participate in the study.

3.5 Operationalisation of variables

The operational definition of variables is how variables were assessed or measured in the questionnaire form. The operational definition of variables in this study is tabulated in Table 3.2 below.

Table 3.2. Operational definition of variables.

Associating factors: Socio-demographic factors	
Age	Measured in completed years of life, as reported by the participant at the time of answering the questionnaire. It is a continuous variable.
Gender	Self-reported identity of participants and recorded as either 'Male' or 'Female'. It is a nominal variable.
Ethnicity	Self-reported ethnic group of the participant, categorised into either 'Malay', 'Sabah or Sarawak origin', 'Chinese', 'Indian', or 'Others'. It is a nominal variable.

Highest education status	Self-reported highest formal education level attained by the participant, either 'Diploma', 'Bachelor's degree', or 'Master's degree and above'. It is an ordinal variable.
Marital status	Self-reported marital status which refers to marriage contract or previously on any marriage contract, with options either 'Married', 'Divorced', 'Widowed', or 'Single'. It is a nominal variable.
Associating factors: Predisposing factors	
Smoking or vaping status	Self-reported smoking or vaping behaviour, and categorised as either 'Yes' or 'No'. This is a nominal variable.
Underlying illnesses	Self-reported underlying medical illnesses, such as, but not limited to, hypertension, diabetes, dyslipidemia, stroke, heart disease, and others. If there was presence of any of the underlying medical illness, option 'Yes' should be chosen. 'No' refers to no underlying medical illnesses. This is a nominal variable.
History of orthopaedic illness	Self-reported musculoskeletal or bone-related medical conditions, injuries, or surgical interventions that occurred prior to the time of study participation. The option is either 'Yes' or 'No'. This is a nominal variable.
Years of experience as an MLT	Self-reported completed years of working experience as an MLT in the NIH laboratories at the time of data collection. It is a continuous variable.
Weight (in kg)	Self-reported body weight, in the unit of kilograms, during the time of data collection. This is a continuous variable.
Height (in cm)	Self-reported body height, in the unit of centimetres, during the time of data collection. This is a continuous variable.
Body mass index (BMI)	BMI was calculated by dividing the self-reported body weight (in kilograms) with square of self-reported height (converted into metres). This is a continuous variable and calculated by the investigator using the Microsoft Excel spreadsheet.
Laboratory centre	There were 7 laboratory centres administratively under the Institute for Medical Research (IMR). National Institutes of Health (NIH), which were Biomedical and Genomics Research Centre (BGRC), Herbal Medicine Research Centre (HMRC), Cancer

	Research Centre (CaRC), Allergy and Immunology Research Centre (AIRC), Environmental Health Research Centre (EHRC), Infectious Disease Research Centre (IDRC), and Nutrition, Metabolic, and Cardiovascular Research Centre (NMCRC). Thus it is a self-reported laboratory centre of the participant with the option of either one of the seven laboratory centres stated above. This is a nominal variable.
Associating factors: Ergonomic risk factors	
REBA risk level	REBA risk level is assessed via direct observation of participants performing their assigned job tasks in their specific laboratory centre. Ergonomic risk factors, such as awkward posture, prolonged static position, forceful exertion, and coupling, were assessed according to the standard REBA worksheet. REBA scoring level has 5 tiers: negligible (1), low risk (2-3), medium risk (4-7), high risk (8-10), and very high risk (11-15). This is an ordinal variable.
Prevalence of WMSDs	
Musculoskeletal disorder	The presence of self-reporting musculoskeletal discomfort at any of the nine body region utilising the Nordic Musculoskeletal Discomfort Questionnaire – Extended (NMQ-E). The presence of MSDs was recalled for the past 12 months. The option was 'Yes' or 'No' for each specific question in each body region. This is a nominal variable.

Musculoskeletal disorders (MSDs) were measured by using the Nordic Musculoskeletal Questionnaire (NMQ-E), which depicts the presence or absence of musculoskeletal discomfort within the last 12 months at specific regions of the body.

Ergonomic risks were quantified by using the scoring from the Rapid Entire Body Assessment (REBA) tool. The scoring is in discrete numerical order, with higher scores corresponding to higher ergonomic risks.

3.6 Research instrument

A self-reported questionnaire was used to collect the data in this research study based on previous similar studies on MSDs. There were three sections: Section A, B, and C. The participant was asked to fill in Section A, the socio-demographic and predisposing factors data, followed by Section B, a self-reported questionnaire on musculoskeletal discomfort.

Sections A and B were measured for addressing specific objective number three: to determine the association between sociodemographic factors, predisposing factors, ergonomic risk levels and MSDs among MLTs. In addition, Section A also measured the requirement of specific objective one: to determine the prevalence of MSDs among medical MLTs at the National Institutes of Health, Malaysia. Section C was the ergonomic risk assessment, filled by the investigator, who is a competent, ergonomic trained person, using the REBA tool. Section C addressed specific objective two: to assess whole-body postural risk levels and job task-related risk among these MLTs.

In section B, the MSDs were measured by using the Nordic Musculoskeletal Questionnaire – Extended (NMQ-E). The NMQ-E was developed by Dawson et al. (2009) [9]. It is a updated version derived from the original Nordic Musculoskeletal Questionnaire (NMQ) developed by Kuorinka et al. (1987) [10]. NMQ as a useful tool for screening work-related musculoskeletal complaints according to nine regions of the body. Each body region consists of 11 questions. Participants were asked about the lifetime prevalence of MSDs, including 12 month prevalence, 1 month prevalence, and point of prevalence (current at the time of the survey) of pain, history of hospitalisations and changes in job, as well as information regarding consequences of pain in the past year such as participation restrictions at home, seeking treatment in a health facility, and sick leaves. Excluding the question regarding the age of the onset of pain, all other response options were dichotomous (yes/no). This instrument is a

structured, reliable, and validated tool that has been used widely across various study settings to quantify the prevalence, severity, and impact of musculoskeletal symptoms. The prevalence of MSDs within the last 12 months was calculated for the specific objective number one.

In section C, the ergonomic risk assessment was assessed by using the Rapid Entire Body Assessment (REBA) tool [11]. The REBA method scoring stratifies risk magnitude with a score of 1: negligible risk, 2-3: low risk, 4-7: medium risk, 8-10: high risk, and 11-15: very high risk. This assessment was conducted by direct observation, with photos of the particular work task taken during the observation with the participant's prior consent. The face of the participant and any identification materials were obscured for confidentiality. Table 3.2 below shows the ergonomic risk level from the REBA scoring chart.

Table 3.3. REBA scoring levels

Risk level	**REBA score**
Negligible risk	1
Low risk	2-3
Medium risk	4-7
High risk	8-10
Very high risk	11-15

3.7 Validity and reliability of the instrument.

A study by Dahl et al. in 2022 using the NMQ-E found that the reliability was good for hip and knee pain (kappa values between 0.63 and 0.68). Moderate kappa values reported for pain in the neck, elbow, shoulder, upper back, wrist/hand, lower back, ankle/feet, and calf between 0.51-0.60 (55).

Schwartz et al. in 2019 reported a high intra-rater reliability of 0.925 for its raw scores and moderate inter-rater reliability (Fleiss kappa = 0.54) for the categorical scoring of REBA (56).

3.8 Ethical considerations

This study was conducted in compliance with ethical principles according to the Declaration of Helsinki and the Good Clinical Practice (GCP) Guideline of Malaysia. Ethical approval was obtained from the IMU University Joint Committee (IMU-JC) and the Medical Research Ethical Committee (MREC). The permission from the Director of the Institute for Medical Research was granted before conducting this study.

Participants were informed of the study during their work tasks. They were requested to contact any study investigator if they were interested to join. An appointment date with the participant was allocated where the participant's information sheet was distributed and explained to them. As they were voluntarity agreed to participate, the consent forms were signed and dated. The investigators declare they have no conflict of interest. No personal information data was disclosed, and subjects were not identified in the study report.

3.9 Data collection procedure

The permission for conducting the study was applied to the Director of the Institute for Medical Research (IMR), the institute under the National Institutes of Health (NIH) that caters to the medical laboratories. After obtaining the permission to conduct the study, the permission letter was circulated to all heads of laboratory centres, a total of 7 of them. Albeit the letter had been circulated, permission for conducting the study at each laboratory needed to be applied to each head of centre personally for building rapport and subsequently easing the process of data collection. The data collection schedule was distributed to all of the laboratory centres after mutual agreement on specified dates.

During each study visit, the participants were approached during their work tasks in their designated medical laboratory. Participants were informed regarding this study via the participant information sheet, and written consent was taken in the presence of a witness. The subjects were given sufficient time to consider their participation in this study. This data collection procedure took about 20 to 30 minutes per subject, starting from the self-administered questionnaire and ending with an ergonomic risk assessment using the REBA tool. Participants with significant REBA scores were informed immediately, and recommendations for reducing ergonomic risks were given adequately. This procedure of assessing ergonomic risks using the REBA tool did not affect participants' working environment, as the ergonomic assessor assessed the risk by observation only and did not interrupt the flow of the working area during laboratory work tasks. Photographs of work tasks for results reporting were taken without revealing the workers' faces to protect their identities. The permission for taking photos and videos, if necessary, was written and explained in the consent form. The data and assessment records were kept in a locked storage cabinet for recordkeeping up to three years after the completion of the study. Figure 3.1 below shows the process flow from ethical approval until the completion of the data collection process.

