UNIVERSITI PUTRA MALAYSIA

EFFECT OF BACK SUPPORT VEST IN REDUCING DISCOMFORT FROM SIMULATED MANUAL HANDLING OF LOADS AMONG MALE WORKERS AT TAMAN PERTANIAN UNIVERSITI, UPM

MUHAMMAD ZULHAILY BIN TAJUL ARIFFIN

EFFECT OF BACK SUPPORT VEST IN REDUCING DISCOMFORT FROM SIMULATED MANUAL HANDLING OF LOADS AMONG MALE WORKERS AT TAMAN PERTANIAN UNIVERSITI, UPM

BY

MUHAMMAD ZULHAILY BIN TAJUL ARIFFIN

Thesis submitted in fulfilment of the requirement for degree of Bachelor Sciences (Environmental and Occupational Health) from Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

ACKNOWLEDGEMENT

With the name of Allah, Most Gracious and Most Merciful. Here, I would like to praises to Allah because for His permission, this thesis could be completed. Without His permission, I would not have the will and bless to run this research and to produce the complete thesis.

My thank goes to my supervisor, Dr. Ng Yee Guan for their support and guidance in the overall coordination in this study. His constructive comments, suggestions and guidance are highly appreciated.

I would like to thanks to all respondents who are participated in my research study which were all agricultural workers from Taman Pertanian Universiti, Universiti Putra Malaysia.

Not forgetting my family for their support that given to me throughout my study until the completion of this project. In additions, I would like to thank Mr Fakrullah Zawawi for agreeing to sponsor in this project. Last but not least, to all who had directly and indirectly given their hands and word helping me during this project, your kindness means a lot to me. Thank you very much.

ABSTRACT

EFFECT OF BACK SUPPORT VEST IN REDUCING DISCOMFORT FROM SIMULATED MANUAL HANDLING OF LOADS AMONG MALE WORKERS AT TAMAN PERTANIAN UNIVERSITI, UPM

MUHAMMAD ZULHAILY BIN TAJUL ARIFFIN

BACKGROUND: Manual handling of loads occurs in almost all working environments and workers are most likely to be exposed to heavy loads. When manual handling of loads performed incorrectly posture and excessively weight of loads, these tasks may expose workers to physical risk factors, discomfort and pain. And many of workers took the initiative to use back support vest in order to reduce discomfort but there are still ambiguous and lacking evidences on the effectiveness of wearing back support vest. Therefore, it is require proving scientifically the effects of wearing back support vest in reducing discomfort to improve worker safety, health and comfort level. **OBJECTIVE:** The purpose of this study is to evaluate the effects of back support vest in order to reduce discomfort and to provide a good lifting posture for workers during manual handling. **METHODOLOGY:** This study was conducted among male workers at Taman Pertanian Universiti (TPU), Universiti Putra Malaysia (UPM). 38 respondents were participated, with 19 respondents for each control and experimental group. Each respondents in experimental group received back support vest intervention but respondents in control group did not received back support vest intervention. Localised Musculoskeletal Discomfort (LMD) scale questionnaires used to assess workers discomfort's level for lifting weight of 5.9 kg, 10.4 kg, 14.9 kg and 19.4 kg. **RESULT:** The results showed lower back part experienced greatest discomfort compared to other body parts. The percentage of improvement can be seen at neck, upper back, middle back and lower back. Throughout this study, there is significant reduction found in LMD's scale measurement in experimental group for certain body parts with the certain weights. **CONCLUSION:** This study suggested that with the application of back support vest during manual handling have potential to improve the comfort level among workers. Therefore, back support vest may have potential in reducing the occurrence of back discomfort during manual handling of loads.

Keywords: Manual handling of loads, Localised Musculoskeletal Discomfort's scale, Back Support Vest.

ABSTRAK

KESAN VEST SOKONGAN BELAKANG DALAM MENGURANGKAN KETIDAKSELESAAN SEMASA SIMULASI PENGENDALIAN BEBAN SECARA MANUAL DI KALANGAN PEKERJA LELAKI DI TAMAN PERTANIAN UNIVERSITI, UPM

