

Musculoskeletal symptoms and ergonomic hazards among material handlers in grocery retail industries

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Abstract. Grocery retail work can be physically demanding as material handler's tasks involve manual lifting, lowering, carrying, pushing and pulling loads. The nature of this work puts them at a risk for serious low back pain, shoulder pain and other musculoskeletal injuries. This study was conducted by using two different types of tools which were Nordic Musculoskeletal Questionnaire (NMQ) as a survey and Washington Industrial Safety and Health Act (WISHA) Checklist as a direct observation method. Among 46 males and 14 females material handlers were involved throughout this study. For NMQ, the highest body part trouble in the last 12 months was low back pain (88.3%), followed by upper back (68.3%), neck (55.3%) and shoulder (36.7%). While for WISHA Checklist, most of them experienced hazard level involving awkward posture and high hand force. From the research conducted, musculoskeletal disorders (MSDs) and ergonomic risk factors (ERFs) do related as it showed that musculoskeletal disorders may arise if the workers ignored the safety in ergonomic hazards.

1. Introduction

Manual handling tasks involve several ergonomic hazards [1]. The most important of these include force, repetition motion, awkward sustained postures, and static postures. The existence of these hazards increases the potential for developing musculoskeletal disorders (MSDs) such as back injuries, neck injuries, carpal tunnel syndrome, rotator cuff injuries, and others. These musculoskeletal problems are very concerning especially for working people [2-5]. Some part of body influence was directly linked to the nature of injury such as finger cut, or wrist, back sprain and carpal tunnel syndrome [6].

Generally, grocery retail work can be physically demanding as material handler's tasks involve manual lifting, lowering, carrying, pushing and pulling loads [7]. Other studies acquired that repetition, overload, awkward positions or some combinations are also some factors related to injuries of the human body [8]. Inappropriate working task could cause MSD to be developed such as low back pain, shoulder pain, carpal tunnel syndrome and others. Increasing of attaining MSD are likely due to repetitive bending of the back and lifting [9-11] and pushing/pulling and arm evaluation [12].

Other studies acquired that manual handling tasks involve with work-related lower back disorders [13]. It was claimed that an average of 27.0% of accidents due to manual handling activities was reported in United Kingdom, UK over a period of 50 years. Besides that, in the newspaper industry the



workers task involve several ergonomic hazards such as manual handling newspaper bundles, awkward postures during printing tasks and repetition motion during loading inserting machines [14]. Apart from grocery industries, mould manufacturing industries also acquire almost the same risk factors among their workers such as repetitive tasks, uncomfortable work postures and excessive work without breaks [15]. These actions can lead to MSDs as the workers in this industry was reported to be at risk in developing MSD. The objectives of this study were to determine musculoskeletal disorders (MSDs) prevalence among material handlers in grocery retail industries using Nordic Musculoskeletal Disorder Questionnaire (NMQ) and to identify the caution or hazard level of ergonomic hazards using Washington Industrial Safety and Health Act (WISHA) Checklist.

2. Methodology

2.0. Introduction

Basically, methodology includes the theoretical ideas and concerns which notify the use of different methods or tools. The methods and tools used in this research were Nordic Musculoskeletal Questionnaire (NMQ) which acts as a structured interview session while Washington Industrial Safety and Health Act (WISHA Checklist) act as a direct observation tool. The interview using the NMQ is performed among material handlers in the grocery retail industries. The employees have been visited and interviewed plus have been observed which was related to their working posture. While ergonomics hazards are assessed through direct observation using WISHA Checklist based on the workers' tasks. The workers are observed as the evaluation of their working posture is assessed. These methods or tools were used in order to determine the musculoskeletal disorders (MSDs) and examine the level of ergonomic hazards among material handlers in grocery retail industries.