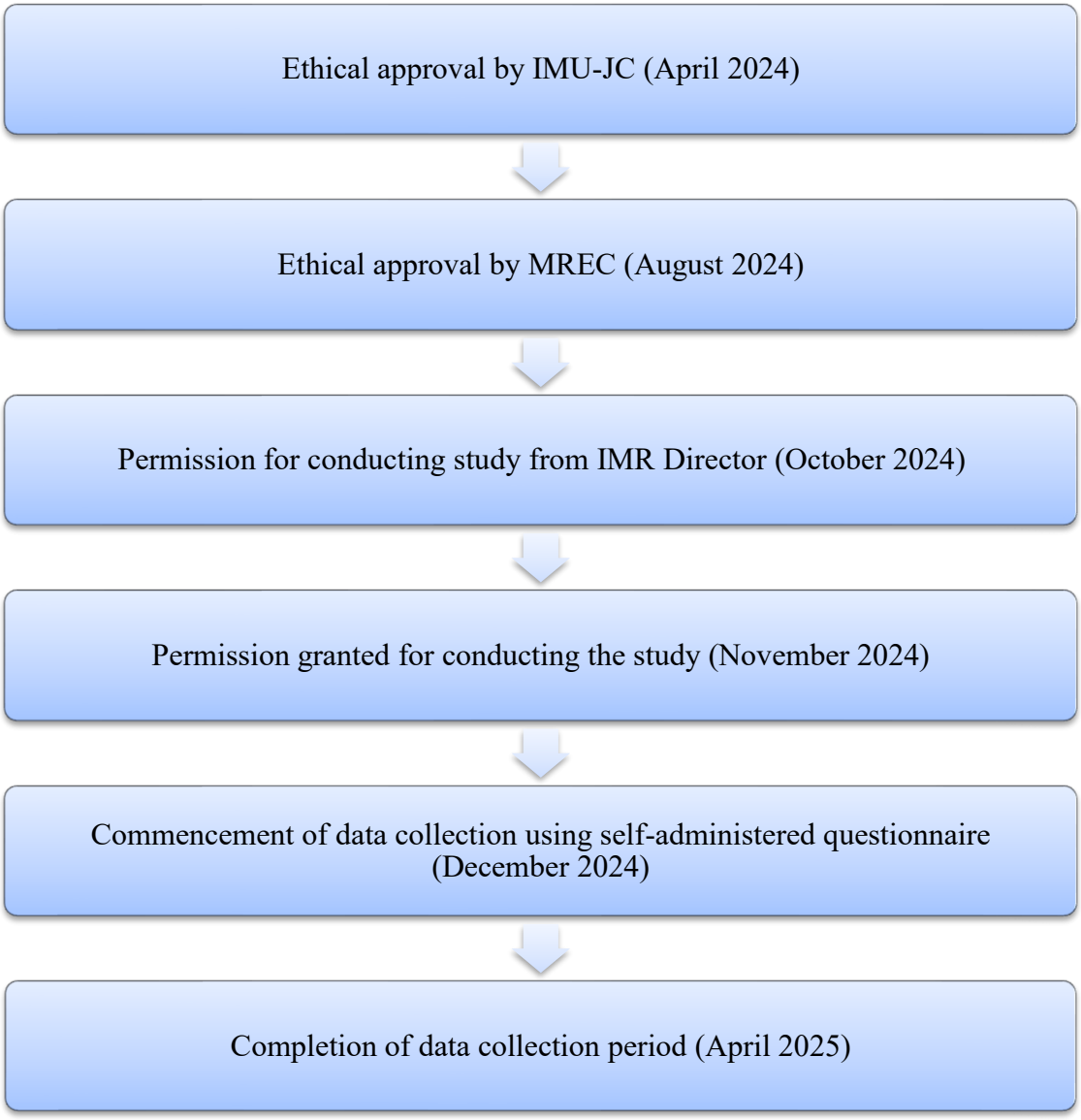

Figure 3.1. The chronology of NMRR, MREC, and the data collection process.

3.10 Data Analysis

All analyses utilised the Statistical Package for Social Sciences (SPSS) software version 29.0 (57), and the graphics were designed from both the SPSS software and Microsoft Excel (58). A thorough screening process for data validity was conducted via Microsoft Excel.

For descriptive analysis, normally distributed data were presented in mean and standard deviation, whilst non-normal distributions were presented in median and interquartile range.

Frequencies and percentages were presented for categorical data. Continuous variables were tested for normality by using the Shapiro-Wilk test.

To address objective 1, the prevalence rate of MSDs in any part of the body region for the past 12 months among the MLTs was presented in percentage, followed by the breakdown of MSDs from each body region.

Meanwhile, for objective 2, the data of REBA risk levels and job task-related risk were described using frequencies and percentages. The relationship between REBA risk levels with job task-related risk was analysed using the Chi-square test, as the REBA risk levels were an ordinal categorical variable, and job task-related risk was a binary outcome.

Participants' socio-demographic profile, predisposing factors, and REBA scores were taken as independent variables. Complaints of musculoskeletal disorders in the last 12 months were taken as the dependent variable, collected via the Extended Nordic Musculoskeletal Questionnaire (NMQ-E). For bivariate analysis, an independent t-test was applied for any normally distributed data, and the Mann-Whitney U test was used for non-normally distributed data with a binary outcome. The Kruskal-Wallis test was applied for non-normally distributed data with three or more categorical outcomes. Categorical data were analysed using the Chi-square or Fisher's exact test for the presence of a significant association. A p-value of less than 0.05 in any of the inferential tests is considered statistically significant.

To estimate the independent effect of each independent variable, a multicollinearity test by using the Variance Inflation Factor (VIF) was conducted. This test is essential to detect and reduce any significant multicollinearity between the numerical variables.

To test for the direction and strength of the association, as recommended by Hosmer and Lemeshow, all the variables with a p-value less than 0.25 in the bivariate analysis were tested in the logistic regression model (59). The model adopted the stepwise forward conditional

method to identify independent predictors of the outcome. This method was chosen to allow for the systematic selection of variables based on their statistical contribution to the model, while minimising the inclusion of non-significant factors. Confounder variables were included in the first block of the stepwise method, regardless of their p-value. These steps addressed objective 3.

The goodness of fit of the final model was tested by using the Hosmer-Lemeshow test, Omnibus test for model coefficients, Classification Table, and Receiver Operating Characteristic (ROC) Curve and Area Under Curve (AUC).

3.11 Data Management

Each participant was given a unique running number, such as '001', '002', and so on. This unique number was labelled as 'Participant ID' in the questionnaire. Personal identifiers such as name, identification number, address, email, phone number, or any medical records registration number were not collected. All data were entered into a computer that is password protected. On completion of the study, the data in the computer was copied to a password-protected external hard disk, and the data in the computer was erased. External hard disks and hardcopy data were stored in the investigators' locked office for at least three years post-study, after which they will be destroyed. Participants were not allowed to view their study data, as the data were consolidated into a database. Participants can write to the investigators to request access to study findings. The study data will be deposited in the NIH data repository, NIH-DaRS, within 1 year after the completion of this study.

CHAPTER 4: RESULTS

4.1 Introduction

This section contains the results from the data collection, with in-depth analysis of each objective, encompassing all variables, including bivariate and multivariate analyses. After the data validation process by screening and validating the data collected, 115 participants were obtained, with a 43.9% response rate (n = 115) from the total population of 262.

4.2 Socio-demographics

The mean age of the sample population was 35.15 years, with a standard deviation (SD) of ±6.98 years. For the categorical variables, females constituted 80.9% (n = 93) of the participants. Most of them were married and were Malay. About a quarter of them had a bachelor's degree. Table 4.1 below shows the socio-demographics of the variables.

Table 4.1. Descriptive statistics of categorical variables for socio-demographics.

Variables	**n (%)**
Gender	
Female	93 (80.9)
Male	22 (19.1)
Marital status	
Married/Divorced/Widowed	73 (63.5)
Single	42 (36.5)
Ethnicity	
Sabah and Sarawak natives	28 (24.3)
Malays	74 (64.3)
Chinese and Indians	13 (11.3)
Highest education level	
Bachelor's Degree	32 (27.8)
Diploma	83 (72.2)

4.3 Predisposing factors

Most of the MLTs were between 3 and 11 years of experience working in NIH laboratories, with a median experience of 7 years (IQR 8). Figure 4.1 below describes the distribution of years of experience among the MLTs involved.

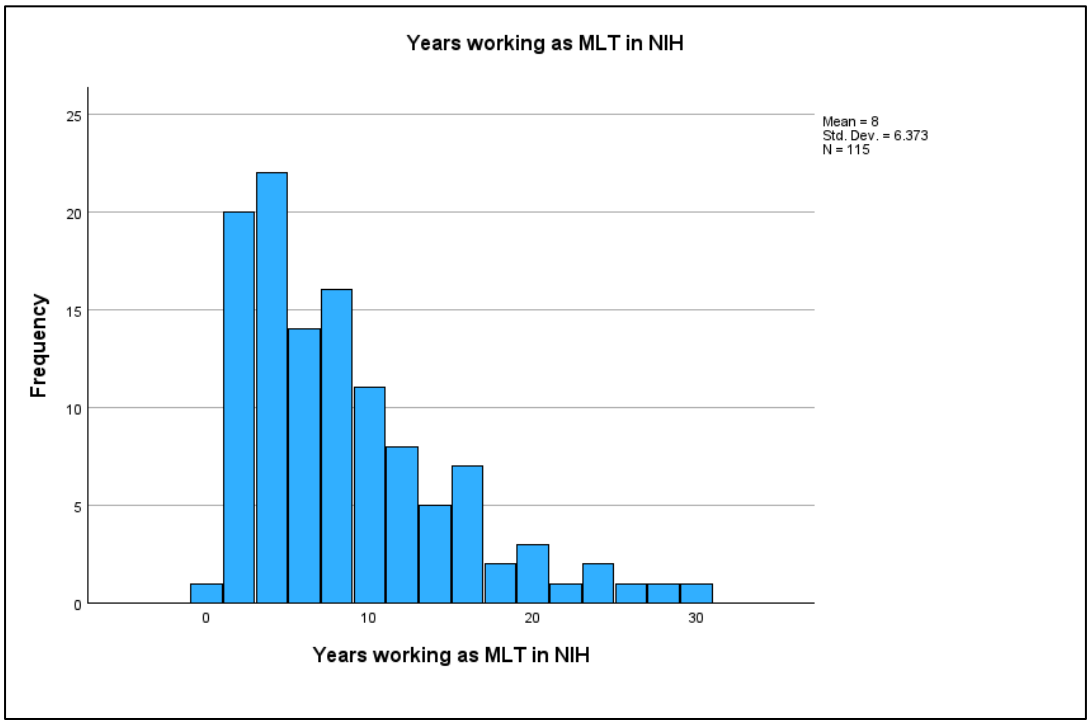

Figure 4.1. Histogram of years of working as MLT in NIH laboratories.

More than half of the population was obese. About a quarter of the MLT had a bachelor's degree, and nearly one-third of them worked in the IDRC laboratory centre. The categorical data were presented in frequencies and percentages as shown in Table 4.2 below.

Table 4.2. Descriptive statistics of categorical variables for predisposing factors.

Variables	n (%)
Body mass index (BMI)	
Normal and underweight	49 (42.6)
Overweight and obese	66 (57.4)
Laboratory	
IDRC	35 (30.4)
AIRC	19 (16.5)
BGRC	18 (15.7)
EHRC	15 (13.0)
CaRC	13 (11.3)
NMCRC	8 (7.0)
HMRC	7 (6.1)
Smoking/vaping status	
Yes	4 (3.5)
No	111 (96.5)
Underlying illness	
Yes	16 (13.9)
No	99 (86.1)
History of orthopaedic illness/surgery	
Yes	14 (12.2)
No	101 (87.8)

4.4 Ergonomic risk factors

Most of the participants had REBA scores of low risk, while others had medium risk. There were no recorded REBA scores in the negligible, high, and very high risk levels. The findings were described in Table 4.3.

