

**PREVALENCE AND RISK FACTORS OF  
WORK-RELATED MUSCULOSKELETAL  
DISORDERS AMONGST NURSES  
IN HOSPITAL SULTAN ABDUL HALIM,  
KEDAH, MALAYSIA**

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**UNIVERSITI SAINS MALAYSIA**

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IN HOSPITAL SULTAN ABDUL HALIM,  
KEDAH, MALAYSIA**

by

**K.SARASWATHI A/P KRISHNAN**

**Thesis submitted in fulfilment of the requirements  
for the degree of  
Master of Science**

**February 2022**

## **DEDICATION**

Specially dedicated to my father, Mr. Krishnan S/O Eliah, who passed away during this study, thank you for always believing in me and encouraging me to further my studies even after my marriage.

## DECLARATION

I hereby declare that “Prevalence and risk factors of work-related musculoskeletal disorders (WRMSDs) among nurses in Hospital Sultan Abdul Halim, Kedah, Malaysia” is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

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(K. Saraswathi A/P Krishnan)

Signature of student

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Date

Approved for final submission

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Dr. Gunasunderi Raju

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Date

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## LIST OF ABBREVIATIONS

MSDs	Musculoskeletal Disorders
WRMSDs	Work Related Musculoskeletal Disorders
SNQ	Standardised Nordic Questionnaire
RN	Registered Nurses
ORN	Operating Room Nurses
WHO	World Health Organisation
HSAH	Hospital Sultan Abdul Halim
JCQ	Job Content Questionnaire
LBP	Low Back Pain
BMI	Body Mass Index
ERIQ	Effort Reward Imbalance Questionnaire
COPSOQ	Copenhagen Psychosocial Questionnaire
RULA	Rapid Upper Limb Assesment
NIOSH	National Institute of Occupational Safety and Health
DOSH	The Department of Occupational Safety and Health
ERA	Ergonomic Risk Assessment

**PREVALENS DAN FAKTOR RISIKO YANG BERPUNCA DARIPADA  
GANGGUAN MUSKULOSKELETAL BERKAITAN KERJA DALAM  
KALANGAN JURURAWAT DI HOSPITAL SULTAN ABDUL HALIM,  
KEDAH, MALAYSIA**

**ABSTRAK**

Kajian ini bertujuan untuk mengenal pasti tahap prevalensi dan faktor risiko kesakitan MSD di pelbagai kawasan anatomi dalam kalangan jururawat. Kajian ini dijalankan secara kuantitatif dengan pengumpulan data melalui borang soal selidik di kalangan jururawat di Hospital Sultan Abdul Halim, Kedah. Data dikumpulkan dari 300 jururawat menggunakan persampelan rawak mudah pada tahun 2019. Borang soal selidik yang telah diubah suai dan diuji terlebih dahulu di kalangan 50 jururawat merangkumi beberapa bahagian yang mengkaji gejala MSD dalam 12 bulan yang lalu, meninjau ketidakselesaan fizikal dengan gambarajah anatomi, dan ciri-ciri demografi. Data menunjukkan jururawat sering mengalami keletihan fizikal (44.0%) tetapi keletihan mental secara sekali-sekala (44.3%). Sebilangan besar (97.3%) jururawat mengadu mengalami sakit pada bahagian-bahagian badan dalam 12 bulan terakhir akibat kerja termasuk bahagian bawah punggung (86.7%), pergelangan kaki (86.7%), leher (86.0%), bahu (85.0%), kaki bawah (84.7%), dan punggung atas (84.3%). Kekserapan kesakitan adalah berlainan di mana mereka mangadu sakit sesekali pada leher dan punggung atas tetapi sering kali pada bahagian lain. Jururawat mengadu sakit teruk pada punggung bawah (19.7%), bahu kanan (29.7%), dan bahu kiri (30.3%). Umur, pendidikan, penggunaan telefon semasa bekerja, pengalaman kerja, keletihan mental dan fizikal, dan faktor psikososial COPSOQ II dikaitkan secara signifikan dengan bahagian badan yang mengalami kesakitan ( $p < 0.05$ ). Aduan WRMSD di

kalangan jururawat harus diberi perhatian serius untuk mencegah risiko lanjutan dari pelbagai masalah muskuloskeletal.

**PREVALENCE AND RISK FACTORS OF WORK-RELATED  
MUSCULOSKELETAL DISORDERS AMONGST NURSES IN  
HOSPITAL SULTAN ABDUL HALIM, KEDAH, MALAYSIA**

**ABSTRACT**

A nursing career is considered one of the most physically labourious professions. It is associated with a high prevalence of Work-related Musculoskeletal Disorders (WRMSDs). WRMSDs constitute a major problem in many countries, resulting in substantial costs and impact on the quality of life. This study aimed to estimate the prevalence and risk factors of MSDs-related pain in various anatomical regions among nurses. A cross-sectional study involving 300 conveniently sampled registered nurses with clinical experience at Sultan Abdul Halim Hospital, Kedah was conducted using a self-administered questionnaire. The questionnaire contained sections of MSDs symptoms for the past 12 months, a survey on physical discomfort using an anatomy diagram, and demographic characteristics. It was pre-tested among 50 nurses. The response rate was 85.7%. The majority of the nurses were 30-39 years old (62.3%), Malays (86.7%), with diplomas (83.7%), and married (84.0%). As high as 86.3% of nurses worked on shift rotations. The nurses presented with mental exhaustion occasionally (44.3%) but physical exhaustion often (44.0%). Almost all (97.3%) complained of having work-related pain during the past 12 months. The most commonly inflicted body parts were the lower back (86.7%), ankles (86.7%), neck (86.0%), shoulder (85.0%), lower legs (84.7%), and upper back (84.3%). The pain frequency was rated as “occasional” for the neck and upper back and “often” for the rest of the parts. Severe pain was complained over the lower back (19.7%), right shoulder (29.7%), and left shoulder (30.3%). Age, education level, phone usage during



work, work experience, mental and physical exhaustion, as well as COPSOQ II psychosocial factors were significantly associated with body parts with pain ( $p < 0.05$ ). WRMSDs complaints among nurses should be taken seriously to curb further risk and hazards of musculoskeletal diseases.