2.1. Subjects and Task Description

This study of musculoskeletal disorders and ergonomic hazards was conducted among material handlers in the grocery retail industries. The data was collected from selected grocery industries in Malaysia. The sample is composed of 60 material handlers' workers. Each of the workers was allow working in their workstation for approximately ten to fifteen minutes while the evaluation process is taken place.



Figure 1. (a) Reaching with hands overhead and elbow above shoulder, (b) Experienced awkward posture with the back bent more than 45°

Figure 1 showed analysis of ergonomic hazards from some samples of workers. In Figure 1 (a), this worker was reaching with the hands overhead and elbow above the shoulder while stocking on the top

shelf. This action can affect the shoulder and plus, neck where he had to tilt his head up. While in Figure 1 (b), this worker experienced awkward posture where he bent with his back more than 45° for a period of time. This action can cause serious back pain if further actions are not taken.

2.2. Nordic Musculoskeletal Questionnaire (NMQ)

Nordic Council of Ministers had funded a project in developing the Nordic Musculoskeletal Questionnaire (NMQ) in purpose for analysis of musculoskeletal symptoms [16]. The purpose was to develop and test a standardized questionnaire methodology allowing comparison of neck, low back, shoulder and general complaints for use in epidemiological studies [17]. Part A of the survey was about personal profile which called as the demographic item regarding gender, age, height, weight, hand dominance, working experience, and hours of work per week. Questions for trouble with locomotive organs were in part B. Questions which were based on trouble organs such as neck, shoulder, elbows, wrist/hands, upper back, low back, one or both hips/thigh, one or both knees and also one or both ankles/feet were ask in this part. In addition, there is the period in the last of 12 months and last of 7 days discomfort or pain in any body part regions. While in part C, it was concentrated on the most common muscles that involves musculoskeletal symptoms such as low back, neck and shoulder. In this section, the questionnaire investigate further analysis that involves the symptoms and durations sign over time ago that was the whole life from the past of 12 months and 7 days in advance.

2.3. Washington Industrial Safety and Health Act (WISHA) Checklist

Washington Industrial Safety and Health Act (WISHA) Checklist provided thresholds of physical exposures across the body parts in order to evaluate a worker's daily exposure risk [18]. In the late 1990's, the tool was developed in Washington State as part of a regulatory effort in order to control exposures to musculoskeletal risks in the workplace. According to Labor & Industries (L&I) Washington State, the common factors in this checklist include awkward posture, high hand force (pinch and grasp), highly repetitive motion, repeated impact, heavy, frequent or awkward lifting, and moderate to high hand-arm vibration [19]. The evaluation of physical risks depends on the conditions presented in the work activities. Basically there were two conditions present which act as an indicator for "Caution" and "Hazard" in the checklist. Most of the conditions were based on duration.

3. Results and Discussion

3.0. Introduction

This chapter includes the analysis that has been conducted in order to achieve the objectives of the study. In NMQ, results of demographic data, prevalence musculoskeletal symptoms and perceived job demand were analysed as descriptive statistics such as percentages, mean and standard deviation. As for WISHA Checklist, results of exposure level were analysed as caution or hazard level. The data collected were carried out using Statistical Package for the Social Science (SPSS) Software Version 22.0.

3.1. Demographic Data

Based on demographic data, it was observed that the number of men working in grocery industries was more than women with a percentage of 76.7% to 23.4%. Mostly, the ages of workers working there were between 21-40 years old with a percentage of 96.7% which were quite young for material handler jobs while the age more than 41 was only 3.34%. The mean ages was 29.8 (SD = 5.25). This explains the high weekly working hours that was more than 51 hours a week with a percentage of 70.0% whereas only 30.0% for working hours between 40 to 50 hours a week. The mean of weekly working hours was 55.4 (SD = 4.07).