Table 4.3. REBA risk levels.

REBA Score	Frequency (n)	Percentage (%)
Negligible	0	0.0
Low risk	97	84.3
Medium risk	18	15.7
High risk	0	0.0
Very high risk	0	0.0

4.5 Objective 1: To determine the prevalence of MSDs among MLTs in laboratory settings.

To address the first objective, the prevalence of MSDs was calculated by the number of participants with the presence of discomfort in any of the body regions for the past 12 months as the numerator, divided by the total number of participants as the denominator. The value from the proportion of participants was converted into percentages.

Among 115 participants, 73 of them (63.5%) reported having experienced discomfort in at least one body region for the past one year. Figure 4.2 describes the proportion of MSDs in this study.

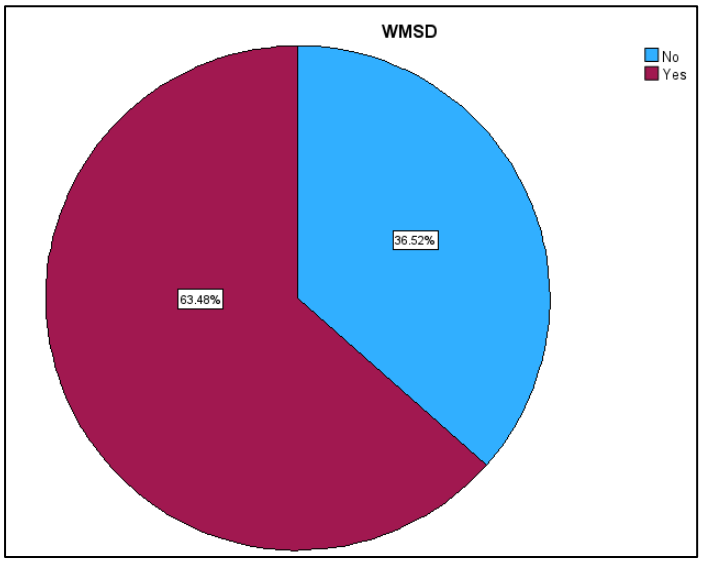

Figure 4.2. Proportions of experience of MSDs within the past one year.

Further analysis showed that the neck region yielded the highest prevalence of MSDs, with more than one-third of the total participants, followed by the lower back and shoulders. Table 4.4 describes in detail the prevalence rate of each body region according to the Extended Nordic Musculoskeletal Questionnaire (NMQ-E).

Table 4.4. Prevalence of MSDs according to body regions.

Body region	Had MSD	Prevalence rate (%)
Neck	43	37.4
Lower back	35	30.4
Shoulders	33	28.7
Wrists and hands	30	26.1
Upper back	24	20.9
Knees	21	18.3
Ankles and feet	21	18.3
Hips and thighs	15	13.0
Elbow	2	1.7

4.6 Objective 2: To assess whole-body postural risk levels and job task-related risk among these MLTs.

To assess the association between whole-body postural risk level (REBA risk level) and job-task related risk, the laboratory centre was taken as the independent variable, as each laboratory centre had unique job tasks from one another. The data is presented in Table 4.5 below.

Table 4.5. Whole-body postural risk levels and job task-related risk.

Laboratory centre	Low risk REBA	Medium risk REBA
IDRC	35	0
AIRC	19	0
BGRC	0	18
EHRC	15	0
CaRC	13	0
NMCRC	8	0
HMRC	7	0
Total	97	18

As the data above has cells with less than 5 counts, Fisher's Exact Test with Monte Carlo simulation was the test of choice, as the data has small sample sizes with sparsity. The test showed a high association of the laboratory centre with REBA score levels (Table 4.6)

Table 4.6. Fisher-Freeman-Halton test for REBA risk level and job task-related risk.

Test	Value	Monte Carlo Significance (p-value)
Fisher-Freeman-Halton	82.40	<0.001

REBA assessments were conducted on each laboratory centre in NIH. Figure 4.3 shows the three different laboratory centres during the REBA assessment.



(a) (b) (c)

Figure 4.3. REBA assessment pictures. a) An MLT performing tissue extraction task in the CaRC laboratory; b) An MLT conducting pipetting task in the BGRC laboratory; c) Digestion task of seafood samples in the EHRC laboratory.

4.7 Objective 3: To determine the association between sociodemographic factors, predisposing factors, ergonomic risk levels and MSDs among MLTs.

This section addresses objective 3 by a step-by-step analysis to determine the associating factors for MSDs among the study population.

4.8 Test for normality

The numerical variables were tested for normality by using the Shapiro-Wilk test. All the numerical variables were not normally distributed, as all the p-values were less than <0.05. Hence, all the numerical variables were tested by using a non-parametric test for bivariate analysis. Table 4.7 describes the outcome of the test for each variable.

Table 4.7. Shapiro-Wilk normality test.

Variables	p-value
Age (years)	<0.001
Years working as MLT in IMR (years)	<0.001

4.9 Test for association

The Mann-Whitney U test was selected as the non-parametric test for the association of numerical variables with the presence of MSDs in the past one year. None of the variables had a significant association independently.

Bivariate analysis, which was the Chi-square test, was conducted for each categorical variable. For variables with cross-tabulation having at least a value of less than five counts, were tested using Fisher's exact test was used, and for cross-tabulation rows of more than two variables, the Fisher-Freeman-Halton test was utilised.

Having a bachelor's degree as the highest education level was statistically significant according to the Chi-square test. Gender and ethnicity, albeit non-significant findings in the bivariate analysis, were later included in the multivariate analysis as their p-values were less than 0.25, as per the statistical regression analysis practices by Hosmer and Lemeshow (59). The categorical bivariate analysis results were presented in Table 4.8.

Table 4.8. Bivariate analysis results of independent variables.

Variable	No MSD, n (%)	Had MSD, n (%)	p-value
Age			0.483[a]
Years of working experience as an MLT			0.308[a]
Gender			
Female	30 (71.4)	63 (86.3)	0.051[b]
Male	12 (28.6)	10 (13.7)	
Marital status			
Single	15 (35.7)	27 (37.0)	0.891[b]
Married/Divorced/Widowed	27 (64.3)	46 (63.0)	
Ethnicity			
Sabah and Sarawak natives	10 (23.8)	18 (24.7)	0.241[c]
Malays	30 (71.4)	44 (60.3)	
Chinese and Indians	2 (4.8)	11 (15.1)	
Body mass index (BMI)			
Normal and underweight	16 (38.1)	33 (45.2)	0.458[b]
Overweight and obese	26 (61.9)	40 (54.8)	
Highest education level			
Bachelor's Degree	6 (14.3)	26 (35.6)	0.014[b]
Diploma	36 (85.7)	47 (64.4)	
Laboratory centre			
AIRC	11 (26.2)	8 (11.0)	0.031[c]
BGRC	5 (11.9)	13 (17.8)	
CaRC	1 (2.4)	12 (16.4)	
EHRC	9 (21.4)	6 (8.2)	
HMRC	3 (7.1)	4 (5.5)	
IDRC	11 (26.2)	24 (32.9)	
NMCRC	2 (4.8)	6 (8.2)	
Smoking/vaping status			
Actively smoking/vaping	2 (4.8)	2 (2.7)	0.622[d]
Non-smoker/non-vaper	40 (95.2)	71 (97.3)	
Underlying medical illness			
Yes	4 (9.5)	12 (16.4)	0.406[d]
No	38 (90.5)	61 (83.6)	
History of orthopaedic illness			
Yes	1 (2.4)	16 (21.9)	0.005[d]
No	41 (97.6)	57 (78.1)	

[a]Mann-Whitney U test; [b]Chi-square test; [c]Fisher-Freeman-Halton Exact test; [d]Fisher's Exact test.

The REBA risk level was tested independently against the presence of MSDs using a Chi-square test, as shown in Table 4.9.

Table 4.9. Chi-square test of REBA risk level with the presence of MSDs.

REBA risk level	MSDs		p-value
	No, n (%)	Yes, n (%)	
Low	37 (88.1)	60 (82.2)	0.402
Medium	5 (11.9)	13 (17.8)	

4.10 Test for multicollinearity

There were two continuous variables among the independent variables. Both variables were tested against each other using the Spearman's rho test, as both of the variables were non-normally distributed. The test yielded correlation coefficient of 0.455, with p-value of less than 0.001. This indicates that both variables were highly correlated. However, as both continuous variables had p-value more than 0.25 in the bivariate analysis, this correlation has no statistical importance in the final model.

4.11 Multivariate analysis

Three variables with a p-value less than 0.25 were included in the multivariate analysis using multiple logistic regression. Age and ethnicity were added in block 1 of the forward conditional method. Other included variables were added in block 2, computed, and insignificant variables were removed by automation.

Participants with a diploma had significantly lower odds of experiencing MSDs (OR 0.27, 95% CI: 0.10-0.78) compared to the participants with a higher education level (bachelor's degree). Ethnicity and laboratory centres, however, did not have any significant association with the

presence of MSDs and were excluded from the final model. Table 4.10 shows the detailed results of the crude odds ratio and adjusted odds ratio for each respective variable.

Table 4.10. Multiple logistic regression using the stepwise forward conditional method.

Variable	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Gender[a]						
Female	1	-	-	1	-	-
Male	0.40	0.15-1.02	0.055	0.44	0.17-1.18	0.102
Ethnicity[b]						
Sabah and Sarawak natives	1	-	-	-	-	-
Malays	0.82	0.33-2.01	0.66	-	-	-
Chinese and Indians	3.06	0.56-16.62	0.20	-	-	-
Highest education level[c]						
Bachelor	1	-	-	1	-	-
Diploma	0.30	0.11-0.81	0.017	0.27	0.10-0.78	0.015
Laboratory centre[b]						
BGRC	1	-	0.071	-	-	-
AIRC	0.28	0.07-1.11	0.070	-	-	-
CaRC	4.62	0.47-45.39	0.19	-	-	-
EHRC	0.26	0.06-1.10	0.068	-	-	-
HMRC	0.51	0.08-3.16	0.47	-	-	-
IDRC	0.84	0.24-2.94	0.78	-	-	-
NMCRC	1.15	0.17-7.74	0.88	-	-	-
History of orthopaedic illness[c]						
Yes	11.51	1.47-90.28	0.020	10.77	1.33-87.00	0.026
No	1	-	-	1	-	-
Age[a]	0.97	0.92-1.03	0.31	0.95	0.89-1.01	0.084

[a]*Essential variables were included in the final model regardless of p-value.*
[b]*Excluded variables in the final model due to insignificant associations.*
[c]*Included variables in the final model.*

4.12 Goodness of fit test

The multiple logistic regression model was tested for its predictive probability by performing a goodness of fit test. The first test was the classification table, with 69.6% predictable probability, with a cut-off value of 0.5.

