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ORIGINAL ARTICLE

Prevalence of Musculoskeletal Discomfort Among Workers in a Medical Manufacturing Facility

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ABSTRACT – Medical manufacturing has shown great growth potential in Malaysia, and this sector has created numerous jobs for both local and foreign workers. The workers involved in this industry are exposed to ergonomic risk factors, which lead to discomfort in different body parts. Despite the numerous studies on occupational hazards and the prevalence of Work-Related Musculoskeletal Disorders (WMSDs), little is known about the prevalence of WMSDs for workers working in the medical manufacturing facility, especially in Malaysia. Thus, the main objective of this study is to identify the prevalence of WMSDs among workers in the selected medical manufacturing industry in Malaysia. Structured interviews using Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) were conducted among 10 male workers (mean age of 44 ± 10.83 years, age range of 24–55 years, and working experience range of <1–27 years). The results indicate that the workers experienced the highest discomfort in three body parts; (1) lower back, (2) shoulders, and (3) upper back. The discomfort felt by the workers was 74.36%, 8.96% and 5.52% in the lower back, shoulders, and upper back, respectively. The findings of this study will provide an insight that could be useful for managers and occupational safety, and health officers in the medical manufacturing industry to prevent WMSDs.

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INTRODUCTION

Malaysia is a prosperous country. One of the many sectors that helps Malaysia to prosper economically is the manufacturing industry. According to a report by the Department of Statistics, Malaysia Department of Statistics, Malaysia [1], Malaysia stood at RM121.2 billion in September 2020 for its sales in the manufacturing sector, which corresponds to an increase of 3.7% compared to the sales of the same month in the previous year. There are various types of manufacturing industries in Malaysia, such as food and beverage, textile, chemicals, rubber, electronics, and metal fabrication.

The manufacturing industry in Malaysia is still human-depending. According to a statistical study by Hirschmann (2020), the number of people employed in the manufacturing industry in Malaysia from 2015 to 2019 was around 2.55 million people [1]. In the heavy industry, advanced machines are used instead of human workers to boost productivity, reduce turnaround, and promote safety. Despite the increasing use of automation in the manufacturing industry, the sector still needs human workers to perform several significant tasks [2]. Some of the tasks involve manual handling operations such as lifting, lowering, carrying, pushing, and pulling objects or materials [3-5]. Performing such tasks on a daily basis can lead to mild to severe occupational diseases or term as WMSDs [6]. WMSDs may lead to low productivity, poor work quality, poor compensation and are the leading cause of absenteeism from work [7].

The World Health Organization (WHO) describes WMSDs as health problems that affect the locomotor apparatus. Some studies explained that it might attack the muscles, bones, joints [4, 8]. It may also affect the associated tissues such as tendons and ligaments [9]. The severity of MSDs is varied from the numbness of fingers due to the repetition of the work tasks to disabling hearing due to the occupational noise [10]. WMSDs are known as a common occupational injury in most of the manufacturing industries and also affected other various sectors in the world [11-13].

Table 1 shows the occurrence of occupational accidents from January to March 2020 as reported by the Department of Occupational Safety and Health, Malaysia (DOSH). The manufacturing sector is ranked first for occupational accident statistics, with 1099 cases of non-permanent disability, 55 cases of permanent disability, and 18 cases of death. This leads to a total of 1172 cases, contributing 61.81% of the total reported cases [14]. This indicates that workers in the manufacturing industry are at high risk of occupational hazards.

WMSDs have reached epidemic proportions which have been recorded in many studies in different settings such as in the automotive industry, construction workers, electronic assembly factory, sewing machine operators and others [15-19]. The occupational hazards and their relationship with WMSDs have also been conducted. For example, Liu et al. [20] studied the relationship between ergonomic and psychosocial work hazards with WMSDs of general employees in Taiwan in 2016. They found that WMSDs in the hands, wrists and lower back were prevalent in manual employees. The study

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also reported that all these diagnosed WMSDs were linked with ergonomic hazards. They recommended that WMSD prevention programs should be customised based on the risk profiles of the workers.

A few other studies also supported the idea of the relationship between occupational hazards with WMSDs. Zare et al. [13] assessed the physical risk factors of workers in a truck assembly plant. The main job tasks in the studied plant involve many manual material handling tasks such as lifting, picking up, and tightening. The tasks involve physical risk factors such as repetition, forceful exertion, awkward posture, vibrations, short cycle times, and short recovery times. They observed that some of the ergonomic risk factors such as awkward trunk and shoulder postures, hand/wrist positions were common in the truck assembly plant. These significant ergonomic risk factors will then lead to WMSDs.