Mostly, their total years of working experience percentage was 93.3% which is between 1 to 5 years. Only 6.67% was occupied by workers working with an experience above 6 years. The mean of

total years of working experience is 2.76 (SD = 1.81). Other than that, most of the workers had a BMI in the normal range with a percentage of 73.3%, followed by the underweight range (16.7%) and the overweight range (10.0%). The mean of the workers' was 23.2 (SD = 1.81). Lastly, most of the workers was right handed with a percentage of 93.3% while the rest were left handed with a percentage of 6.67%.

Table 1. Demographic data (n=60)

Characteristics	N	%	Mean	SD
Gender				
Male	46	76.7	-	-
Female	14	23.4	-	-
Age				
≤20	0	0		
21-40	58	96.7	29.8	5.25
≥41	2	3.34		
Working Experience (Year)				
1 to 5	56	93.3		
≥6	4	6.67	2.76	1.81
Weekly Working Time (Hours)				
40 to 50	18	30.0		
≥51	42	70.0	55.4	4.07
Body Mass Index				
Underweight	10	16.7		
Normal Weight	44	73.3		
Overweight	6	10.0	23.2	1.81
Obesity	0	0		
Hand Dominance				
Right Handed	56	93.3		
Left Handed	4	6.67	-	-

3.2. Number of Self-Reported Symptoms

From the data of numbers of self-reported symptoms among material handlers occurring in the last 12 months, it shows that material handlers have a high level of MSDs. Men (n = 46) and women (n = 16) have different prevalence of musculoskeletal symptoms on different body region. The highest symptom affected to males was the lower back with a percentage of 89.1%, followed by upper back (67.4%) and neck (54.3%). Same goes for the females, the highest symptom affected was the lower back with a percentage of 85.7%, followed by upper back (71.4%) and neck (50.0%). The lowest prevalence of musculoskeletal symptoms affected men and women was the elbow with a percentage of 6.53% and 0% respectively.

In Figure 2, symptoms affected males and females were mainly of the neck, shoulders, upper back, and lower back. Based on studies, it was reported that the highest MSIs affected was the back (46%), followed by the upper limbs (38%), then the lower limbs (7%) and lastly the neck (5%) [20]. However, other studies claimed that the highest MSD prevalence was the lower limb (31.7%), followed by the thoracic back (27.7%), lower back (27%), and shoulders (17.3%) [21]. Back

problem is common all around industries as workers in construction industries also reported a high prevalence of back problem ^[22].

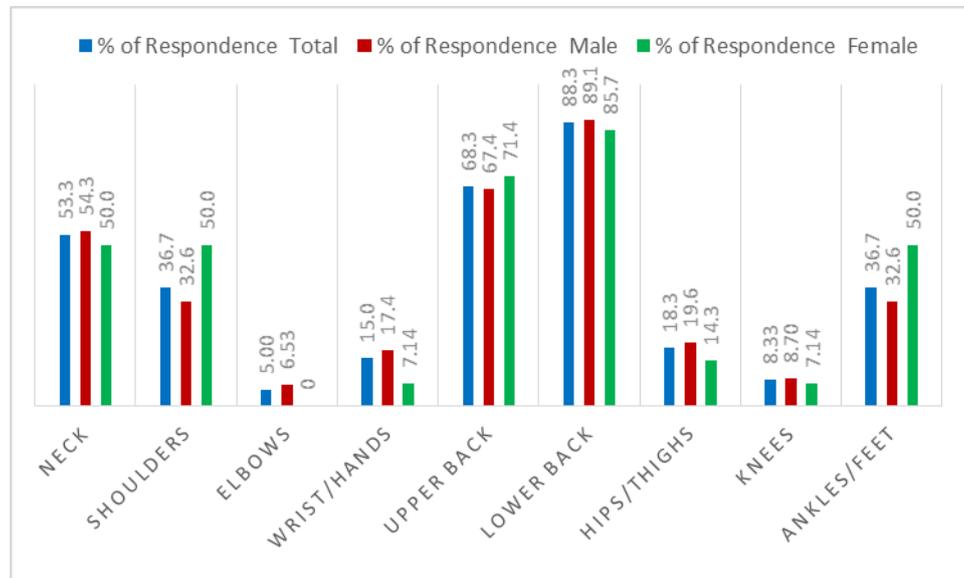


Figure 2. Percentage of Nordic Musculoskeletal Questionnaire Respondents with Body Part Trouble in the Last 12 Months