The second test was the Hosmer and Lemeshow test, with a Chi-square value of 6.68 and a p-value of 0.57. A p-value more than 0.05 indicates a good model fit.

The third test was the Omnibus test of model coefficients. This tests whether the model is significantly better with predictors than a model without predictors. The Chi-square value was 21.13, with a p-value of less than 0.001. Hence, this model with predictors is significantly better than the null model (without predictors).

The final test was the ROC curve and AUC, which evaluates the discriminative ability of the final model. The AUC value was 0.738, meaning the model has a 73.8% chance of correctly distinguishing between positive and negative cases in a randomly chosen sample. Hence, this model suggests acceptable discrimination. The ROC curve with AUC is shown in Figure 4.4 below.

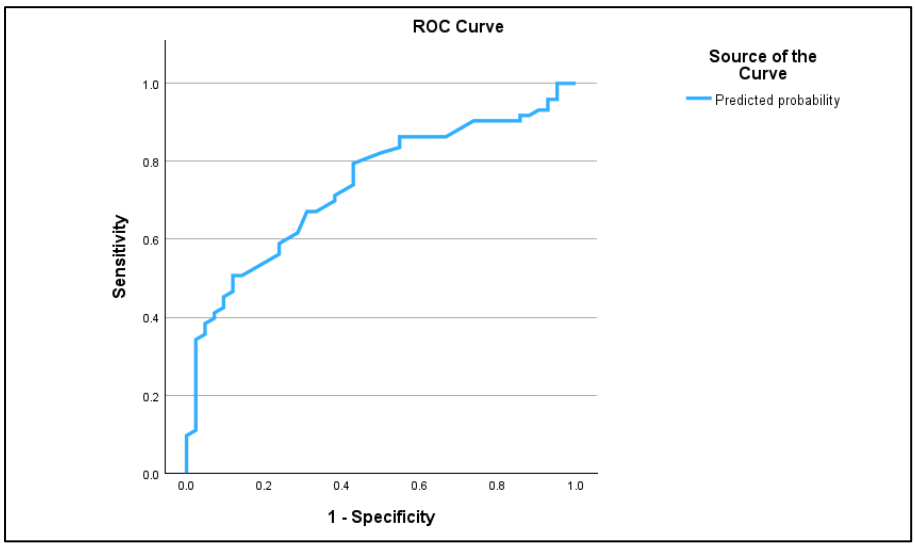

Figure 4.4. ROC curve and AUC of 0.738.

4.12 Exploratory cross-tabulation tests for higher incidence of MSDs among Bachelor's Degree

For the significant finding of higher incidence of MSDs among Bachelor's Degree holders, Table 4.11 below showed the additional exploratory bivariate analysis of this phenomenon.

Table 4.11. Chi-square test of highest education level with other independent variables.

Independent variable	Highest education level		p-value
	Diploma, n (%)	Bachelor, n (%)	
History of orthopaedic illnesses			
No	72 (86.7)	26 (81.3)	0.457
Yes	11 (13.3)	6 (18.8)	
Underlying medical illnesses			
No	72 (86.7)	27 (84.4)	0.742
Yes	5 (15.6)	5 (15.6)	
Gender			
Female	66 (79.5)	27 (84.4)	0.553
Male	17 (20.5)	5 (15.6)	
Ethnicity			
Malay	57 (68.7)	17 (53.1)	0.072
Sabah and Sarawak origin	20 (24.1)	8 (25.0)	
Chinese and Indians	6 (7.2)	7 (21.9)	
Marital status			
Single	31 (37.3)	11 (34.4)	0.767
Married/Divorced/Widowed	52 (62.7)	21 (65.6)	
Body mass index			
Normal and underweight	38 (45.8)	11 (34.4)	0.268
Overweight and obese	45 (54.2)	21 (65.6)	
REBA risk levels			
Low risk	70 (84.3)	27 (84.4)	0.996
Medium risk	13 (15.7)	5 (15.6)	

Note: none of the independent variables had significant p-value of less than 0.05.

CHAPTER 5: DISCUSSION, RECOMMENDATIONS, AND LIMITATIONS

5.1 Introduction

This chapter discusses thoroughly the interpretation of the findings according to each objective of the study. This study aimed to determine the prevalence of MSDs among MLT, to assess whole-body postural risk levels and job task-related risk, and to determine the associating factors and ergonomic risk assessments and MSDs.

5.2 Prevalence of MSDs among MLTs

In this study, the prevalence of musculoskeletal disorders (MSDs) among MLTs within the past 12 months in any body region was 63.5%. This result correlates with 10 other studies on laboratory workers, which ranged from 61.8% to 91.0% prevalence (see Table 1) (22,23). In comparison with the latest literature available in 2024, conducted in Kuala Lumpur, the prevalence rate among medical laboratory workers was 91.8%, higher than the prevalence rate of this study (4). This significant difference in prevalence rate may be due to a higher ergonomic risk level reported in that study, with a high risk level according to the Rapid Upper Limb Assessment (RULA) tool (29), with the top three body regions reported MSDs were the neck (91.8%), shoulders (87.5%) and lower back (85.7%). In contrast, this study reported neck (37.4%), lower back (30.4%), and shoulders (28.7%) among the top three body regions of MSD complaints. The differences in the body regions are heavily influenced by the physical demands of the work task and the differences in workstation settings (60,61). Therefore, the laboratory workplace settings in this study may have better ergonomics in designing the workstation.

5.3 Assessment of whole-body postural risk levels and job task-related risk.

This result aligns with the findings from a study of MSDs prevalence among laboratory workers in India, utilising REBA as the ergonomic risk assessment tool, type of job task had a

significant association with the prevalence of MSDs (27). This indicates that utilising REBA as an ergonomic risk assessment tool among laboratory workers is highly sensitive in predicting the prevalence of MSDs, due to the nature of laboratory workers' bending, stretching, and prolonged standing in executing their daily tasks (13). In addition, other ergonomic risk assessment tools such as the Rapid Upper Limb Assessment (RULA) and the Assessment of Repetitive Tasks (ART) were also useful in determining ergonomic risk levels in medical laboratory settings; the former focusing on the upper body region, and the latter focusing on repetitive motions (4).

These findings highlight the need to carry out risk assessments in any workplace to ensure the health, safety, and well-being of the workers performing their daily work tasks. It aligns with the recently amended Occupational Safety and Health Act 2022, which mandates risk assessment in every workplace as stated in Section 18(B) of the Act (6).

The assessment of ergonomic risk in this study showed that the ergonomic principles in the medical laboratory setting in the National Institutes of Health were acceptable, as there were no high-risk REBA level findings. However, corrective measures in improving the workplace, especially in the moderate risk laboratories, need to be taken into consideration. Appropriate risk control measures, such as conducting ergonomic training for MLTs and improving laboratory furniture and arrangements, are of paramount importance in reducing the risk of MSDs (61).

5.4 Associating factors and ergonomic risk assessments, and MSDs

In this study, age and gender were the two variables identified as variables of theoretical importance in the association between associating factors, ergonomic assessments, and MSDs. Age, for example, may be associated with greater cumulative exposure to physical strain and ageing decline in resilience of the musculoskeletal system, which increases the likelihood of

musculoskeletal discomfort symptoms (62,63). Gender was also considered a key predictor due to its differences in musculoskeletal structure, hormonal factors, and osteoporotic risk, especially in menopausal women (64,65).

According to the findings of the bivariate analysis of this study, age was not a significant factor, possibly due to the young sample population, as a large chunk of the participants were between the ages of 30 to 39 years. On the contrary, Ethiopian medical laboratory workers had a significant relationship between age and MSDs ($p = <0.05$) (30).

Gender also had an insignificant statistical value; this finding may be affected my the relatively small sample size. However, a study in Ethiopia showed that female laboratory workers had nearly doubled the odds of having MSDs (AOR 1.89, 95% CI: 1.61-8.04) (30).

Ethnicity did not show a significant factor in this study. This contradicts the ethnicity findings among Malaysian supermarket cashiers (32). Likewise, marital status had no significant association with MSDs, and this result supports the findings of no association of marital status and MSDs in Iranian nurses (35).

As for the education level, this result contradicts the study by Hansen et al. in 2023, which found that higher education levels were associated with lower odds of musculoskeletal pain (OR 0.56, 95% CI: 0.41, 0.74) (36). In addition, a study among Malaysian nurses showed lower education level was a significant risk factor for MSDs (37). This provides a basis for further exploratory research on levels of education and their relation with MSDs among MLTs, as there was no available scientific evidence to support these findings.

Findings of a previous study among Ethiopian laboratory workers showed that higher BMI had increased odds of MSDs (30). However, there was no significant association between BMI and MSDs in Saudi Arabian laboratory workers, which is consistent with the findings of this study (31).

Years of experience as an MLT did not have a significant association with MSDs. This result contradicts a study among medical laboratory workers in Ethiopia, which highlighted an increase in 4.1 times higher likelihood of developing MSDs in workers with more than 15 years of experience (AOR 4.1, 95% CI: 1.5-10.8) (30).

Participants with underlying medical illnesses, such as hypertension, diabetes, dyslipidemia, and mental health issues, were not a significant predictor for MSDs in this study. This result is consistent with a study among medical laboratory workers in Ethiopia (30). However, according to a large cohort study conducted in Brazil, depression and sleep disorders had a significant association with MSDs (40). Moreover, mental illnesses such as personality disorders and depression were the predictors of MSDs (41,66). Three similar studies that conceptualised psychosocial factors as a risk in MSDs did not directly measure the outcome of mental health issues in their studies (28,31,46).

Study findings on participants with a history of orthopaedic-related illnesses or surgery with a significant association are consistent with a similar study conducted among healthcare providers in Ethiopia, where workers with a history of orthopaedic illness had significantly higher odds of developing MSDs (AOR 6.85; 95% CI: 1.91-22.7) (42). These findings confirm the higher likelihood of MSDs in workers with existing orthopaedic conditions. Proper rehabilitation post-injury, along with adherence to physiotherapist advice and continuous health monitoring from an orthopaedic surgeon, are important in maximising the potential for recovery of orthopaedic conditions. Special attention and specific job allocation need to be considered in assigning workers with any history of these injuries to maintain the workers' productivity and free from MSD symptoms.