Malaysia also observed similar findings. A few studies have in Malaysia have indicated the prevalence of WMSDs among manufacturing employees. Md. Zein et al. [21] conducted a questionnaire survey on the postures of 28 Malaysian industrial workers. The results showed that the following postures were practised by most of the industrial workers: (1) shoulder at chest level (30.1%); (2) back moderately bent forward (90.8%), and (3) lifting loads of 1-5 kg (80.5%). They highlighted that industrial workers were frequently exposed to occupational injury and WMSDs because of improper postures such as bending, twisting, overreaching, repetitive task, and uncomfortable posture.

Md Deros et al. [3] investigated the ergonomic risks of 11 manual material handling workers in a company in Port Klang, Selangor, Malaysia. The studied company is a manufacturer of sintered metal parts. The following postures (lowering, twisting, and lifting) were rated 9 on the Rapid Entire Body Assessment (REBA) score, indicating that the workers were at high risk and changes need to be implemented. They recommended that the employers should provide training and education to the employees in order to reduce the prevalence of WMSDs, improve workplace design, reduce load depending on the task duration (by 30% if the task was repeated once or twice a minute, by 50% if the task is repeated 5–8 times a minute, by 80% if the task is repeated more than 8 times a minute), alternate heavyweights with light ones, promote job variety to minimise repetitiveness, rotate workers so that they will use different muscle groups, and incorporate exercise and stretching programs.

To sum up, all of these studies indicate that WMSDs are prevalent in employees, particularly those involved in manual material handling. Despite the abundance of studies pertaining to occupational hazards and the prevalence of WMSDs available in the literature, little is known on the prevalence of WMSDs in workers working in a medical manufacturing facility, particularly in Malaysia. In this medical manufacturing facility, workers are exposed to many demanding physical activities. The tasks require workers to perform jobs in an awkward posture, handle heavy loads, perform highly repetitive tasks, and work in a static, sustained work posture that can contribute to occupational accidents and diseases [22, 23]. Therefore, the objective of this study is to identify the prevalence of WMSDs among workers in the selected medical manufacturing facility. This study is beneficial for managers and occupational safety and health officers to prevent WMSDs in workers of the medical manufacturing industry, as well as other manufacturing industries.

Table 1. Occupational accident statistics for January–March 2020 [14].

Sector	Non-permanent disability	Permanent disability	Death	Total
Hotel and restaurant	42	1	1	44
Utilities (electricity, gas, water, and sanitary services)	71	1	0	72
Finance, insurance, real estate, and business services	99	2	2	103
Construction	48	1	23	72
Transport, storage, and communication	110	1	1	112
Manufacturing	1099	55	18	1172
Wholesale and retail trade	18	0	0	18
Public services and statutory authorities	15	0	0	15
Mining and quarrying	9	0	2	11
Agriculture, forestry, and fishery	259	4	14	277
Total	1770	65	61	1896

METHODS AND MATERIALS

Subjects and Selected Job Tasks

A medical manufacturing plant located in Bayan Lepas, Penang, was selected as the study location. This plant manufactures medical, surgical, and pharmaceutical products not only for domestic use but also for exportation. The subjects were selected from three Plastic Technology departments (PT1, PT2, and PT3) to participate in this study, and the details of the selected job tasks are shown in Table 2. Since this study is a case study design, a small sample size among 10 workers have been selected. This sample size is considered adequate and in-line according to Diem and Goldman for such a survey [24, 25]. The selected job tasks were manual handling of (1) 25.00-kg chemical bags, (2) 28.61-kg tumbling container, and (3) 22.88-kg bag of nylon film rolls, as shown in Figure 1. All of these activities involve

lifting, twisting, lowering, and repetitive motions. All subjects were briefed about the purpose and methodology of the study and the written consent form was obtained from each of them.

Table 2. Details of the selected job tasks.

Department	Worker no.	Task	Load (kg)
PT1	1	(A) Lifting chemical bags from the pallet and stacking five of these chemical bags on top of a trolley	25.00
	2		
	3		
PT2	4	(B) Lifting the tumbling container from the floor and placing it inside the tumbler	28.61
	5		
	6		
	7		
	8		
PT3	9	(C) Lifting the bag of nylon film rolls from the receiving area and placing it on top of the trolley	22.88
	10		

(a) (b) (c)

Figure 1. Manual lifting of (a) chemical bags, (b) tumbling container, (c) bag of nylon film rolls.