3.3. Reported Lower Back, Neck and Shoulder Trouble

Based on Table 2, the lower back had the highest trouble affecting the workers with a percentage of 88.3%, followed by the neck (53.3%) and shoulders (36.7%). Back was proved to be the most trouble as the back was the most troubled affecting the workers with a percentage of 31%, followed by shoulders and leg (12%) and shoulder (4.0%) [6]. Workers had hurt their shoulder in an accident with a percentage of 16.7% while none was hurt affected the neck or lower back. Due to these troubled, they had to change jobs mostly because of lower back with a percentage of 15.0%, followed by the shoulder (3.3%) and neck (1.7%).

Most of the workers suffered from lower back with a percentage of 41.7% for about 1 to 7 days, followed by 20% for 0 days and 1.7% for 8 to 30 days. For the neck problem, most of them suffered for 0 days with a percentage of 16.7%, followed by 15.0% for 1 to 7 days and 3.3% for 8 to 30 days. However for the shoulder problem, 11.7% of them suffered for 1 to 7 days, followed by 10.0% for 0 days and 6.7% for 8 to 30 days. Based on studies, shoulder was the most troubled in the previous 7 days with a percentage of 41%, followed by neck (33.0%) and elbows (28.0%) [23]. However, other studies acquired that 56.0% was accounted to have troubled in the lower back in the previous 7 days [24].

In terms of work activity, these symptoms have effect and reduce the work activity for the workers. The prevention was most from the lower back (43.3%), followed by the neck (18.3%) and shoulder (16.7%). While for the leisure activity, the percentage does not differ much from the work activity. Based on one study, the percentage prevention from doing work at work or home is mostly due to the lower back (26%), neck (11%) and shoulder (21%) [20]. Besides that, only a few percent of workers (10.0%) have been hospitalized due to lower back trouble while fortunately, none for the neck and shoulder. The workers had also sought doctors for therapy where about 20% were due to low back pain, followed by neck (11.7%) and shoulder (5.0%). Researchers mentioned that about 11% of workers have missed work due to the symptoms with low back pain being the most factor in the last 12 months [25]. Also, about 25% of workers sought doctors for their medical care with low back pain being the most common cause.

Table 2. The prevalence of Musculoskeletal Symptoms by body parts among material handlers

Symptoms	N = 60		
	Lower Back (%)	Neck (%)	Shoulder (%)
Any trouble	88.3	53.3	36.7
Ever had accident	0.0	0.0	16.7
Change job	15.0	1.7	3.3
Total time with trouble last 12 months (Days)			
0	20.0	16.7	10.0
1 to 7	41.7	15.0	11.7
8 to 30	1.7	3.3	6.7
More than 30	0	0	0
Everyday	0	0	0
Reduce work activity last 12 months	43.3	18.3	16.7
Reduce work leisure last 12 months	33.3	15.0	16.7
Total time prevented work last 12 months			
0	3.3	0	5.0
1 to 7	40.0	13.3	6.7
8 to 30	1.7	3.3	6.7
More than 30	0	0	0
Sought doctor	20.0	11.7	5.0
Hospitalized	10.0	0	0

In Table 3, it shows the 12 month prevalence of musculoskeletal symptoms and work interference by anatomical region. The highest prevalence ratios that affected the upper extremity region were the shoulder with a percentage of 36.7%, followed by hand/s wrists (15.0%) and elbows (5.0%). In the lower extremity region, ankles/feet was the highest prevalence with a percentage of 36.7%, followed by hips/thighs (18.3%) and knees (8.33%). While axial skeleton region, the lower back had the highest prevalence with a percentage of 88.3%, followed by upper back (68.3%) and neck (53.3%). Agrawal & Panjwani [24] shows 60% of the subjects had trouble with lower back region in the last 12 months. Others affected were knees, ankles/feet, hips/thighs, upper back, neck and lastly shoulders. However according to other researches, it was claimed that back injury has the highest prevalence with a percentage of 60.0%, followed by the neck and upper extremities and knees [26].