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

Work-related Musculoskeletal Disorders (WRMSDs) are the largest contributors to occupational disease. It is closely related to poorly controlled ergonomic factors in the workplace (Schneider *et al.*, 2010) such as repetitive vigorous tasks that involve constant exertions of certain body parts, weight lifting, prolonged pushing or pulling in uncomfortable positions. WRMSDs can be isolated or combined problems involving muscles, tendons, synovial membrane (connective tissues), nerves, fascia (joint tissue), and ligaments with or without tissue degeneration as a result of job tasks (Lelis *et al.*, 2012). The symptoms of WRMSDs include numbness, ache, feeling of heaviness, swelling, tenderness, tingling sensation, clumsiness, discomfort, and burning sensation. Some may also encounter sensations of “pins and needles”, changes in skin colour, excessive sweating on their hands, fatigue, and loss of strength (Nunes & Bush, 2012; Mathew, 2015). The symptoms can vary from mildly recurring to acute and disabling (Rambabu & Suneetha, 2014). At the initial stage, the impacted limb may manifest sensation of ache and tiredness during the work shift that tends to reduce at night and during off days, thus indicating the association with work-related factors. In the intermediate stage, the pain and tiredness symptoms may be present early during the work shift and remain until night time, hence affecting the work productivity, especially those that involve repetitive movements. When the condition reaches a severe stage, the workers may feel pain, fatigue, and weakness even at rest time, causing poor sleep patterns and inclination to perform mainly light-weight tasks. However, not every affected individual will experience the different stages of WRMSDs in a similar way.

In addition, it is also challenging to identify when the end of one stage and the beginning of the next stage. The first pain experienced by an individual is often an indication that the muscles and tendons should be rested. Otherwise, an injury can be prolonged and worsened, leaving some severe cases irreversible. The earlier an individual detects the symptoms, the sooner the symptoms should be checked out to determine if they are WRMSDs (IJOEM, 2010). The World Health Organisation (WHO) reported that musculoskeletal diseases are the commonest cause of disability that limits activities of daily living and employment (Briggs *et al.*, 2018). WRMSDs can be diagnosed through the identification of workplace risk factors using a tool or survey that measures the person's occupation and require a comprehensive explanation of all the processes involved in a usual workday. Considerations were granted for frequency, intensity, duration, and consistency of exposure of each task performed at work. WRMSDs is confirmed diagnostically with laboratory and electronic tests that specifically identify damage on the nerve or muscle.

As reported in various ergonomic studies, many workplaces have yet to adapt to technological advancement (Akodu & Ashalejo, 2019), especially in lower and middle-income countries. High-income countries such as the United Kingdom and Japan pay a greater focus to the safety and health of the working population since they make up the majority of the workforce that represents the human resource backbones of the economy.

WRMSDs are one of the major health issues among medical personnel worldwide. Nurses account for the biggest proportion of healthcare professionals in hospitals. Nursing is considered one of the most physically strenuous professions and thus strongly affiliated with a high prevalence of WRMSDs (Amin *et al.*, 2016; Wasserstein, 2013).

The incidence rate of WRMSDs was 38 cases per every 10,000 workers. It attributed to 34% of occupational sicknesses (Amin *et al.*, 2016). About 33% of the hospital staff was made up of nurses and they accounted for 60% of all the notified occupational injuries (Bernal *et al.*, 2015; Ribeiro *et al.*, 2017). Nurses are tasked to maintain patients' hygiene, keep an eye on their needs, and supply them with the correct medication. All these conditions predispose the nurses to MSDs (musculoskeletal disorders) during their working hours (Raithatha & Mishra, 2016). Generally, hospital nurses carried out their duties for eight hours every day for five days a week. They are involved in tough physical activities such as the lifting of heavy loads, working in awkward positions, transferring patients, and operating hazardous apparatus. Working under a high physical load for long hours while handling patients' requirements can increase the high risk of WRMSDs (Sukadarin *et al.*, 2016). Moreover, among the various occupational, biological, and environmental hazards, the manual handling of patient management was acknowledged as the key source of musculoskeletal burden among hospital nurses (Abedini *et al.*, 2015; Moreira-Silva *et al.*, 2016).

## **1.2 Problem statement & study rationale**

Dr. Paola Cenni, a European ergonomist, defined ergonomics as a science or governance of work that refers to a culture and technique used in designing a human-centered working system that aims to improve psychophysical wellbeing as well as safety and quality of performance (Mohamed *et al.*, 2020). Ergonomic hazards can cause physical and psychological illnesses. This study focused on physical diseases, i.e. the musculoskeletal disorders (MSDs) suffered by nurses and the associated risk factors that affect the occupational safety and health of the nurses.

A recent review of 34 publications (Soylar & Ozer, 2018) found the prevalence of WRMSDs among the nursing profession to range between 33.0% and 88.0%. Another review of 27 publications (Ellapen & Narsigan, 2014) reported a mean prevalence of 71.85% WRMSDs. Studies involving Indian and Portuguese nurses recorded a higher prevalence of WRMSDs (Serranheira *et al.*, 2015; Yasobant & Rajkumar, 2015).

According to Tan Sri Lee Lam Thye, the chairman of the Malaysian National Institute of Occupational Safety and Health (NIOSH), the number of MSDs cases in Malaysia has been steadily increasing from ten cases in 2005 to 708 cases in 2015. Without proper mitigation, the subsequent morbidity from MSDs may lead to burnout that negatively affects the human resource. Although measures have been put in place to minimise the risks of MSDs among nurses, the problem persisted in many places, as evidenced by the long term sick leaves and absenteeism from work (Erick & Smith, 2014; Freimann *et al.*, 2013; Moussa *et al.*, 2015). Based on the USA Bureau of Labor Statistics (2013), almost 11,610 registered nurses (RN) quit their job in 2012 due to MSDs, giving an incidence rate of 58.4 per 10,000 full-time RNs (Lee *et al.*, 2015).