This study only had four participants who were declared as active smokers or vape users. The bivariate statistical test confirmed no significant findings with MSDs. In other similar research,

industrial workers with moderate smoking behaviour had a significantly higher tendency for neck pain (OR 3.1; 95% CI: 1.4-6.8), low back pain (OR 2.4; 95% CI: 1.1-5.1), and in lower limbs (OR 3.4; 1.5-7.8) (67). It may be influenced by the small sample size of smokers and vape users in this study.

The viability of the final model showed a good model fit, suggesting that the relevance of the history of orthopaedic illness, along with education level, were important associating factors to the risk of developing MSDs among the study population.

5.5 Conceptual framework revisited

Based on the results, it is clear that those with any orthopaedic illness history had a significant effect on the occurrence of MSDs in this study. Notably, lower education levels in this study were unexpectedly associated with reduced MSD risks, contrary to other research findings on various professions (36,37). Albeit ergonomic risk levels were significant in a specific type of work task, the risk levels did not have an independently significant effect in predicting MSD occurrence.

5.6 Limitations of this study

There were a few limitations of this study. Firstly, this is a cross-sectional study design, which restricts the ability to establish causality due to the absence of a temporal sequence of events, as cross-sectional studies only capture the data at a given point in time. Therefore, this study can present the findings on the associations between independent variables (socio-demographic factors, predisposing factors, and ergonomic risk assessment) without the direction of the causality.

Due to the short period of data collection, this study only limits the study to MLT about a few associated factors. As psychosocial factors were a significant element in the causality of MSDs,

in-depth mental health data collection was not done, and may influence the final result due to its absence of psychosocial data (68).

The self-reported nature of the questionnaire may lead to recall bias, as participants may not be able to recall precisely their musculoskeletal discomfort history for the past 12 months. Collecting more reliable data such as utilising medical records data or sickness absenteeism data may reduce the recall bias.

Moreover, the calculated minimum sample size was 140 to achieve the power of 0.8 with 95% confidence, but due to the low response rate among the MLTs in NIH, only 115 participants completed the questionnaire form. Thus, the findings of this study need to be applied with caution, with the original margin of error of 5.0% has increased to 6.6% due to unable to achieve the minimum sample size. Collaboration with local health authorities during health screening programs may increase the response rate.

During the ergonomic risk assessment procedure, the presence of an ergonomic risk assessor may affect the risk scores due to participants' awareness of being assessed, a phenomenon called the Hawthorne Effect (69). This occurs when study participants knowingly modify their behaviour because they are aware of being observed for a risk assessment. Workers may adopt better posture or alter their usual negative habits to look good in the eyes of the risk assessor. Thus, involvement of artificial intelligence devices in ergonomic risk assessment such as motion sensing devices may generate a more comprehensive and precise ergonomic risk quantification scores.

Due to REBA assessment that focuses only on static and awkward postures, other ergonomic risks such as repetitive motions and manual handling were not extensively explored. Thus, using additional ergonomic risk assessment tools such as Assessment of Repetitive Tasks (ART) may yield more precise ergonomic risk scores.

5.7 Recommendations

The prevalence rate of MSDs among MLTs can be reduced by conducting ergonomic risk assessment, especially in work tasks that have been identified as hazardous to the workers' natural body posture. Appropriate ergonomic risk assessments have been proven to be sensitive to job task-related risks; therefore, detection of poor ergonomic practices such as awkward posture and prolonged static position in a certain work task can be identified, and subsequent risk control measures can be taken to address the shortcomings of the work task.

Workers who had a history of orthopaedic illness are recommended to undergo a thorough pre-placement and periodical medical examinations, which aids in screening the workers' health condition before and during employment to maintain good musculoskeletal health. These measures are following the need for periodic medical examinations as per the amended Occupational Safety and Health Act 2022 (6).

After identifying and assessing the ergonomic risks in the medical laboratories, risk control measures such as elimination or substitution of the hazard are most desirable, but often practically impossible. Engineering control, for example, using an automated pipetting machine or using a robotic arm, helps in reducing repetitive motions and prolonged static posture among workers, or using an adjustable table and chairs to cater to various anthropometry differences of the workers, is often practicable but requires financial investment in a mechanical device that is usually expensive. Administrative control is usually practicable and cost-effective. Examples are job rotation, frequent supervision, buddy system, and enforcement of standard operating procedures that promote safe lifting techniques usually improve workers' adherence to ergonomic principles. Therefore, ergonomic awareness and ergonomic training programs are essential to be introduced in every workplace to equip workers with proper body mechanics, posture and enhance knowledge on ergonomic

principles. Finally, providing proper working equipment such as hand gloves or working gear of appropriate size is also required, but it is the least effective method. A systematic approach in risk control, as per the hierarchy of control principle, may improve workers' ergonomics, subsequently aiding the prevention of work-related musculoskeletal disorders. Figure 5.1 shows the levels of hierarchy of control, adapted from the National Institute of Occupational Safety and Health (NIOSH) of the United States of America (USA) (70).

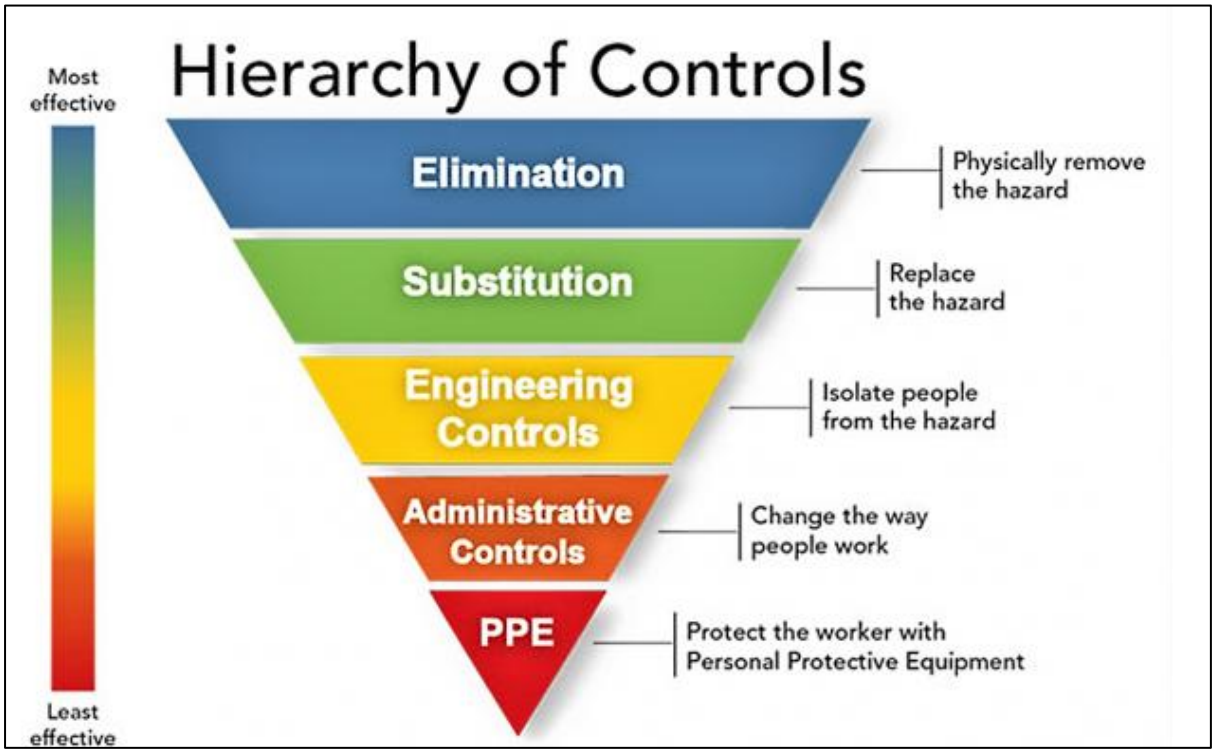

Figure 5.1. The concept of hierarchy of control in risk control measures. Picture taken from the NIOSH USA (70)**.**

In the aspect of research, further observational studies with better study design, such as cohort studies, are important in investigating the causality of incidences of musculoskeletal disorders. An interventional study, for example quasi-experimental intervention study by introducing structured ergonomic training programmes, would be beneficial in evaluating the effectiveness of the programme in reducing the incidence of work-related musculoskeletal disorders in the workplace. Another recommendation that is applicable in all types of study design, including

cross-sectional design, is that having a longer study duration and a larger sample size may improve the power of the study and yield more precise and accurate findings.

With the advancement of technology and artificial intelligence, ergonomic risk assessment can benefit from more accuracy by adding the temporal sequence of events using computer vision-based ergonomic risk assessments (71). This is particularly useful in dynamic work tasks with multiple body postures. Conventional ergonomic risk assessment is the equivalent of a cross-sectional study, as it only captures the body posture of the worker at a point in time, rather than cumulative risks throughout the entire working day. Thus, the application of artificial intelligence is the way forward in transforming the ergonomic risk assessment into a more comprehensive approach.

Application of work-relatedness diagnostic tools such as Electromyography studies may yield stronger work-relatedness of MSDs as it measures muscle fatigue in pre- and post-working shifts effects.

CHAPTER 6: CONCLUSION

The findings of this study showed that MLTs with previous history of orthopaedic illnesses and having higher educational background were significantly at higher odds in the occurrence of MSDs, with the prevalence rate of MSDs among them recorded at 63.5%. Certain specific job tasks had higher ergonomic risks, as shown in the biomedical and genomics laboratories in this study. Thus, this study has met all its objectives.

The REBA scores of low and medium risk levels indicated fairly controlled ergonomic risks. Age was identified as essential variable of importance and was controlled in the regression analysis to ensure robust results. Ergonomic risk assessment is essential in prioritising appropriate risk control measures to reduce the ergonomic risk in the laboratories.

However, ergonomic risk assessment alone does not significantly reduce the MSD incidences. This study underscores the importance of multifactorial approaches to MSDs, ensuring a conducive working environment for medical laboratory workers.