In terms of prevention from doing work during the last 12 months, the highest prevalence percentage in upper extremity region were the shoulder with a percentage of 15.0%, followed by hands/ wrists (6.7%) and elbows (1.7%). In addition, ankles/feet was the most case prevented from doing work with a percentage of 8.3% while only 5.0% for knees and hips/thighs. In the skeleton region, lower back had the most prevalence percentage with a percentage of 46.7%, followed by upper back (30.0%) and neck (16.7%). According to studies, workers tend to be restrained from doing work as the trunk is the major problem in this case with a percentage of 35.0%, followed by upper

extremities (30.0%), back (23.0%) and lower extremities (22.0%) [6]. However, according to Waters & Anderson [27], 78.9% of the workers experience neck/shoulder injury which have prevented them from doing their work during the last 12 months, followed by the back (36.8%), and the lower extremity (10.5%).

Regarding to the results about the trouble last 7 days, it differs from the trouble last 12 months. Based on the table in upper extremity region, the shoulders and hands/wrists had the same prevalence percentage which were 3.3%. As in the lower extremity, knees had the highest percentage which was 6.7%, followed by hips/thighs (5.0%) and ankles/feet (1.7%). In terms of axial skeleton, the lower and upper back had the same percentage of troubled and only 3.3% was the neck in the last 7 days. 56% of the workers reported pain in the last 7 days [24]. Furthermore, trouble with neck/shoulders was accounted by 46% while the elbows/hands were only 13% [23].

Table 3. Twelve-month prevalence of Musculoskeletal Symptoms and work interference by body region

Anatomical Region	N = 60		
	Any Trouble Last 12 Months (%)	Prevented From Normal Work (%)	Trouble Last 7 Days (%)
Upper Extremity			
Shoulders	36.7	15.0	3.3
Elbows	5.0	1.7	0
Hands/Wrists	15.0	6.7	3.3
Lower Extremity			
Hips/Thighs	18.3	5.0	5.0
Knees	8.33	5.0	6.7
Ankles/Feet	36.7	8.3	1.7
Axial Skeleton			
Neck	53.3	16.7	3.3
Upper Back	68.3	30.0	5.0
Lower Back	88.3	46.7	5.0

3.4. Risk Level of Awkward Posture

For awkward posture checklist, the most troubled body part was the shoulder where the workers worked with raising hands repetitively above the head or elbows for more than 2 hours total per day with a percentage of 43.3% while the least was kneeling for more than 4 hours total per days with a percentage of 8.33%.

An approximate 73.0% of workers had repeated trauma cases which include the shoulder as a priority [6]. In addition, United States Department of Labor outlined that 50.0% of workers had back trouble due to forward bending back in 2009 [28]. Moreover, Health and Safety Executive (HSE) stated that kneeling and squatting may result in chronic pain and approximately 69.0% to 84.0% had troubled with these situation [29].

Table 4. Risk level of awkward posture

Awkward Posture	Risk Level			
	Caution ^h		Hazard ⁱ	
	N	%	N	%
Shoulder ^a	11	18.3	8	13.3
Shoulder ^b	26	43.3	14	23.3
Neck ^c	19	31.7	8	13.3
Back ^d	16	26.7	6	10.0
Back ^{e (h)}	N/A	N/A	13	21.7
Knees ^f	15	25.0	9	15.0
Knees ^g	20	33.3	5	8.33