MUHAMMAD ZULHAILY BIN TAJUL ARIFFIN

LATAR BELAKANG: Pengendalian beban secara manual berlaku dalam hampir semua persekitaran kerja dan para pekerja adalah kemungkinan besar akan terdedah kepada beban berat. Apabila pengendalian beban secara manual dilakukan dengan postur badan yang tidak betul dan berat beban berlebihan, tugas-tugas ini boleh mendedahkan pekerja kepada faktor risiko fizikal, ketidakselesaan dan kesakitan terutamanya pada tulang belakang. Dan para pekerja mengambil inisiatif memakai vest sokongan belakang untuk mengurangkan ketidakselesaan tetapi bukti keberkesanannya masih lagi samar-samar dan masih kurangnya bukti mengenai keberkesanan intervensi ini. Oleh itu, adalah perlu untuk membuktikan secara saintifik keberkesanan penggunaan vest sokongan belakang ini dalam mengurangkan ketidakselesaan untuk meningkatkan keselamatan, kesihatan dan tahap keselesaan pekerja. **OBJEKTIF:** Menilai kesan memakai vest sokongan belakang dalam mengurangkan ketidakselesaan dan untuk menyediakan postur yang baik untuk pekerja semasa pengendalian beban secara manual. **METODOLOGI:** Kajian ini dijalankan di kalangan pekerja lelaki di Taman Pertanian Universiti (TPU), Universiti Putra Malaysia (UPM). 38 responden telah mengambil bahagian, iaitu 19 responden bagi setiap kumpulan kawalan dan kumpulan eksperimen. Setiap responden dalam kumpulan eksperimen menerima vest sokongan belakang tetapi responden dalam kumpulan kawalan tidak menerima vest sokongan belakang. Borang soal selidik Skala Ketidakselesaan Muskuloskeletal Setempat digunakan untuk menilai ketidakselesaan para pekerja dalam mengangkat beban seberat 5.9 kg, 10.4 kg, 14.9 kg dan 19.4 kg. **KEPUTUSAN:** Hasil kajian menunjukkan bahagian bawah belakang badan mengalami ketidakselesaan yang tinggi berbanding bahagian-bahagian badan yang lain. Peratusan pembaikan dapat dilihat pada leher, atas belakang badan, tengah belakang badan dan bawah belakang badan. Sepanjang kajian ini, terdapat pengurangan yang ketara dijumpai di dalam pengukuran skala ketidakselesaan dalam kumpulan eksperimen pada bahagian badan tertentu dengan berat yang tertentu. **KESIMPULAN:** Kajian ini mencadangkan bahawa dengan penggunaan vest sokongan belakang semasa pengendalian beban secara manual berpotensi meningkatkan tahap keselesaan di kalangan pekerja. Oleh itu, vest sokongan belakang mempunyai potensi dalam mengurangkan kejadian ketidakselesaan belakang semasa pengendalian beban secara manual.

Kata Kunci: Pengendalian Beban Secara Manual, Skala Ketidakselesaan Muskuloskeletal Setempat, Vest Sokongan Belakang.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BMI	Body Mass Index
CM	Centimetre
CR-10	Category Ratio-10
KG	Kilogram
LMD	Localised Musculoskeletal Discomfort
MHL	Manual handling of load
MSDs	Musculoskeletal Disorders
NIOSH	National Institute for Occupational Safety and Health
PILE	Progressive Isoinertial Lifting Evaluation
RWL	Recommended Weight Limit
SOCSO	Social Security Organisation

CHAPTER 1

INTRODUCTION

1.1 Background

Manual handling is any of the following activities carried out by one or more workers such as lifting, holding, putting down, pushing, pulling, carrying or moving of loads. In facts, manual handling occurs in almost all working environments and workers are most likely to be exposed with heavy loads for example working in construction, agriculture, and manufacture (European Agency for Safety and Health at Work, 2007).

According to Nancy et al. (2006) when manual handling performed with awkward postures or heavy loads, these tasks may expose workers to ergonomic hazards, fatigue, and back discomfort or pain. Back discomfort can also exist in sustained postures which place excessive force on joint and overload the muscles and tendons. And back pain is caused by damage to the muscles and ligaments of the back. A herniated disc in the lumbar spine can put pressure on spinal nerve roots, causing discomfort and pain in the lower back (Stephen, 2008).

In additions, the need to spend long periods in awkward posture in manual handling can contribute to the worsening of scoliosis symptoms in adulthood. However, adolescent idiopathic scoliosis can usually be treated by appropriate back support and exercise (Polastri & Romano, 2016).

Therefore, maintaining good posture while manual handling is very important to keep back body in good condition. Intervention such as wearing back support vests to keep body in order to correct posture can be implemented to the worker while handling manual. The purpose of a back support is principally to support an unstable lumbar spine and reduce pain (Polastri & Romano, 2016). In facts, regarding muscle activity and body stability, the back support can be considered a useful assistive device to reduce muscle activity and increase body stability during manual handling (Chen et al., 2006).