Nurses are highly demanded in developed countries including the United States and developing countries like Malaysia. With a growing population in Malaysia, more nurses are needed to meet the healthcare demand (Omar *et al.*, 2018). As high as 70% of the hospitals in Malaysia suffered from nursing shortages according to recent statistics (Human Resources Division, 2018). Long working hours with inadequate staffing further elevate the risk of developing conditions such as musculoskeletal disorder, hypertension, and depression among nurses.

According to the Bureau of Labour Statistics under the U.S. Division of Labor, four main characteristics can be used to explain basic injury topology among nurses

that result in MSDs accounting for high DART injuries (total days away from work, job change, or restriction events). Normally, one-third and one-half of all injuries can lead to days away from work, occupation restriction, or job transfer (Dressner & Kissinger, Nov 2018; Drennan & Ross, 2019)

### 1.3 Basic injury topology among nurses

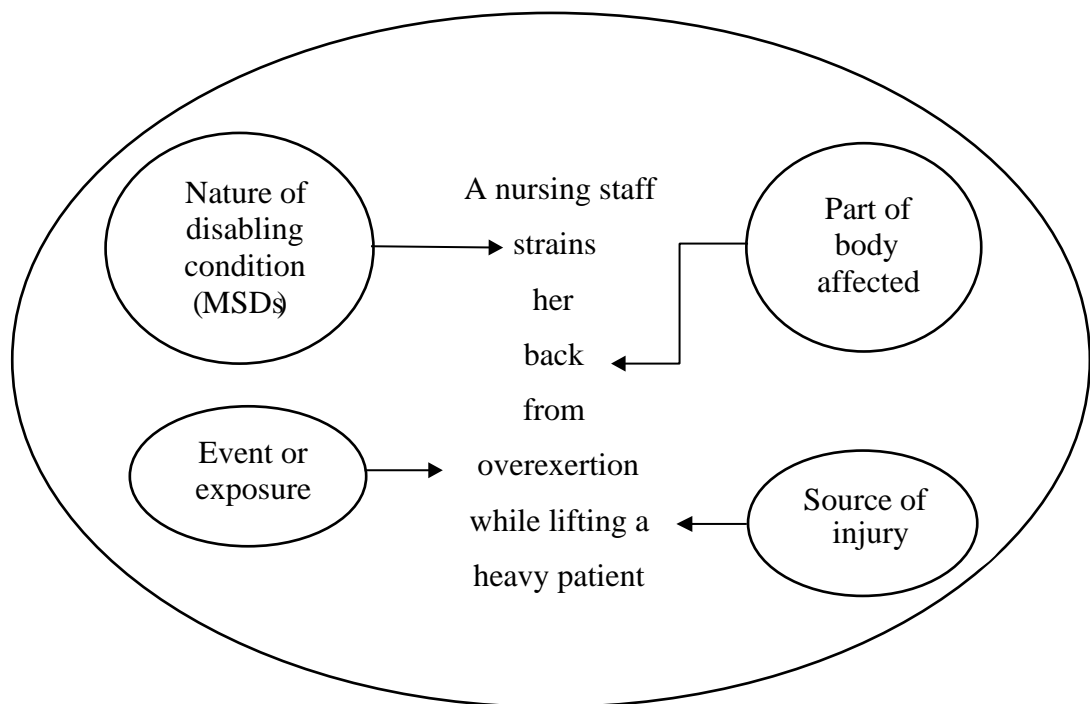


Figure 1.1 Basic injury topology among nurses described from four viewpoints (US Bureau of Labor Statistics, 2016)

1. Nature of disabling situation (MSDs), or the first physical features of the employee's injury: **STRAINS**
2. Portions of the body straightaway plagued by the injury: **BACK**
3. Origin of injury, either the object, substance, bodily movement or work nature that directly produced or imposed the injury: **OVEREXERTION**
4. Event or exposure, or the way the injury occurs: **LIFTING**

According to the research by Passali *et al.* (2018), a low staffing ratio has been associated with an increased rate of WRMSDs. In Malaysia, the Occupational Safety and Health Act 1994 (*Akta Keselamatan dan Kesihatan Pekerjaan 1994*) was gazetted on 24<sup>th</sup> February 1994 by the Malaysian Parliament (1994) in which the general duties of the employers are to secure, as far as possible, the safety, health, and welfare of all his labourers at work. Occupational safety and health is vital in ensuring a safe working environment that does not pose a risk to employees. These risks should be addressed to ensure that employees do not have to work in unsafe or uncomfortable environments that can lead to a high prevalence of WRMSDs.

To address this problem, comprehensive information on the prevalence and associated factors of WRMSDs is needed to design practical strategies. In Malaysia, evidence on WRMSDs among nurses was only available from a study conducted in Klang Valley whereby the ratio of nurses versus population was 1:340. The study reported the prevalence of WRMSDs amongst hospital nurses in Selangor as 73.1% (Amin *et al.*, 2018). However, no similar studies have been performed in the Northern region of the country.

Table 1.1 Number of nurses by state, sector and ratio of nurses to population in Malaysia as of 31 December 2018

**JADUAL 4.24 : BILANGAN JURURAWAT MENGIKUT NEGERI, SEKTOR DAN NISBAH JURURAWAT KEPADA PENDUDUK, MALAYSIA SEPERTI PADA 31 DISEMBER 2018**  
**Table 4.24 : Number of Nurses by State, Sector and Ratio of Nurse to Population, Malaysia as at 31 December 2018**