Notes:

a: Working with the hand(s) above the head or the elbow(s) above shoulder(s)

b: Repetitively raising the hand(s) above the head or the elbow(s) above the shoulder(s) more than once per minute

c: Working with the neck bent more than 45° (without support or the ability to vary posture)

d: Working with the back bend forward more than 30° (without support or the ability to vary posture)

e: Working with the back bent forward more than 45° (without support or the ability to vary posture)

f: Squatting

g: Kneeling

h: Duration-more than 2 hours total per day

i: Duration-more than 4 hours total per day

3.5. Risk Level of High Hand Force

In terms of high hand force checklist, the most troubled body part was pinching an unsupported objects with no other risk factors for more than 2 hours total per day with a percentage of 61.7% while the least was pinching an unsupported objects with wrists bend in flexion 30° or more for more than 3 hours total per day with a percentage of 5.00%. IOWA stated that studies showed repeated forceful exertions of hands and arms correlated with work-related MSDS especially when dealing with tools, pinching or pushing with fingers ^[30]. In addition, power grip should be applied rather than applying pinch and grasp unless the items were small and light ^[1].

Table 5. Risk level of high hand force

High Hand Force	Risk Level							
	Hazard ^c		Hazard ^d		Caution ^e		Hazard ^f	
	N	%	N	%	N	%	N	%
Pinch ^a	6	10.0	3	5.00	37	61.7	6	10.0

Grasp ^b	10	16.7	4	6.67	29	48.3	7	11.7
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Note:

a: Pinching an unsupported object(s) weighing 2 or more pounds per hand, or pinching with a force of 4 or more pounds per hand (comparable to pinching half a ream of paper)

b: Gripping an unsupported object(s) or with a force weighing 10 pounds or more pounds per hand (comparable to clamping light duty automotive jumper cables onto a battery)

c: Highly repetitive motion (more than 3 hours total per day)

d: Wrists bent in flexion 30° or more, or in extension 45° or more, or in ulnar deviation 30° or more (more than 3 hours total per day)

e: No other risk (caution - more than 2 hours total per day)

f: No other risk (caution - more than 2 hours total per day)

3.6. Risk Level of Highly Repetitive Motion

In highly repetitive motion, neck, shoulders, elbows, wrists and hands that were used in same motion with no other risk factors for more than 2 hours total per day had the highest percentage which was 51.7% while the least was involving intensive keying with awkward posture for more than 4 hours total per days which was 8.33%. WorkSafe explained that lifting tasks repetitively with such time duration increases the risk of injury [31]. Moreover, Occupational Health and Safety Act 1985, OSHA stated that pliers which does not have return spring were also required to open for the workers where repetitive motion occurred to hands and fingers [32]. These lead to awkward movements and postures of the hand.

Table 6. Risk level of highly repetitive motion

Highly Repetitive Motion	Risk Level			
	Caution ^e		Hazard ^f	
	N	%	N	%
Neck, shoulders, elbows, wrists, hands ^a	31	51.7	0	0
Neck, shoulders, elbows, wrists, hands ^b	N/A	N/A	6	10.0
Neck, shoulders, elbows, wrists, hands ^c	N/A	N/A	5	8.33
Neck, shoulders, elbows, wrists, hands ^d	11	18.3	0	0

Notes:

a = Same motion with little/no variation (no other risk factors)

b = Same motion with little/no variation (wrists bend 30°/45° or more AND high, forceful exertions with hand(s))

c = Intensive keying (awkward posture, including wrists bend in 30°/45° or more, or ulnar deviation 30° or more)

d = Intensive keying (no other risk factors)

e = More than 2 or 4 hours total per day

f = More than 6 or 7 hours total per day

3.7. Risk Level of Repeated Impact

As for the repeated impact checklist, it was found that involving hands as a hammer for more than 2 hours total per day had a percentage of 8.33%. Repeated impact has the fewest symptoms and risk level. According to Gagne et al, approximately 9.0% of the workers have been struck by objects [1]. IOWA also mentioned that applying the knee acts like a hammer alone may expose the workers to such a degree of physical stress that they might harm themselves [30].