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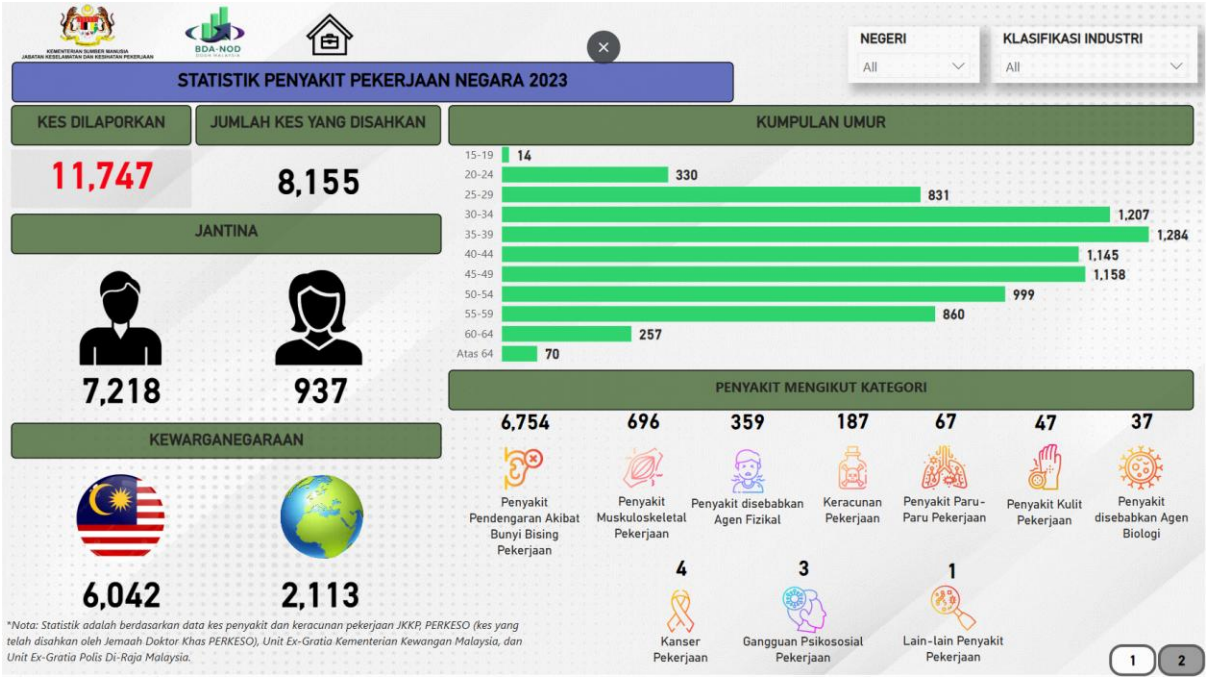
APPENDICES

APPENDIX I: Occupational Diseases Statistics 2023, Malaysia





APPENDIX II: IMU University Joint Committee Approval Letter

IMU UNIVERSITY

IMU Main Campus
Bukit Jalil

126, Jalan Jalil Perkasa 19
Bukit Jalil, 57000 Kuala Lumpur
Malaysia
603 8656 7228
imu.edu.my

Formerly known as International Medical University.

Date: 9 April 2024

Dr. Siew Wei Fern
Principal Investigator
International Medical University
Bukit Jalil
Kuala Lumpur

Dear Dr. Siew Wei Fern,

Re: Confirmation of Approval of Research Proposal

The following proposal has been approved by the IMU Joint-Committee on Research and Ethics on 4 April 2024.

Project ID: MSPH I-2024(06)
Title of Project: Prevalence of Work-related Musculoskeletal Disorders, the Associating Factors, and Ergonomic Risk Assessment among Medical Laboratory Technologists at the National Institutes of Health Malaysia.
Co-Investigators: Imanul Hassan Bin Abdul Shukor
Grant Amount: 6000
Duration: 2 September 2024 to 2 March 2026
Location of Research / Trial Site: National Institutes of Health (NIH) building complex at Setia Alam and IMR Jalan Pahang, Kuala Lumpur.

Please use this Identification Number in all correspondence relating to the research project together with the COA Number (as attached) when making all your claims.

Note:
Please be informed that with the issuance of this approval letter you are also responsible:
a. To submit the Six-Monthly Progress and Financial Report.
b. To submit the End-of-Project Report on time when it is due for submission.

In addition, for any clinical trials or stem cells research, you are required:
a. To notify to the IMU-JC on all protocols, recruitment material, Patients/Study Information Sheet, Informed Consent form and participants' information amendments.
b. To inform of any serious and unexpected adverse event reports be it serious

Thank you.

Yours sincerely,

Prof. Dr. Tan Eng Lai
Secretary, IMU Joint-Committee on Research & Ethics
Date: 9 April 2024

cc: Ms. Lilian Tan Teng Ming - Finance Department
Prof. Wong Shew Fung - Deputy Director, Research

TO: **ALL STAFF / RESEARCHERS / STUDENTS**

RE: **GUIDELINES FOR SUBMISSION OF RESEARCH EXPENSES CLAIM FORM TO FINANCE DEPARTMENT** *{For Researchers and Students involved in Research}*

With immediate effect, please adhere to the following guidelines strictly, when submitting your claims (for research purpose) especially for Supervisors in charge of student's research projects.

1. Submit payment requests digitally via the new Digital Payment Request site - https://bpm.imu.edu.my – *Please proceed to - All Forms/Group Finance & Procurement*
   (Bookmark this URL for ease of reference and access in the future)

2. The digital form is for non-trade and non-staff related requests. It is not applicable to requests for purchase of goods & trade services; all requests for purchase of goods and trade services must be made via the IMU Procurement System/process. It is also not applicable to staff requests for expense reimbursement or e-claims; all requests for expense reimbursement must be made via the IMU HRMS e-claims System.

3. To enable processing of the request, softcopy receipts/invoices must be attached as supporting documents. Requests must be in relation to receipts/bills received or expenses incurred within **3 months** from the date of requests; documents or expenses incurred after the 3 months period will not be processed.

4. Please note however that the requirement to attach softcopy documents as evidences to support your expense claims submissions must remain. With the abolishment of need to submit printout evidences, an additional requirement for all to comply will be that individuals are required to keep the evidences of claims in their "original forms" for a period of one (1) year from the date of expense claims submission. These evidences in their original form must be made available upon request by HR or Finance for internal audit purpose.

5. Please take note Finance does not issue out cash advances.

6. The digital form shall be reviewed by Research project PI (for student's claim) and approved by the HOD, Deputy Director (Research) or Director of IRDI (if research project involves the Deputy Director as PI or Co-PI). Note: Supervisors are responsible for their own student's claim.

As of 14th January 2021
Re: Guidelines for Submission of Research Expenses Claim Form to Finance Dept.

IMPORTANT: FOR ALL RESEARCHERS (PLEASE TAKE NOTE)

Directive from Ketua Pengarah Kesihatan (Letter dated 24 December 2010 Ref. No.: KKM.KPK.5305.20/11Jld.47 (13) and Jabatan Pengajian Tinggi (Letter dated 28 January 2011 Ref. No.: PT.S(BPK)2000/018/01 Jld.3 (58)

Please be informed that, it is now a requirement for researchers to register all research projects especially clinical research, contract or industry sponsored trial in the National Medical Research Register (NMRR) for statistical analysis by Ministry of Health. You may register online via www.nmrr.gov.my

For your information, registration of your research project online with NMRR will contribute to efficiency and transparency. Through the NMRR website all research titles can be easily accessed and duplication of research projects titles among researchers can be avoided. Registration of research projects with NMRR will also help to produce a research directory that will enable sponsors to identify and contact clinical experts for any industry sponsored trials.

Thank you and your cooperation in this matter is highly appreciated.

Director, IRDI
Co-Chairman, IMU Joint-Committee on Research and Ethics

APPENDIX III: Study Gantt Chart

Gantt Chart MSD MLT Study (Version 4.0, 10/07/2024)

Month	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25
Stage I: Data Collection												
Stage II: Data Analysis												
Stage III: Report Writing												

APPENDIX IV: Medical Research and Ethics Committee Approval Letter

JAWATANKUASA ETIKA & PENYELIDIKAN PERUBATAN
(*MEDICAL RESEARCH & ETHICS COMMITTEE*)
KEMENTERIAN KESIHATAN MALAYSIA
MINISTRY OF HEALTH MALAYSIA
Kompleks Institut Kesihatan Negara (NIH)
No.1, Persiaran Setia Murni U13/52,
Seksyen U13 Setia Alam,
40170 Shah Alam, Selangor. Tel.: +(6)03-33628888/ 33628205

Ruj.Kami/ *Ref.* : **24-01404-BMY**
Tarikh/ *Date* : **15-08-2024**

IMANUL HASSAN BIN ABDUL SHUKOR
INTERNATIONAL MEDICAL UNIVERSITY, MALAYSIA

Dato'/ Dr/ Tuan/ Puan,

SURAT KELULUSAN ETIKA/ *LETTER OF ETHICAL APPROVAL*:

NMRR ID-24-01404-BMY (IIR)
PREVALENCE OF WORK-RELATED MUSCULOSKELETAL DISORDERS, THE ASSOCIATING FACTORS, AND ERGONOMIC RISK ASSESSMENT AMONG MEDICAL LABORATORY TECHNOLOGISTS AT THE NATIONAL INSTITUTES OF HEALTH MALAYSIA

Dengan hormatnya perkara di atas adalah dirujuk.

This letter is made in reference to the matter above.

2. Bersama dengan surat ini dilampirkan surat kelulusan saintifik dan etika bagi projek ini. Segala rekod dan data subjek adalah SULIT dan hanya digunakan untuk tujuan kajian dan semua isu serta prosedur mengenai *data confidentiality* mesti dipatuhi. **Kebenaran daripada Pengarah Hospital/ Institusi di mana kajian akan dijalankan mesti diperolehi terlebih dahulu sebelum kajian dijalankan.** Dato'/ Tuan/ Puan perlu akur dan mematuhi keputusan tersebut dan undang-undang lain yang berkaitan.