Cornell Musculoskeletal Discomfort Questionnaire

The prevalence of WMSDs among the subjects was assessed by using the Cornell musculoskeletal discomfort questionnaire (CMDQ). CMDQ is a questionnaire developed by Dr Alan Hedge and his team of ergonomics graduate students at Cornell University after reviewing the literature on postural discomfort measures [26]. The validity and reliability of CMDQ have been extensively tested by various studies before, and they were found to be acceptable for use in the evaluation of musculoskeletal discomfort [27-30]. In addition, this questionnaire is also recommended by DOSH Malaysia in the Guidelines on Ergonomics Risk Assessment at Workplace 2017. This questionnaire consists of structured, forced, and multiple-choice variants. It consists of 60 items for 20 body parts, which identify areas of the body that are prone to musculoskeletal problems. A body-map diagram is provided to indicate the 20 body parts, including neck, shoulders, upper back, upper arms, lower back, forearms, wrists, hip/buttocks, thighs, knees, lower legs, and foot. The questionnaire was distributed to all subjects, and the subjects were interviewed directly to obtain their responses. The questionnaire consists of three sections to rate the discomfort of the subjects in the following areas: (1) frequency of ache, pain, or discomfort, (2) the intensity of ache, pain, or discomfort, and (3) the interference of ache, pain, or discomfort with work. The rating scale of each aspect is shown in Table 3. According to the CMDQ scoring guidelines [31], the total discomfort score of a worker's specific body part can be determined by multiplying the frequency, intensity, and interference of discomfort scores as follows:

$$\text{Total discomfort score} = \text{Frequency score} \times \text{Intensity score} \times \text{Interference score} \quad (1)$$

Table 3. Rating scores for the frequency, intensity, and interference of discomfort.

Frequency of discomfort	Intensity of discomfort	Interference of discomfort
0= Never		
1.5= 1–2 times/week	1= Slightly uncomfortable	1= Not at all
3.5= 3–4 times/week	2= Moderately uncomfortable	2= Slightly interfered
5= Every day	3= Very uncomfortable	3= Substantially interfered
10= Several times every day		

RESULTS

Demographic Information of Subjects

In this study, the sample consisted of all male workers (mean age: 44 ± 10.83 years, age range: 24–55 years). Seven (70%) subjects were Malays, whereas three (30%) were Indians. Eight (80%) subjects' highest education level was in secondary school whereas one (10%) subject's highest education level was in primary school and college, respectively. Four (40%) subjects had 1–10 years of working experience, whereas two (20%) had less than one year of working experience and 11–20 years of working experience, respectively. Only one (10%) subject had more than 20 years of working experience. The mean in terms of the working experience was 8.64 ± 8.93 years. The demographic characteristics of the subjects are summarised in Table 4.

Table 4. Demographic information of the subjects.

Demographics	Number of subjects	Percentage of subjects (%)	Mean ± standard deviation
Age (years)			44 ± 10.83
<30	2	20	
41–45	2	20	
46–50	2	20	
51–55	4	40	
Race			
Malay	7	70	
Indian	3	30	
Education level			
College	1	10	
Secondary school	8	80	
Primary school	1	10	
Working experience			8.64 ± 8.93
Less than 1 year	2	20	
1–10 years	4	40	
11–20 years	2	20	
More than 20 years	1	10	

Musculoskeletal Discomfort for Task A

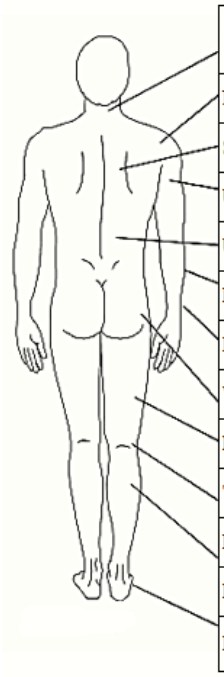
Task A involves lifting chemical bags containing homopolymer, each with a weight of 25 kg. For this task, initially, the workers bent their trunks forward at an angle of more than 45° to reach for the load. Then, they hold and grip the load by using both of their hands where the forceful exertion occurs (grasping the unsupported load). The load is then lifted and transferred onto the trolley. While transferring the load, the workers experienced twisting and bending body parts asymmetrically where the body deviates from the neutral position. The chemical bag was lifted one at a time and was then stacked into five layers on top of a trolley. Figure 2(a) shows the number and percentage of subjects who felt discomfort in various body parts. It is evident that the lower back is the most affected body part, where the total discomfort score was highest with a value of 38.45%. Meanwhile, the total discomfort score in both shoulders was 14.07%, while the total discomfort score was 10.05% in the upper back and thighs. Slight discomfort was also experienced in the left forearm (1.76%) and both feet (0.75%).