Table 7. Risk level of repeated impact

Repeated Impact	Risk Level			
	Caution ^a		Hazard ^b	
	N	%	N	%
Hands	5	8.33	0	0
Knees	0	0	0	0

Notes:

a = Using body parts as hammer more than 10 times per hour

b = Using body parts as hammer more than 60 times per hour

*Both applies the duration of more than 2 hours total per day

3.8. Risk Level of Heavy, Frequent or Awkward Lifting

Moreover, in heavy, frequent or awkward lifting, lifting more than 25 pounds for more than 25 times per day where back and shoulders were affected had the highest percentage (13.3%) while lifting 55 or more pounds for more than 10 times per day had the lowest percentage (3.33%). It was accounted that 28.0% cases were recorded where workers were exposed to overexertion specifically in lifting [1]. WorkSafe explained that force was an important causal agent in injuries from manual material handling activities [31]. Lifting heavy loads below the waist level or above the shoulders strains the back. Lastly, for the arm vibration risk level, cushion should be provided on the standing surface for the driver using the stand-up pallet jacks to reduce vibration. Using tools with low vibration or wearing gloves might help in reducing vibration to hands or arms [26].

Table 8. Risk level of heavy, frequent or awkward lifting

Heavy, Frequent or Awkward Lifting	Risk Level	
	Caution	
	N	%
Back and shoulders ^a	0	0
Back and shoulders ^b	2	3.33
Back and shoulders ^c	7	11.7
Back and shoulders ^d	8	13.3

Notes:

a = Lifting 75 or more pounds with no other risk factors. Duration = one or more times per day

b = Lifting 55 or more pounds with no other risk factors. Duration = more than 10 times per day

c = Lifting more than 10 pounds with more than 2 times per minute. Duration = more than 2 hours total per day

d = Lifting more than 25 pounds with above the shoulders, below the knees and at arm's length. Duration = more than 25 times per day

3.9. Risk Level of Moderate to High Hand-Arm Vibration

Lastly, in moderate to high hand-arm vibration, it was analysed that using tools with hands, wrists and elbows that exposed to vibration for more than 30 minutes total per day had a percentage of 11.7% while for more than 2 hours total per day had percentage of 18.3%.

Table 9. Risk level of moderate to high hand arm vibration

Arm Vibration	Risk Level - Caution	
	N	%
Using hand tools that typically have high vibration levels ^a	7	11.7
Using hand tools that typically have moderate vibration level ^b	11	18.3

Notes: a - more than 30 minutes total per day, b - more than 2 hours total per day

4. Conclusion

In conclusion, determination of the musculoskeletal disorders (MSDs) prevalence among material handlers in grocery retail industries using Nordic Musculoskeletal Disorder Questionnaire (NMQ) and to identify the caution or hazard level of ergonomic hazards using Washington Industrial Safety and Health Act (WISHA) Checklist have been achieved. Based on NMQ, most of the workers acquired prevalence of MSDs particularly involving lower back, upper back, neck, shoulder and ankles/feet. Males were likely to get injured as they used more energy and force with relation to the work ergonomic. As for WISHA Checklist, most of the workers are exposed to ergonomic hazards mainly due to awkward posture and high repetitive motion risk level. Supposedly, the interventions must be reviewed by the workers based on their own experiences and needs. Proper lifting is one of the improvements that can reduce the body injury especially dealing with the back and shoulder ^[33]. Occupational Safety and Health Administration (OSHA) also suggested that the shoulder should be in a relax position, the elbow must be close to the body and working at about elbow height ^[34]. In addition, knee pads or stool should be provided to avoid knee strain when kneeling against the floor to stock low shelves in a period of time ^[35]. For future works, code of practices improvement, workplace improvement, effective prevention strategies and awareness manual handling should be implemented in workplace to minimize the injury activities.

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