1.2 Problem Statement

Manual handling is one of the main causes of musculoskeletal injuries in the workplace. Based on Social Security Organisation (SOCSO) Malaysia (2015), the numbers of accident reported for back injury increased drastically with 1396 cases in 2009 to 2218 cases in 2015. In facts, one of the factor lead to back injury is from manual handling over-exertion or strenuous movement) and this factor of injury also increased from 2009 with 2715 cases until 2015 had reached 5462 cases. Therefore, the numbers of employees with back pain is increasing and will continue to increase if no prevention be carried out.

Although back support are being bought and sold under the premise that they claimed it able to reduce the risk of back injury but there is still insufficient scientific evidence that they actually deliver what is promised (Centers for Disease Control and Prevention, 2014 & National Institute for Occupational Safety and Health, 1996) from United States of America. Due to limitations of the studies that have analysed workplace use of back support, therefore the results cannot be used to either support or refute the effectiveness of back support in injury reduction.

In additions, most of previous studies only discuss about belts and corsets design (Ammendolia et al., 2005). As a result were researchers unable to conclude the overall of back support effectiveness from other studies because there are many types and designs of back support used in sport and occupational. And each of back support has which may deliver different result. Therefore, the design and type of fabric used plays an important role. And for this study, use back support vest that had been commercialized in a large scale in Malaysia and commonly used in occupational.

1.3 Significance of study

So it is necessary to conduct study concerning employee posture using a back support which is one of the ergonomic interventions to predict in improving lifting comfort. National Institute for Occupational Safety and Health (NIOSH) have mentioned that encourages efforts to more adequately determine the association between back support use and the prevention of low back injury and is committed to supporting further research in this area (Centers for Disease Control and Prevention, 2014) from United States of America.

Currently, there is no study on effect of back support vest uses among Malaysian industrial population. Therefore, this study able to prove scientifically data on the effect of back support that currently used in occupational for manual handling. This study use back support vest that a commonly use with a latest design which are largely marketed in Malaysia. This study collects data by using Localised Musculoskeletal Discomfort (LMD) scale questionnaire. For LMD's scale the respondent rated the effect of wearing back support vest by their own perceptions. Therefore, the data from this study will add additional scientific evidence in the use of back support vest.

1.4 Conceptual Framework

This study is to assess worker discomfort caused by manual handling of loads. Under manual handling of loads, there are several factors which can contribute to workers discomfort during the work process. However, load factor which affect worker discomfort was focused on this study. The other factors such as task, environmental and individual also affect the discomfort level but these factors were controlled in the design of experimental study and in the selection of the respondents.

In order to improve worker discomfort, a back support vest has been introduced. There are two separate groups which are workers with back support vest and workers without back support. The workers with back support vest will experience low or no discomfort from manual handling. However the workers with back support vest will experience fatigue, discomfort and pain. The effect of this back support was assessed by measuring the discomfort level. See figure 1.1.