NEGERI State	SEKTOR AWAM Public Sector			SEKTOR SWASTA <sup>2</sup> Private Sector <sup>2</sup>	JUMLAH Total	NISBAH JURURAWAT KEPADA PENDUDUK Nurse to Population Ratio
	KKM <sup>1</sup> MoH <sup>1</sup>	BUKAN KKM <sup>2</sup> Non MoH <sup>2</sup>	JUMLAH Total			
Johor	6,634	43	6,677	3,709	10,386	1: 360
Kedah	4,610	8	4,618	1,129	5,747	1: 376
Kelantan	3,460	1,266	4,726	684	5,410	1: 343
Melaka	2,091	33	2,124	1,662	3,786	1: 244
Negeri Sembilan	2,582	9	2,591	1,274	3,865	1: 292
Pahang	3,979	18	3,997	1,190	5,187	1: 321
Perak	5,798	28	5,826	1,883	7,709	1: 325
Perlis	892	14	906	44	950	1: 267
Pulau Pinang	3,489	42	3,531	4,222	7,753	1: 228
Sabah	7,043	72	7,115	1,553	8,668	1: 450
Sarawak	5,637	103	5,740	1,423	7,163	1: 390
Selangor	8,711	987	9,698	9,317	19,015	1: 340
Terengganu	2,835	73	2,908	347	3,255	1: 378
W.P. Kuala Lumpur	5,616	3,645	9,261	6,413	15,674	1: 115
W.P. Labuan	229	1	230	9	239	1: 415
W.P. Putrajaya	1,547	4	1,551	15	1,566	1: 58
<b>MALAYSIA</b>	<b>65,153</b>	<b>6,346</b>	<b>71,499</b>	<b>34,874</b>	<b>106,373</b>	<b>1: 304</b>

**Nota/Note:**  
<sup>1</sup> Data dari Bahagian Sumber Manusia, Kementerian Kesihatan Malaysia  
 Data from Human Resource Division, Ministry of Health Malaysia  
<sup>2</sup> Data dari Lembaga Jururawat Malaysia  
 Data from Malaysia Nursing Board

**Punca :** Pusat Informatik Kesihatan, Kementerian Kesihatan Malaysia  
**Source :** Health Informatics Centre, Ministry of Health Malaysia

Based on Table 1.1, the statistics from the Health Informatics Center (2019) of the Ministry of Health Malaysia reported that a total of 71,499 RNs worked in the government hospitals in Malaysia during 2018. The World Health Organisation (WHO) recommended a nurse-to-population ratio of 1:200. However, it was only 1:304 in Malaysia. Out of the total, 4,618 of them were stationed in the government hospitals in Kedah, giving a lower nurse: population ratio of 1:376. In other words, the nursing sector in Kedah can be considered as short-staffed compared to other states such as Perak, Perlis, and Penang.

Hospital Sultan Abdul Halim (HSAH) is a government hospital located in Sungai Petani, Kedah. It provides a variety of high-quality, efficient, and effective medical services to the population of the surrounding areas. In addition, this hospital also serves as a secondary referral centre with various inpatient and daycare services



for patients from district hospitals in Kedah such as Hospital Baling, Hospital Yan, Hospital Sik, and Hospital Kulim. Despite the wide range of services, HSAH suffers a serious shortage of nurses just like other hospitals in the Kedah state, based on the statistics from the Health Informatics Center (2019) of the Ministry of Health Malaysia. One of the possible reasons was the brain drain of nurses in Malaysia (Balang & Burton, 2014; Yunus *et al.*, 2017).

Physical overload due to long working hours and excessive patient handling can lead to a high risk of WRMSDs (Sukadarin *et al.*, 2016). As a result of the physical toll, many nurses developed chronic back pain (Naushad *et al.*, 2019). Female nurses were 2.1 times more likely to suffer from WRMSDs due to the multiple after-work responsibilities including parenting and household chores. Because of these reasons, women also had a lack of rest and physical exercise (Luan *et al.*, 2018).

Job demand is directly related to MSD development among nurses (Anap *et al.*, 2013). Generally, WRMSDs are known to reduce the workers' effectiveness in the work environment. In the United Arab Emirates and many other countries, nurses continue to struggle with nursing shortages while working hard to maintain an acceptable standard of care with suboptimal human resources.

In general, WRMSDs can negatively affect the efficiency of nurses and adversely impact patient safety in clinical practice. With a higher level of MSDs and job burnout among healthcare professionals, especially nurses, a study of the WRMSDs and relevant ergonomic aspects is necessary to determine the prevalence and risk factors of MSDs.

#### **1.4 Study aim**

The study aimed to determine the period prevalence of WRMSDs in the past 12 months and to investigate the associated risk factors among nurses in the study site, i.e. HSAH.

#### **1.5 Research questions**

1. Are the nurses in HSAH burdened with WRMSDs?
2. Nurses from which unit or ward are associated with a high prevalence of WRMSDs?
3. What are the significant risk factors associated with WRMSDs among the nurses?
4. What is the recommendation to resolve this problem?

#### **1.6 Study objectives**

1. To estimate the prevalence of MSDs pain /discomfort.
2. To determine the significant risk factors of WRMSDs among nurses.
3. To provide recommendations to improve the working condition of nurses to reduce WRMSDs.

#### **1.7 Significance of the study**

To tackle any health problems, solid evidence and a clear understanding of the situation at hand are needed, for example, the prevalence and associated risk factors of WRMSDs. This study would be able to provide the necessary evidence for the healthcare planners and hospital managers on the dangers of WRMSDs and on the best way to prevent or reduce WRMSDs. Furthermore, there is no established evidence on this issue in the northern region of Malaysia.

Therefore, suggestions made based on outcomes of this study can be used to convince lawmakers to enforce proper mitigation strategies such as the installation of patient lifting facilities and crews as well as proper training of ward managers and nurses about ergonomic problems. Findings from this study can also be applied to advocate for the implementation of preventative plans or subsequent reinforcement of prevention tactics. Ultimately, this can improve the health of the nurses and in turn, render good quality health services to the patients.

## **1.8 Conclusion**

Nurses are indispensable in the healthcare environment so that the ergonomic risks that they are exposed to in their daily jobs should be given due attention. This chapter outlined the context, significance, and objectives of this study. We hypothesised a high risk of MSDs amongst nurses in a government hospital in Kedah. The next chapter will present the literature review of the study.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter reviews the literature relating to the occurrence, extent, and risk factors of Work-Related Musculoskeletal Disorders (WRMSDs). Published studies about MSDs among nurses, student nurses, and allied healthcare workers in the Science Direct, PubMed, Medline, Google Scholar, and EBSCO databases were reviewed to develop the conceptual framework of the study. The keywords used for the literature search included job-related musculoskeletal disorders, musculoskeletal disorders, risk factors, nurses.