   *The Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (MOH) has provided ethical approval for this study. Please take note that all records and data are to be kept strictly **CONFIDENTIAL** and can only be used for the purpose of this study. All precautions are be taken to maintain data confidentiality. Permission from the District Health Officer / Hospital Administrator/ Hospital Director and all relevant heads of departments /units where the study will be carried out must be obtained prior to the study. You are required to follow and comply with their decision and all other relevant regulations.*

3. Penyelidik- penyelidik dan lokasi penyelidikan yang terlibat ialah:

   The investigators and sites involved in this study are:

   INSTITUTE FOR MEDICAL RESEARCH (IMR)- SETIA ALAM
   Imanul Hassan bin Abdul Shukor (Penyelidik Utama/ *Principal Investigator*)

   INSTITUTE FOR MEDICAL RESEARCH (IMR)- JALAN PAHANG
   Siew Wei Fern

…/4-

Ruj.Kami/ *Ref*: **24-01404-BMY**

4. Dokumen- dokumen kajian berikut telah diterima dan disemak dengan merujuk kepada kajian di atas:

   The following study documents have been received and reviewed with reference to the above study:

Senarai dokumen yang diterima dan disemak/ *List of documents received and reviewed:*

1. Surat iringan kepada JEPP
   Cover letter to MREC
   (Versi/ *Version* 5, bertarikh/ *dated* 12-08-2024)

2. Pengisytiharan Konflik Kepentingan
   Declaration of Conflict of Interest (COI)
   (Versi/ *Version* 3, bertarikh/ *dated* 26-04-2024)

3. Protokol
   Protocol
   (Versi/ *Version* 5, bertarikh/ *dated* 12-08-2024)

4. Lembaran maklumat dan borang persetujuan peserta
   Participant information sheet and informed consent form
   Versi Bahasa Inggeris/ *English version* (Versi/ *Version* 5, bertarikh/ *dated* 12-08-2024)

5. Borang soal selidik
   Questionnaire
   (Versi/ *Version* 1, bertarikh/ *dated* 24-04-2024)

6. Carta *Gantt*
   Gantt Chart
   (Versi/ *Version* 4, bertarikh/ *dated* 10-07-2024)

7. Borang IA-HOD-IA, *Curiculum Vitae (CV)* dan sijil *Good Clinical Practice (GCP)*
   IA-HOD-IA form, Curiculum Vitae (CV) and Good Clinical Practice (GCP) certificate of:
   - Imanul Hassan bin Abdul Shukor
   - Siew Wei Fern

5. Adalah dimaklumkan bahawa kelulusan ini adalah sah sehingga **14-08-2025**. Tuan/ Puan perlu menghantar dokumen-dokumen seperti berikut selepas mendapat kelulusan etika. Borang-borang berkaitan boleh dimuat turun daripada laman web *National Medical Research Registry (NMRR)*.

   *Please note that the approval is valid until **14-08-2025**.The following are to be reported upon receiving ethical approval. Required forms can be obtained from the National Medical Research Registry (NMRR) website.*

   i. ***Continuing Review Form*** harus dihantar kepada JEPP dalam tempoh 2 bulan (60 hari) sebelum tamat tempoh kelulusan ini bagi memperbaharui kelulusan etika.

      Continuing Review Form *must be submitted to MREC within 2 months (60 days) prior to the expiry of ethical approval.*

   ii. ***Study Final Report (Closure Notification)*** harus dihantar kepada JEPP pada penghujung kajian.

      Study Final Report (Closure Notification) *must be submitted to MREC upon study completion.*

iii. Mendapat kelulusan etika sekiranya terdapat pindaan **ke atas sebarang dokumen kajian/ lokasi kajian/ penyelidik**. Pihak JEPP mempunyai hak untuk menarik balik kelulusan etika sekiranya terdapat perubahan dokumen kajian yang tidak diisytiharkan.

*Ethical approval is required in the case of **amendments/ changes** to the **study documents/ study sites/ study team**. MREC reserves the right to withdraw ethical approval if changes to study documents are not completely declared.*

iv. **Kajian berkenaan intervensi klinikal sahaja:** Laporan mengenai ***all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs)*** dan ***Protocol Deviation/Violation*** di lokasi kajian yang diluluskan oleh JEPP jika berkenaan. *SAE* perlu dilaporkan dalam tempoh 15 hari kalender dari kesedaran kejadian (*awareness of event)* oleh penyelidik. Laporan awal *SUSAR* perlu dikemukakan seawal mungkin tapi tidak melewati 7 hari calendar dari kesedaran kejadian oleh penyelidik, disusuli dengan laporan lengkap dalam tempoh tambahan 8 hari kalender.

Applicable for Clinical interventional Studies only: *Report occurrences of **all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs)** and **Protocol Deviation/Violation** at all MREC approved sites to MREC. 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 7 calendar days from awareness of event by investigator, followed by a complete report within 8 additional calendar days.*

6. Bilangan **subjek/ pesakit/ responden** yang akan terlibat dalam kajian ini di Malaysia adalah seramai **145 orang**.

*There will be **145 subjects/ patients/ respondents** involved in this study within Malaysia.*

7. Sila ambil maklum bahawa sebarang urusan surat-menyurat berkaitan dengan penyelidikan ini haruslah dinyatakan nombor rujukan surat ini untuk melicinkan urusan yang berkaitan.

Please take note that the reference number of this letter must be stated in all future correspondence related to this study to facilitate the administrative processes.

8. Jawatankuasa Etika & Penyelidikan Perubatan, Kementerian Kesihatan Malaysia, beroperasi mengikut *Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH)*. Mana-mana ahli JEPP yang terlibat dalam kajian/ projek yang dinilai tidak akan mengambil bahagian dalam kelulusan kajian/ projek.

The Medical Research & Ethics Committee, Ministry of Health Malaysia, operates in accordance to the International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH). Any member of the MREC who is involved in the study/ project under review will not participate in the approval of the study/ project.

Ruj.Kami/ *Ref*: **24-01404-BMY**

Lokasi kajian/ *Project Sites*:
INSTITUTE FOR MEDICAL RESEARCH (IMR) - SETIA ALAM
INSTITUTE FOR MEDICAL RESEARCH (IMR)- JALAN PAHANG

Keputusan Jawatankuasa Etika & Penyelidikan Perubatan/
Decision by Medical Research & Ethics Committee:
(√) Lulus/ *Approved*
( ) Tidak lulus/ *Disapproved*

Tarikh Kelulusan Etika/ *Date of Ethical Approval*: **15-08-2024**

Sekian terima kasih.
Thank you.

"MALAYSIA MADANI"

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,
I who carry out the trust,



.....
DR. NURAIN BINTI MOHD NOOR
Pengerusi/ *Chairperson*
Jawatankuasa Etika & Penyelidikan Perubatan/ *Medical Research & Ethics Committee*
Kementerian Kesihatan Malaysia/ *Ministry of Health Malaysia*
(No. MPM/ *MMC No*: 31576)

APPENDIX V: Participant Information Sheet and Informed Consent Form

Version 5.0, dated 12/08/2024

PARTICIPANT INFORMATION SHEET AND INFORMED CONSENT FORM
(for adult subjects)

1. **Title of study**: Prevalence of Work-related Musculoskeletal Disorders, the Associating Factors, and Ergonomic Risk Assessment among Medical Laboratory Technologists at the National Institutes of Health Malaysia.

2. **Name of investigator and institution:** Imanul Hassan bin Abdul Shukor (IMU University), and Siew Wei Fern (IMU University)

3. **Name of sponsor**: IMU University

4. **Introduction:**

   It is important that you understand why the research is being done and what it will involve. Please take your time to read through and consider this information carefully before you decide if you are willing to participate. Ask the study staff if anything is unclear or if you would like more information. After you are properly satisfied that you understand this study, and that you wish to participate, you must sign this informed consent form.

   Your participation in this study is voluntary. You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time. If you withdraw, any data collected from you up to your withdrawal will still be used for the study. Your refusal to participate or withdrawal will not affect any medical or health benefits to which you are otherwise entitled.

   This study has been approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia.

5. **What is the purpose of the study?**

   The purpose of this study is to determine the prevalence of work-related musculoskeletal disorders among Medical Laboratory Technologists at the National Institutes of Health, Malaysia. The objective of this study is to determine the prevalence of work-related musculoskeletal disorders among medical laboratory technologists (MLT) at the National Institutes of Health, Malaysia.

   This research is necessary to improve the understanding of both the employers and employees in contributing for a better workspace, and will be an important stepping stone in developing a guideline for ergonomic practices in medical laboratories in the National Institutes of Health, Malaysia. Ergonomics in workplaces are one of the welfares that needed to be optimized as per Section 4(C) of the Occupational Safety and Health (Amendment) Act 2022.

   The data collection period for this research will be conducted for duration of 4 months (01/09/2024 till 31/12/2024). The minimum expected number of participants is 145 subjects.

6. What are my responsibilities when taking part in this study?

It is important that you answer all the questions asked by the study staff honestly and completely which will take about 20 to 30 minutes of your time. Study team will also observe your specified work tasks for quantifying the ergonomic risks involved, which will be expected to be around 5 to 10 minutes.

You will be interviewed by Imanul Hassan bin Abdul Shukor. This form contains 2 sections which will enquire about your socio-demographic profile and your musculoskeletal discomfort history using the Extended Nordic Musculoskeletal Questionnaire (NMQ-E).

After completing the interview, ergonomic risk assessment will be done by observing your usual work tasks in your medical laboratory. You will be asked to perform your usual daily work tasks, and the ergonomic risk assessment will be evaluated by observing your working posture, duration of sustained posture position, any repetitive motions, and other ergonomic elements as per Rapid Entire Body Assessment (REBA) tool. Your work tasks will not be affected by this observation, as there will be no physical intervention during the assessment. Pictures and videos may be recorded during this assessment for publication purposes; thus, this written consent includes permission for taking pictures and videos. Pictures of your face, if included, will be blurred to protect your privacy and identity. The assessor will notify you after the assessment has ended. This ergonomic risk assessment will be carried out by Imanul Hassan bin Abdul Shukor.

In an event of any unexpected circumstance, for example; if there is lack of recruitment, time constraints, decision by either the sponsor or investigator due to safety concerns, or inability to sustain or further manage the study, your participation in this study may be terminated.

You will be informed of any new information/changes made to the existing/current Patient Information Sheet/ Informed Consent Form (PIS/ICF) which is signed during the consenting process for reconsenting purposes.

7. What are the potential risks and side effects of being in this study?

Participation to this study will not affect your work tasks or your current work position, and the risk is minimal. You are free to decline to answer any of the questions that you feel uncomfortable with.

8. What are the benefits of being in this study?

There may or may not be any benefits to you. Information obtained from this study will help to improve your workspace to decrease any ergonomic risks that can cause work-related musculoskeletal disorders. You will be informed with regards to your study findings in the context of ergonomic risk assessment.

9. Who is funding the research?

This study is sponsored by IMU University. You do not need to pay for participating in this study.

10. Will my medical information be kept private?

All your information obtained in this study will be kept and handled in a confidential manner, in accordance with applicable laws and/or regulations. No personal identifiers will be taken during this research. When publishing or presenting the study results, your identity will not be revealed without your expressed consent. Individuals involved in this study, qualified monitors and auditors, and governmental or regulatory authorities may inspect the study data, where appropriate and necessary.