Musculoskeletal Discomfort for Task B

Task B involves lifting a tumbling container, which will be used to mix polypropylene homopolymer with the clarifying agent masterbatch, with a weight of 28.61 kg. For this task, the worker lifts the tumbling container from the floor and places the tumbling container into the tumbler. Initially, the workers work in a squat position to reach for the load on the floor. At this point, the upper arms angled away from the body and their trunks were bent forward at an angle more than 60°. After that, the workers hold and grip the load where the forceful exertion is involved (grasping the unsupported object). The load is then lifted and were placed into the tumbler. While doing this task, the worker bends and twisted their body posture. Figure 2(b) shows the musculoskeletal discomfort scores for Task B. It can be seen that the highest discomfort was experienced in the lower back (89.93%). Some also experienced discomfort in the upper back (3.37%), neck (2.69%), and left foot (2.02%). Slight discomfort was also felt in the right upper arm (0.63%), left knee (0.45%), right shoulder (0.27%), left shoulder (0.27%), left lower leg (0.27%), left forearm (0.13%), and left upper arm (0.07%).

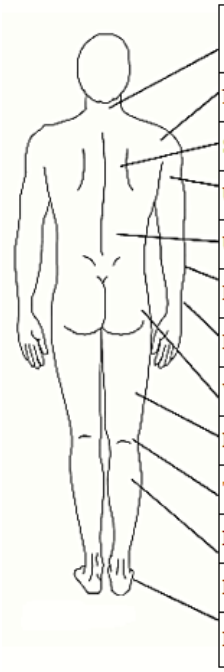
Musculoskeletal Discomfort for Task C

Task C involves lifting a bag of nylon film rolls with a weight of 22.88 kg. For this task, the worker lifts the bag of nylon film rolls from the receiving area and these rolls are lowered on top of the trolley. Initially, the workers reach for the load at the receiving area by bending their trunks at an angle more than 60°. Then, they hold and grip the load using both of their hands and placed them on the trolley. The forceful exertion was involved where they grasp the poor grip load. This task also required workers to work in an awkward posture where the upper arms were angled away and trunks were bent forward. Figure 2(c) shows the musculoskeletal discomfort scores for Task C. The results revealed that the discomfort was highest in the lower back (47.60%), followed by in the right shoulder (23.34%), and upper back (10.98%). Meanwhile, some discomfort was felt in the neck (8.24%) and in the right forearm and right thigh (2.75%). The discomfort was less pronounced in the left shoulder (1.60%), right upper arm (1.37%), and wrist (1.37%).



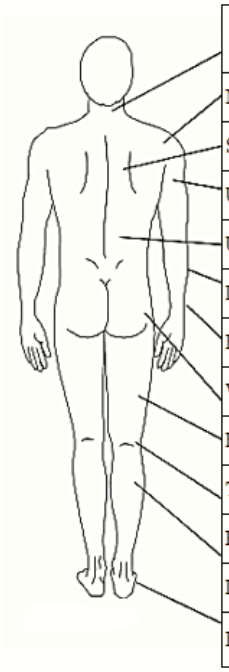
Body Parts		Total discomfort score	Total discomfort score (%)
Neck		0	0.00
Shoulder	Right	112	14.07
	Left	112	14.07
Upper back		80	10.05
Upper arm	Right	0	0.00
	Left	0	0.00
Lower back		306	38.45
Forearm	Right	0	0.00
	Left	14	1.76
Wrist	Right	0	0.00
	Left	0	0.00
Hip/Buttocks		0	0.00
Thigh	Right	80	10.05
	Left	80	10.05
Knee	Right	0	0.00
	Left	0	0.00
Lower leg	Right	0	0.00
	Left	0	0.00
Foot	Right	6	0.75
	Left	6	0.75

(a)