This chapter starts with the definition of WRMSDs, followed by details of the prevalence and cost of MSDs, MSDs among nurses, risk factors for MSDs before presenting the theoretical framework used in this study. According to Kumar (2018), a literature review plays an important role to identify the existing gaps related to the research idea. Based on the literature review findings, this chapter will focus on the discussion of published studies relevant to WRMSDs among nurses, notably the prevalence, associated risk factors, and consequences of WRMSDs.

#### 2.2 WRMSDs

WRMSDs are also known as MSDs, or in other words, the injuries or disorders of human muscles, nerves, bones, tendons, ligaments, joints, cartilages, and spinal discs that encompass strains, tears, and connective tissue injury due to work surroundings and employment conditions. Furthermore, the condition is known to be perpetuated or aggravated by the working condition (Gomaa *et al.*, 2015).

MSDs were first identified as work-related diseases by Ramazzini in the 18<sup>th</sup> century. He reported classical presentation of work-related injuries in his book (Franco, 2010). MSDs can be further classified as specific MSDs that show clear clinical features or non-specific MSDs that present with pain without the clear evidence of a specific disorder. According to the World Health Organisation (WHO), WRMSDs can be aggravated by certain job tasks, especially when carried out in an extended period (Reed *et al.*, 2014). WRMSDs are also referred interchangeably to Repetitive Motion Injuries (RMIs), Cumulative Trauma Disorders (CTDs), Repetitive Strain Injuries (RSIs), Overuse syndrome, as well as Regional Musculoskeletal Disorders and Soft Tissue Disorders (STDs) (Amin *et al.*, 2016).

According to a recent report, WRMSDs were the second commonest occupational disease after respiratory disease (Bernal *et al.*, 2015), accounting for 48% of the total diseases. Workers can either develop WRMSDs after prolonged exposure to the agents causing these disorders or due to a sudden forceful impact on a part of the musculoskeletal system. In addition, the European Agency for Safety and Health at Work (EU-OSHA) reported that MSDs also led to high financial impact for various organisations and healthcare systems due to the morbidity and productivity loss from WRMSDs among the workers.

### **2.3 Nurses and WRMSDs**

Nurses occupy an important position in the hierarchy of healthcare institutions. Besides being the front liners, they are also the main mediator between the doctor and the patient. As such, nurses are expected to maintain a good relationship with patients regardless of their social background, cultures, and occupations.

They also need to perform multiple daily tasks including attending ward rounds, making home visits, providing palliative care, providing consultation for the

patient and their families, and other social services. The tasks intensify when they need to manage different departments. With regard to direct patient care, the nurses carry out the periodical assessment and monitoring of patients as ordered by the doctors. They also assist patients' needs and administer daily medications besides juggling with management work such as clerical documentation. Tasks that require repetitive physical efforts such as weight lifting and moving patients often involve poor body postures that can predispose to WRMSDs among nurses (Lelis *et al.*, 2012).

Therefore, it is not surprising that nursing is the profession ranked with the highest risk of MSDs. This was supported with two studies that reported nurses as having the highest prevalence of MSDs in the world (Drennan & Ross, 2019; Mailutha, 2020). According to the WHO, WRMSDs often worsen with hectic daily activities of the nurses (Reed *et al.*, 2014). This is not surprising as nurses need to carry out physical tasks that involve excessive manual handling of patients at awkward postures (Mutanda *et al.*, 2017). However, the extent of their musculoskeletal symptoms varies is influenced by the wards, the hospitals, and the countries they worked in (Ribeiro *et al.*, 2017; Serranheira *et al.*, 2015).

For instance, the process of patient transfer can exert various physical demands in different contexts, one of the most common being trunk mobilisation in the immediate postures.

In a recent study, it was mentioned that the onset of WRMSDs might impact the nurses' judgement as to whether they should return to work or remain in the same area of practice, leading to human resource issues such as manpower shortages and obstacles in hiring and retention efforts (Yasobant & Rajkumar, 2014). Such phenomenon has been associated with nursing shortage issues across different countries in the world.

## **2.4 Dose-response models for the pathogenicity of WRMSDs**

The common body sites affected by WRMSDs include the low back, neck, shoulder, knees, forearms, hands, and ankles/ feet, with increasing attention being focused on the lower extremity recently. MSDs are more commonly observed when muscle fatigue set in following repetitive movement with little time in between for recovery. Figure 2.1 shows a conceptual model that explains the complex relationship between WRMSDs and the multiple workplace and individual risk factors (Armstrong *et al.*, 1993). This model suggests that repetitive or sustained microtrauma (mechanical or physiological) may reduce the integrity and affect the function of specific tissues and structures within the musculoskeletal system. This dynamic relationship is also characterised as a series of cascading events in which the response may be viewed as a further “dose” that either improves or decreases the individual muscular capacity. The amount, duration, and frequency of loads imposed on the muscles, as well as the recovery time, eventually determine whether the tolerance increases due to the effect of training or conversely, decreases and resulting in MSDs (Armstrong *et al.*, 1993). Furthermore, muscular damage can be due to high tension development, especially during eccentric contractions that predispose to the rupture of the muscle fiber Z-line (Friden *et al.*, 1981).

Muscle damage like this also results in a delayed increase of large amount of serum creatine kinase (Newham *et al.*, 1986). Studies have established that the increased level of serum creatine kinase is associated with excessive occupational work (Hagberg *et al.*, 1982; Mairiaux *et al.*, 1986). Such changes are commonly reported among individuals with muscle soreness and the condition is reversible if the muscle is given sufficient rest.

Nevertheless, if the injured tissue is not given sufficient time to regenerate, it may trigger a series of responses that can further compromise the existing capacity, eventually leading to structural tissue deformation that manifests as pain, swelling, or restricted movement (Elsayed, 2019; Kachala *et al.*, 2016).