11. Who should I call if I have questions?

If you have any questions about the study or if you think you have a study related injury and you want information about this study, please contact the study doctor, Imanul Hassan bin Abdul Shukor at telephone number 019-3783175.

If you have any questions about your rights as a participant in this study, please contact: The Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia, at telephone number 03-3362 8407/8205/8888.

INFORMED CONSENT FORM

Title of Study: Prevalence of Work-related Musculoskeletal Disorders, the Associating Factors, and Ergonomic Risk Assessment among Medical Laboratory Technologists at the National Institutes of Health Malaysia.

By signing below, I confirm the following:

- I have been given oral and written information for the above study and have read and understood the information given.
- I have had sufficient time to consider participation in the study and have had the opportunity to ask questions and all my questions have been answered satisfactorily.
- I understand that my participation is voluntary and I can at any time free to withdraw from the study without giving a reason and this will in no way affect my future treatment. I am not taking part in any other research study at this time. I understand the risks and benefits, and I freely give my informed consent to participate under the conditions stated. I understand that I must follow the investigator's instructions related to my participation in the study.
- I understand that photos and videos will be taken during this study and I am voluntary giving consent to the investigators in taking such photos and videos during the study period.
- I understand that study staff, qualified monitors and auditors, the sponsor or its affiliates, and governmental or regulatory authorities, have direct access to my medical record in order to make sure that the study is conducted correctly and the data are recorded correctly. All personal details will be treated as STRICTLY CONFIDENTIAL
- I will receive a copy of this subject information/informed consent form signed and dated to bring home.
- I agree/disagree* for my family doctor to be informed of my participation in this study. *(*delete which is not applicable)*

Subject:

Signature:	I/C number:
Name:	Date:

Investigator conducting informed consent:

Signature:	I/C number:
Name:	Date:

Impartial witness:

Signature:	I/C number:
Name:	Date:

APPENDIX VI: Socio-demographic and Predisposing Factors Questionnaire

SOCIO-DEMOGRAPHIC QUESTIONNAIRE

Prevalence Of Work-Related Musculoskeletal Disorders, The Associating Factors, And Ergonomic Risk Assessment Among Medical Laboratory Technologists At The National Institutes of Health, Malaysia – A Cross-Sectional Study

Participant's ID: __ __ __ __

Please answer all the questions accordingly

No.	Question	Answer	Code
1	Sex	Male	1
		Female	2
2	Age (in years)		
3	Race	Malay	1
		Chinese	2
		Indian	3
		Iban	4
		Others, please specify:_____	5
4	Highest Education Status	Diploma	1
		Bachelor's Degree	2
		Master's Degree	3
5	Laboratory Centre	AIRC	1
		BGRC	2
		EHRC	3
		HMRC	4
		IDRC	5
		NMCRC	6
		BGRC	7
6	Laboratory Name	_____	
7	Smoking/Vaping Status	Smoking	1

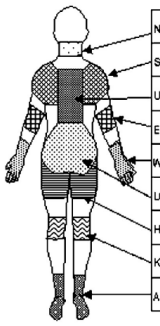
		Vaping	2
		None	3
8	Underlying illnesses	Hypertension	1
		Diabetes	2
		Dyslipidemia	3
		Stroke	4
		Heart Disease	5
		Others: _____	6
		None	7
9	History of orthopaedic illness	Yes, please specify: _____	1
		No	
10	Years of work as an MLT in NIH	_____	
11	Marital status	Single	1
		Married	2
		Divorced/Widowed	3
12	Weight (in kg)		
13	Height (in cm)		

APPENDIX VII: Extended Nordic Musculoskeletal Questionnaire (NMQ-E)

Extended Nordic Musculoskeletal Questionnaire (NMQ-E)

How to answer the questionnaire:

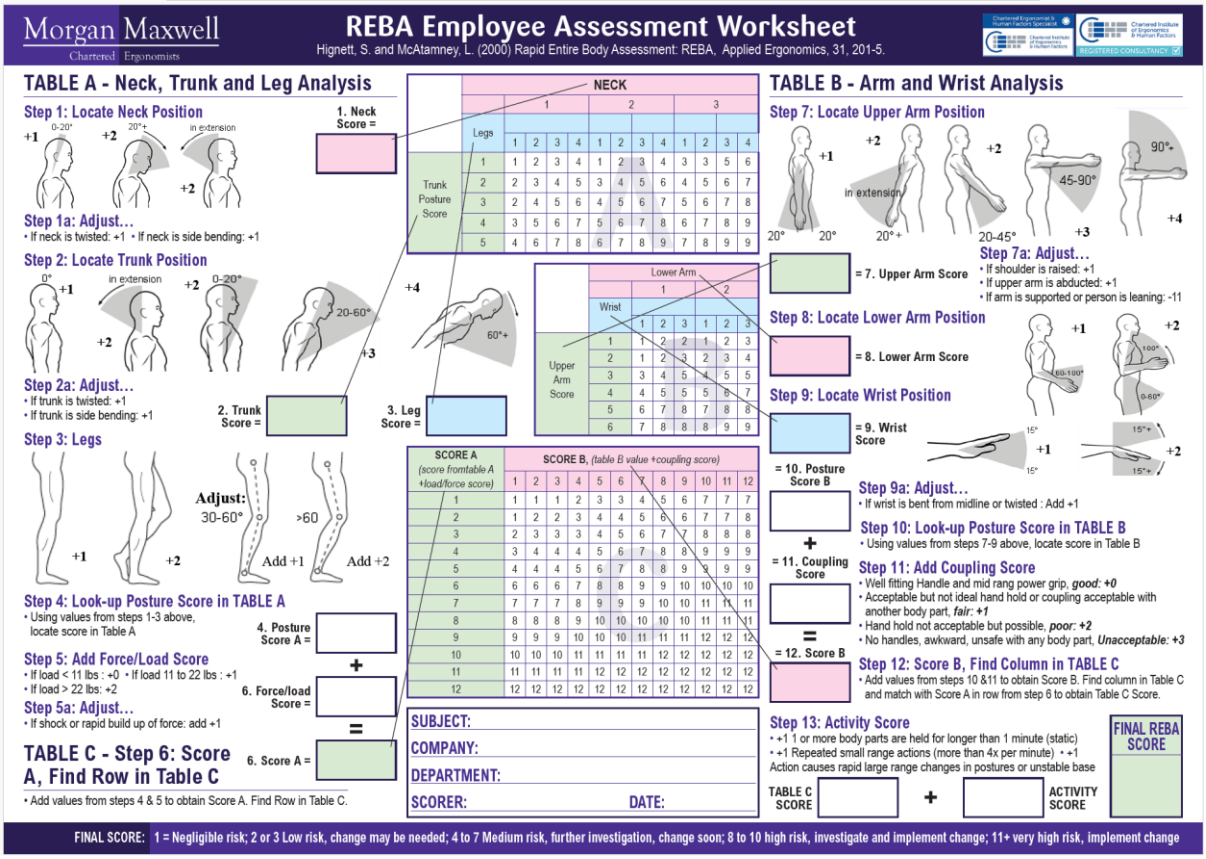
Please answer by putting a cross in the appropriate box - one cross for each question. Answer every question, even if you have never had trouble in any part of your body. Please answer questions from left to right before going down to the next body region. This picture shows how the body has been divided. Limits are not sharply defined and certain parts overlap. You should decide for yourself which part (if any) is or has been affected.



	Have you **ever** had trouble (ache, pain or discomfort) in:	**If 'No', go on to the next body region. If 'Yes', please continue**	At the time of initial onset of the trouble, what was your age?	Have you **ever** been hospitalised because of the trouble?	Have you **ever** had to change jobs or duties (even temporarily) because of the trouble?	Have you had trouble (ache, pain, discomfort) at any time during the **last 12 months?**	**If 'No', go on to the next body region. If 'Yes', please continue**	Have you had trouble (ache, pain, discomfort) at any time during the **last month (4 weeks)?**	Have you had trouble (ache, pain, discomfort) **today?**	During the **last 12 months** have you at any time:			
										been prevented from doing your normal work (at home or away from home) because of the trouble?	seen a doctor, physio-therapist, chiropractor or other such person because of the trouble?	taken medication because of the trouble?	taken sick leave from work/studies because of the trouble?
NECK	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
SHOULDERS	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
UPPER BACK	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
ELBOWS	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
WRISTS/ HANDS	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
LOW BACK	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
HIPS/ THIGHS	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
KNEES	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
ANKLES/ FEET	☐ No ☐ Yes		___ years	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes		☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes

Appendix 1. The Extended Nordic Musculoskeletal Questionnaire (NMQ-E).

APPENDIX VIII: Rapid Entire Body Assessment (REBA)



BIODATA

Imanul Hassan bin Abdul Shukor obtained a Medical Bachelor and Bachelor of Surgery (MBBS) degree from Jagadguru Jayadeva Murugharajendra Medical College (JJMMC), Davangere, under the umbrella of Rajiv Gandhi University of Health Sciences (RGUHS), India. Upon his return to Malaysia in 2014, he served as a House Officer in Selayang Hospital for 2 years. In 2016, he was posted as a Medical Officer in Klinik Kesihatan Senaling, Kuala Pilah. He managed various cases of primary care during his time in Senaling. As he was the sole Medical Officer in the clinic, he was appointed the Head of Clinic, and experienced first-hand exposure to management of a primary healthcare facility, in tandem with clinical work. He completed his Graduate Certificate in Family Medicine in 2019, under the Academy of Family Physicians Malaysia (AFPM). He completed his Occupational Health Doctor training at the National Institute of Occupational Safety and Health (NIOSH) of Malaysia in 2020 and was subsequently appointed as the Head Unit of Occupational Health of Kuala Pilah District Health Office in the same year. During the COVID-19 pandemic, he was given the mandate as the manager of the COVID-19 vaccination centre. Experiencing the head of clinic, followed by the head of district health unit, and subsequently managing the vaccination centre redirected his career from a primary care practitioner into the realm of public health practice. In 2022, he passed an interview and was transferred to the National Institutes of Health, Setia Alam, and is currently working as a Medical Officer of Research in the Occupational Health Research Unit, Environmental Health Research Centre (EHRC), Institute for Medical Research (IMR), National Institutes of Health (NIH), Ministry of Health Malaysia. To date, he has 3 scientific publications in Web of Science-indexed journals, and presented numerous conference proceedings, notably winning third place in his first-ever oral presentation in 2024 entitled ‘Ergonomic Risks in Pharmacy Settings’. His research interest is in occupational health, particularly regarding ergonomics and mental health in the workplace.