Body Parts		Total discomfort score	Total discomfort score (%)
Neck		60	2.69
Shoulder	Right	6	0.27
	Left	6	0.27
Upper back		75	3.37
Upper arm	Right	14	0.63
	Left	1.5	0.07
Lower back		2000	89.93
Forearm	Right	0	0.00
	Left	3	0.13
Wrist	Right	0	0.00
	Left	0	0.00
Hip/Buttocks		0	0.00
Thigh	Right	0	0.00
	Left	0	0.00
Knee	Right	0	0.00
	Left	10	0.45
Lower leg	Right	0	0.00
	Left	6	0.27
Foot	Right	0	0.00
	Left	45	2.02

(b)



Body Parts		Total discomfort score	Total discomfort score (%)
Neck		18	8.24
Shoulder	Right	51	23.34
	Left	3.5	1.60
Upper back		24	10.98
Upper arm	Right	3	1.37
	Left	0	0.00
Lower back		104	47.60
Forearm	Right	6	2.75
	Left	0	0.00
Wrist	Right	3	1.37
	Left	0	0.00
Hip/Buttocks		6	2.75
Thigh	Right	0	0.00
	Left	0	0.00
Knee	Right	0	0.00
	Left	0	0.00
Lower leg	Right	0	0.00
	Left	0	0.00
Foot	Right	0	0.00
	Left	0	0.00

Figure 2. Musculoskeletal discomfort scores for (a) Task A, (b) Task B and (c) Task C.

DISCUSSION

In this study, the lower back, shoulders, and upper back were the body parts where WMSDs were most prevalent. By contrast, the least affected body part was the hip/buttocks. The discomfort experienced by the workers is likely caused by the following: (1) handling heavy loads, (2) high force exertion, and (3) awkward working posture.

While performing the lifting and lowering tasks, the worker is required to hold and lift the load with high muscular force. According to the Department of Occupational Safety and Health, Malaysia [32], the recommended weight for lifting and lowering tasks for men between shoulder and elbow height far from the body is 10 kg. In this study, the weight lifted by the workers for Tasks A–C is far beyond the recommended weight, with a value of 25.00, 26.81, and 22.88 kg for Task A, B, and C, respectively. Such tasks may lead to acute overload or fatigue of muscles, particularly in the lower back and shoulder areas. In addition, the tasks also exert high forces on the musculoskeletal system, which can lead to acute overloading and damage to the tissues.

High force exertion is a risk factor obtained when the worker lifts heavy objects. This is evident in all three tasks, especially in Task A, where the worker transfers the chemical bags from one location to another and stacks five of these bags on top of a trolley. The worker uses the strength of the back and shoulders to perform the job. The high amount of force exerted on the trunk will eventually lead to damage of the lumbar spine tissues.

An awkward working posture occurs when the workers perform the tasks with their body parts, significantly deviating from the neutral position. A high force applied in the skeletal system when performing a task in an awkward working posture can result in acute overloading and damage of the skeletal structure. Prolonged tasks with a sloping trunk may generate WMSDs associated with lower back pain, particularly in the lumbar region.

Based on the discussed causes of discomfort, there is a need to propose control measures to minimise the WMSDs among material handlers in the medical manufacturing facility. The following engineering and administrative controls are proposed in this study.

Engineering controls:

i. Use scissors lift or load lifter to lift or lower the load so that it is level with the work surface. Slide the load instead of lifting.
ii. Use a turntable for stacking tasks. Rotate the turntable to bring the load closer.
iii. Use a vacuum lifter to handle sacks and bags that are difficult to grip by hand.
iv. Work within the power zone. Tilt the bag or container to improve the handling of materials.
v. Redesign the container so that handles, grips or handholds are accessible.
vi. Get assistance from a co-worker and discuss the movement plan.

Administrative controls:

i. Conduct comprehensive training on manual material handling for the workers so that they will be more aware on the safe practices for material handling.
ii. Consider the workers' welfare to improve occupational health.

The limitations of this study are as follows. First, since the research design is a case study, small sample size was chosen, with only 10 workers. Therefore, larger sample size is needed to conduct a cross-sectional study and compare the results between the industrial sectors. Secondly, we studied only male workers in the medical manufacturing department, where the workers in this department were mostly males. Therefore, the findings cannot be generalised to all material handlers in medical manufacturing facility workers.

CONCLUSION

The following conclusions were drawn based on the results of this study:

i. In the medical manufacturing industry, WMSDs were most prevalent in the lower back, shoulders, and upper back.
ii. The main causes of the prevalence of WMSDs are poor working conditions such as handling heavy loads, high force exertion, and awkward working posture. Taking corrective measures to reduce the risks of WMSDs was essential.

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