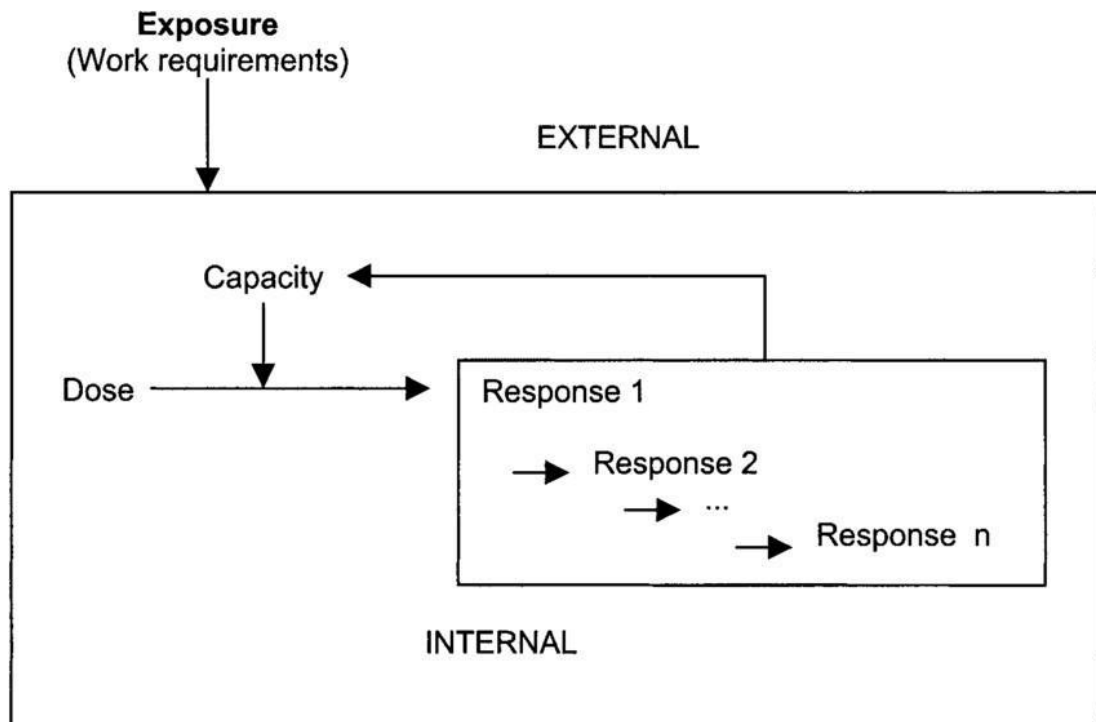


Figure 2.1 The proposed model contains sets of cascading exposure, dose, capacity, and response variables whereby the response at one level can act as a dose at the next level

## 2.5 The prevalence of WRMSDs by different body regions of nurses

Different body parts can be linked to different prevalence rates of WRMSDs depending on the risk factors that the nurses are exposed to, their working environment, and psychosocial risk factors such as job demand and stress (Cheung *et al.*, 2018; Soylar *et al.*, 2018; Yang *et al.*, 2019). Based on the literature, the body regions that are most commonly associated with WRMSDs are the low back, neck, shoulder, knees, forearms, hands, and ankles/ feet. MSDs may involve the upper or lower extremities and the trunk. However, the lower extremities are given more



attention in recent years. The distribution of WRMSDs on the body regions differs among nurses depending on the organisational factors such as hospitals setting, workloads, instrumentation as well as cultural diversities in terms of the perception and active reporting of symptoms (Abdulla, 2018; Yasobant & Rajkumar, 2014). For example, a higher prevalence of WRMSDs was reported amongst nurses in China (77.4%) (Yan *et al.*, 2017), Malaysia (73.1%) (Amin *et al.*, 2016), India (89.2%) (Raithatha & Mishra, 2016), and Vietnam (74.7%) (Luan *et al.*, 2018). Globally, it had been noted that the prevalence of MSDs among nurses working in middle-sized hospitals (200-500 beds) was generally higher, i.e. 91.9% in rural Japan, 84% in Sweden, 72.5% in the United States, and 70% in China (Mutanda *et al.*, 2017).

Table 2.1 The 12-month prevalence of WRMSDs from different countries

Country	12- month prevalence	Authors
Malaysia	73.1	Amin <i>et al.</i> , 2016
China	77.4	Yan <i>et al.</i> , 2017
South West Nigeria	60.4	Akodu <i>et al.</i> , 2019
Zimbabwe	82.1	Chiwariidzo <i>et al.</i> , 2018
India	89.2	Raithatha & Mishra, 2016
Vietnam	74.7	Luan <i>et al.</i> , 2018
Egypt	85.9	Elsherbeny <i>et al.</i> , 2018
South west Ethiopia	60.8	Regassa <i>et al.</i> , 2018
Iraq	67.0	Abdulla <i>et al.</i> , 2018
USA	72.5	Mutanda <i>et al.</i> , 2017
Pakistan	31.6	Rathore <i>et al.</i> , 2017

As for the different body regions, studies have shown that low back pain (LBP) was the commonest MSDs (30-78%), followed by neck and shoulder pain (Bolarinde *et al.*, 2019; Yasobant & Rajkumar, 2015). Similar investigations conducted in Asia,

North America, South America, Antarctica, and Australia have revealed that the most prevalent MSDs among nurse practitioners over 12 months was LBP (30%-62%), followed by neck pain (36%-54%), and shoulder pain (36%-53%) (Freimann *et al.*, 2016; Maria *et al.*, 2017; Yan *et al.*, 2017). Other studies have documented a higher prevalence of MSDs in at least one human body part and/or region that varied between 40% and 95% in a population of Asian nurses. In contrast, among the Western nurses, the low back, neck, and shoulder areas were the most significantly affected body parts, with a prevalence of 29%-64%, 34%-63%, and 17%-75% respectively (Amin *et al.*, 2016; Yang *et al.*, 2019).

On the contrary, the knees and ankles/ feet regions showed the highest level of MSDs in the past 12 months among female nurses based on a literature review (Stolt *et al.*, 2016). The prevalence of MSDs affecting the knees and ankles was 7.5%- 77% and 3.2%-100% respectively. The prevalence of MSDs in the lower legs (the shins) varied between 8.5% and 10.5% whereas the prevalence ranged between 11% and 100% in the thigh/ hip area (Stolt *et al.*, 2016). This was echoed by Nkhata *et al.* (2015) in which the most commonly affected body parts were ankles and feet with a prevalence of 54.8%.

On a different note, the most significant body regions related to WRMSDs among nursing professionals were LBP, neck pain, and shoulder pain (Taghinejad *et al.*, 2016). Chiwaridzo *et al.* (2018) discovered that eight out of ten nurses with WRMSDs experienced LBP. LBP can be attributed to the awkward bending or twisting of their backs while and lifting/ transferring dependent patients, prolonged standing while treating patients, and insufficient rest.

## **2.6 Risk factors of WRMSDs**

The common risk factors for the development of WRMSDs can be broadly categorised as physical, demographic, psychosocial, lifestyle, and organisational factors (Piranveyseh *et al.*, 2016). MSDs rarely manifest acutely but rather develop over a period following poor posture or unfavourable job conditions. According to the Jagadish *et al.* (2018), MSDs are mostly caused by the handling of heavy loads that involves awkward and static body postures such as bending and twisting as well as powerful actions. Other risk factors include vibration, poor lighting, or low temperature, prolonged sitting or standing.

### **2.6.1 Demographic factors**

Demographic factors such as gender, age, marital status, education level, and years of employment also cast an impact on the occurrence of musculoskeletal symptoms (Abdollahzade *et al.*, 2016; Yitayeh *et al.*, 2015).

Women are three times more likely to develop MSDs because they have less muscular strength than men (Santos *et al.*, 2017). This was echoed by another study in which females were 1.1 times greater risk of developing WRMSDs than males (Luan *et al.*, 2018), indicating that women have lower adaptive levels than men in patient-related activities.

Regarding age, Zayed *et al.* (2019) noticed the prevalence of WRMSDs was statistically higher in the younger age groups and the prevalence decreased with increasing age with the lowest prevalence recorded among nurses aged 50 to 59 years (9.8%). This could be attributed to the fact that most of the manual tasks would be handled by the junior nurses. Similar findings were reported in another study (Elsherbeny *et al.*, 2018) in which nurses aged 20 to 29 years showed a higher prevalence of WRMSDs (91.2%) than older age groups. In contrast, Ribeiro *et al.*

(2017) explained that nurses between 31-40 years (35.7%) and 41-50 years (35.9%) were more affected by WRMSDs. The difference could be attributed to variation in nursing tasks and procedures between the countries where the studies were based on.

Next, age was also a contributing factor of WRMSDs pain at the neck, shoulder, elbows, wrists/hands, thighs, knees, and ankles/ feet. The possibility of developing WRMSDs in these regions among nurse practitioners above 35 years old was 1.38 to 2.27 higher than junior nurses (Choobineh *et al.*, 2015; Khudhir, Saleh, *et al.*, 2017).

LBP was also directly related to the seniority and marital status of nurses. The risk of LBP among married female workers and those with work experience of more than 10 years was higher than their counterparts who were single or with job tenure of fewer than ten years (OR = 1.41 and OR = 1.27) (Choobineh *et al.*, 2015; Raithatha & Mishra, 2016).

Body mass index (BMI), i.e. Weight (kg)/ Height (m<sup>2</sup>) is used to classify individuals into normal weight, underweight, overweight, and obesity. The BMI level for the adult population can be influenced by their age, gender, and ethnicity (Lim *et al.*, 2017; Thon *et al.*, 2016). However, BMI does not differentiate between fat and lean mass and it cannot be used to reflect body fat distribution.

Table 2.2 Obesity classification according to the WHO and the Asia Pacific guidelines

Obesity classification	WHO (BMI) (kg/m <sup>2</sup> )	Asia Pacific (BMI) (kg/m <sup>2</sup> )
Underweight	< 18.5	< 18.5
Normal	18.5 – 24.9	18.5 – 22.9
Overweight	25 – 29.9	23 – 24.9
Obese	≥ 30	≥ 25
<b>Abbreviations:</b> WHO, World Health Organisation; BMI, body mass index.		

The spine is designed to support the body weight and to distribute the masses exerted by the body throughout rest and activity. In the event of excessive load, the spine is forced to absorb the burden. This may result in structural compromise and injury to the lower back or lumbar region (Frost *et al.*, 2019).

An overweight individual is more prone to new onset or recurrence of MSDs as a result of the elevated pressure placed on the disc endplates and facet joints. Studies have shown that high BMI can lead to MSDs among workers, especially at the hips and knees (El Ata *et al.*, 2016). Obesity has also been associated with LBP or other MSDs among hospital workers. In two systematic reviews, obese individuals (BMI >30) were significantly predisposed to LBP (Azizpour *et al.*, 2017; Mutanda *et al.*, 2017).

In a study conducted in Uganda, Munabi (2014) reported that females who were married with children were more prone to MSD than males. In this study, female nurses were twice more likely to report MSDs in different body regions as compared to male nurses. On the other hand, Raithatha & Mishra (2016) stated that married nurses with children were associated with a higher incidence of MSDs because they also needed to tend to domestic workload such as house chores. Therefore, the double work burden experienced by women increases the physical and psychological demands on them and hence, putting them at an increased risk of acquiring MSDs. Nevertheless, one recent study by Lee & Dik (2017) reported the opposite findings whereby married nurses who received support from spouses and family members were less likely to report WRMSDs symptoms compared to unmarried nurses.

### **2.6.2 Organisational factors**

The prevalence of WRMSDs is high among hospital nurses. With the establishment of new departments, the demand for the nursing workforce continues to

increase. In many hospitals, the nursing shortage is a common problem. Mustafa (2013) highlighted a significant association between nursing shortage and neck pain.

Among nurses who were exhausted due to excessive workload from personnel shortage, 53.2% complained of neck pain compared to those who were not working in an understaffing environment (31%).

Furthermore, nurses are generally frustrated with hectic work schedules and shift work. The work schedules contributing to the development of WRMSDs include shift work, long hours, prolonged work shifts, compulsory overtime, weekend work, and less than ten hours of a gap for rest between shifts. Many studies reported a higher risk of WRMSDs among nurses who performed rotating shifts, as well as those who worked longer than eight hours per shift with fewer hours of rest in between shifts (Heidari *et al.*, 2019). On a similar note, another study showed that the prevalence of WRMSDs was higher among nurses with irregular work patterns, daily night shifts, or those who needed to stay up at night (Yao *et al.*, 2019).

In terms of the departments, nurses working in the operation theatre reported a relatively high prevalence (74.3%) of WRMSDs compared to other departments (Clari *et al.*, 2019). This is likely triggered by their works in organising surgery by arranging devices, transferring the patient onto the surgical table, helping the surgeon with apparatus, and moving the machines during the surgery. In the operation theatre, scrub nurses directly assist the surgeon while circulating nurses assist the scrub nurses in maintaining a sterile environment and taking care of the patient pre- and post-operatively.

Generally, scrub nurses are at a higher risk of WRMSDs because they need to create and maintain a sterile operating site as well as passing the correct surgical apparatus to surgeons. Due to the nature of their tasks that involve continuous

repetitive movements, abnormal motions, static and awkward postures, for a long duration, as well as lifting and holding up heavy surgical instruments when assisting the surgeon and caring for the patient, they are highly prone to WRMSDs.

### **2.6.3 Physical factors**

Physical risk factors for WRMSDs include forces, repetition, vibrations, and awkward postures. Involvement in patient handling tasks is known as the major contributing factor of WRMSDs among nursing staff. Overexertion related to numerous manual patient handling activities can predispose to injuries. Heavy manual lifting associated with patient transferring and repositioning requires nurses to work in extremely awkward postures. Examples of high-risk patient handling tasks include shifting from toilet to chair, moving from chair to bed, transferring from bathtub to chair, repositioning the patient in the bed or on the chair, lifting a patient in bed, or changing the bed sheets while the patient is still on the bed (Hallmark *et al.*, 2015; Tanui *et al.*, 2016; Zayed *et al.*, 2019).

Many physical factors associated with nursing tasks in the hospital environment can affect the health of the nurses. Nurses commonly experience physically demanding tasks such as moving objects, pulling/ pushing machines, lifting patients, and tasks that involve recurring motions, extreme flexion, bending, twisting, and sudden movements (Bhimani, 2016; Nourollahi, *et al.*, 2018; Weiner *et al.*, 2015). All these increased the risk of WRMSDs in different body parts (Chiwariidzo *et al.*, 2018; Raithatha & Mishra, 2016; Thinkkhamrop & Laohasiriwong, 2017; Yasobant *et al.*, 2015). Other factors related to MSDs include prolonged standing positions and awkward postures, for instance, when transferring patients from one location and another (Singh, 2018).

Similarly, another study reported that lifting or moving dependent patients, providing wound care, working in the same position for long period, working in malpositions, providing care for disoriented patients, bending or twisting during work, as well as the working units were factors significantly associated with WRMSDs among nurses (Regassa *et al.*, 2018). Nurses involved in lifting and moving their patients during their daily tasks were 2.1 times more likely to experience WRMSDs.

In a recent study (Khudhir, Saleh, *et al.*, 2017), the Rapid Upper Limb Assessment (RULA) risk assessment on Kurdistan nurses found a high level of risk of exposure (48.4%) to WRMSDs and a statistically significant relationship between the RULA risk level and WRMSDs (SNQ ( $P < 0.001$ )). He concluded that these findings could be associated with the need for nurses to perform extreme awkward postures such as bending and twisting of their bodies as well as applying extreme force and muscle strength in their daily tasks.

#### **2.6.4 Psychosocial factors**

Psychosocial factors at work can be defined as the interactions between the work environment, job content, and organisational conditions with the workers' capacities, needs, cultural beliefs, and personal considerations that may influence their health, work performance, and job satisfaction (Roquelaure *et al.*, 2018). Nurses often encounter various difficulties during their work that may contribute to WRMSDs, including stress, patient demands, issues with management and doctors (Yasobant & Rajkumar, 2015).

The relationship between job-related psychosocial factors and MSDs has been broadly documented in many investigations (Boocock *et al.*, 2019; Freimann *et al.*, 2016; Khudhir *et al.*, 2018). The findings showed that certain psychosocial factors and physical exhaustion led to an increased risk of MSDs among the nurses. Factors



that constantly affected nurses in their daily work were heavy workload, role conflicts, lack of job satisfaction, lack of social support, pressure from time constraints, and respect issues (Kaburi *et al.*, 2019; Bernal *et al.*, 2015). Another study also concurred that nurses' experiences of musculoskeletal pain are mostly related to psychosocial factors. A positive relationship was detected between somatic stress symptoms such as stomach ache, headache, palpitations with musculoskeletal discomfort or pain (Fischer *et al.*, 2010).

A study conducted by Khudhir *et.al.* (2018) proved that the risk of MSDs among nurses who experienced high psychological demand was 6.69 (95% CI: 3.318–13.468) as compared to their counterparts with low psychological demand. Similarly, the risk of MSDs among nurses with low social support was 3 times higher than those with high social support (95% CI: 1.202– 4.814). Nurses who were dissatisfied with work tasks were 2.44 times more likely to develop MSDs (OR = 2.44, 95% CI: 1.04, 5.63) than those who were satisfied with their work environment.

Various tools have been developed to evaluate psychological factors at work, including the 'Job Content Questionnaire' (JCQ) by Karasek and Theorell and the 'Effort-Reward Imbalance Questionnaire' (ERIQ) by Siegrist (Chouanière *et al.*, 2011). In 2018, the Danish National Research Centre for the Working Environment identified several categories of psychosocial factors at work and used them as the foundation of the Copenhagen Psychosocial Questionnaire (COPSOQ I and II) (Roquelaure *et. al.*, 2018).

In a recent study, among all the participants who had at least one WRMSDs in any body areas, more than half (57.3%) were not satisfied with their jobs, 122 (54.9%) cited a lack of cooperation among staff, 107 (48.2%) experienced poor nurse-physician interaction, and 96 (43.2%) commented that their immediate supervisors were not