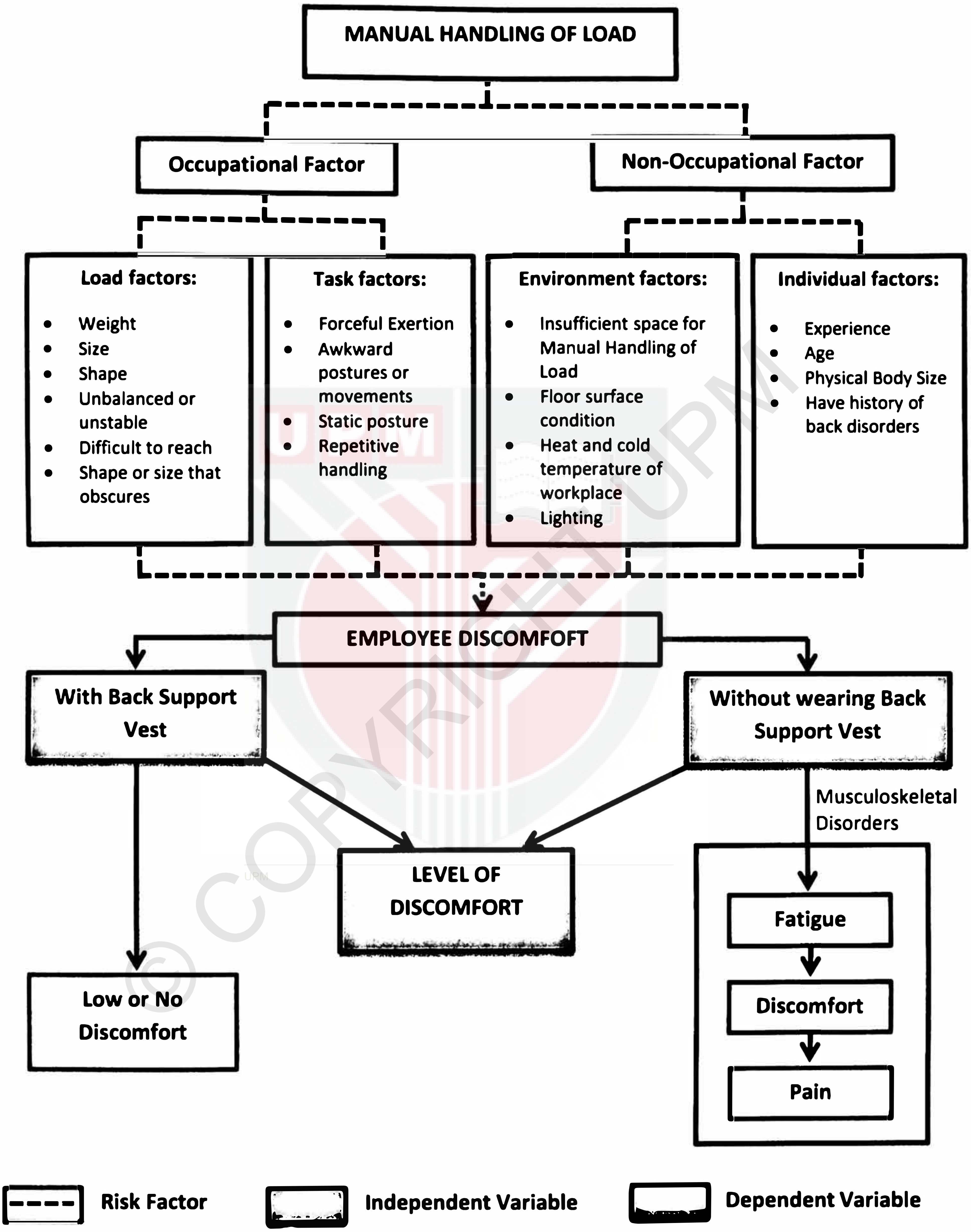


Figure 1.1: Conceptual Framework
(The study of back support vest effect on back discomfort due to manual handling of loads)

1.5 Research Objective

1.5.1 General Objective

To determine the effect of back support vest in reducing discomfort due to manual handling.

1.5.2 Specific Objective

The specific objectives of this study are as follows:

1) To determine the level of musculoskeletal discomfort for control and experimental group respectively during manual handling.
2) To compare the level of musculoskeletal discomfort within pre-test and post-test among control group and experimental group.
3) To compare the level of musculoskeletal discomfort between control group and experimental group.

1.6 Hypotheses

1) There is no significant different of musculoskeletal discomfort during pre-test and post within control group.
2) There is significant different of musculoskeletal discomfort during pre-test and post within experimental group.
3) No significant difference between controls with experimental group in pre-test.
4) There is significant difference between controls with experimental group in post-test.

1.7 Definitions of Terms

1.7.1 Conceptual Definitions

1.7.1.1 Manual Handling

Manual handling means any activities carried out by workers for example lifting, holding, putting down, pushing, pulling, carrying or moving of a load (European Agency for Safety and Health at Work, 2007).

1.7.1.2 Musculoskeletal Discomfort

Musculoskeletal Discomfort is often related to tension, overuse or muscle injury from exercise or physically-demanding work. The pain or discomfort usually tends to involve specific muscle and starts during or just after the activity (National Library of Medicine, 2014). It can affect any part of the body which include hands, back, neck and shoulder.

1.7.2 Operational Definitions

1.7.2.1 Manual Handling

In this study, manual handling is considered lifting loads for 5.9 kg, 10.4 kg, 14.9 kg and 19.4kg. These weights are under ideal conditions and safe to be lifted (Waters at al., 1994). During experimental session, respondent were asked to lift-up the loads from floor and put onto table height repeated for 4 times and the duration of the testing is total of 10 minutes. In this experiment, respondent need to lift and lowering the loads in one place only, no need to move around.

1.7.2.2 Musculoskeletal Discomfort

Muscle discomfort is considered occurred during the experimental sessions when the respondents rated their discomfort level at rating 5 and above in the musculoskeletal discomfort's scale.

CHAPTER 2

LITERATURE REVIEW

2.1 Anatomy and Physiology of Vertebrate Column

2.1.1 Overview of Lumbar Vertebrate

The lumbar spine is designated to incredibly strong protect the highly sensitive spinal cord and spinal nerve roots. At the same time, it is highly flexible bone providing for many movement including flexion, extension, bending, and rotation (Martini et al., 2014). It is built for both power and flexibility which is lifting, twisting, and bending (Eben, 2013).

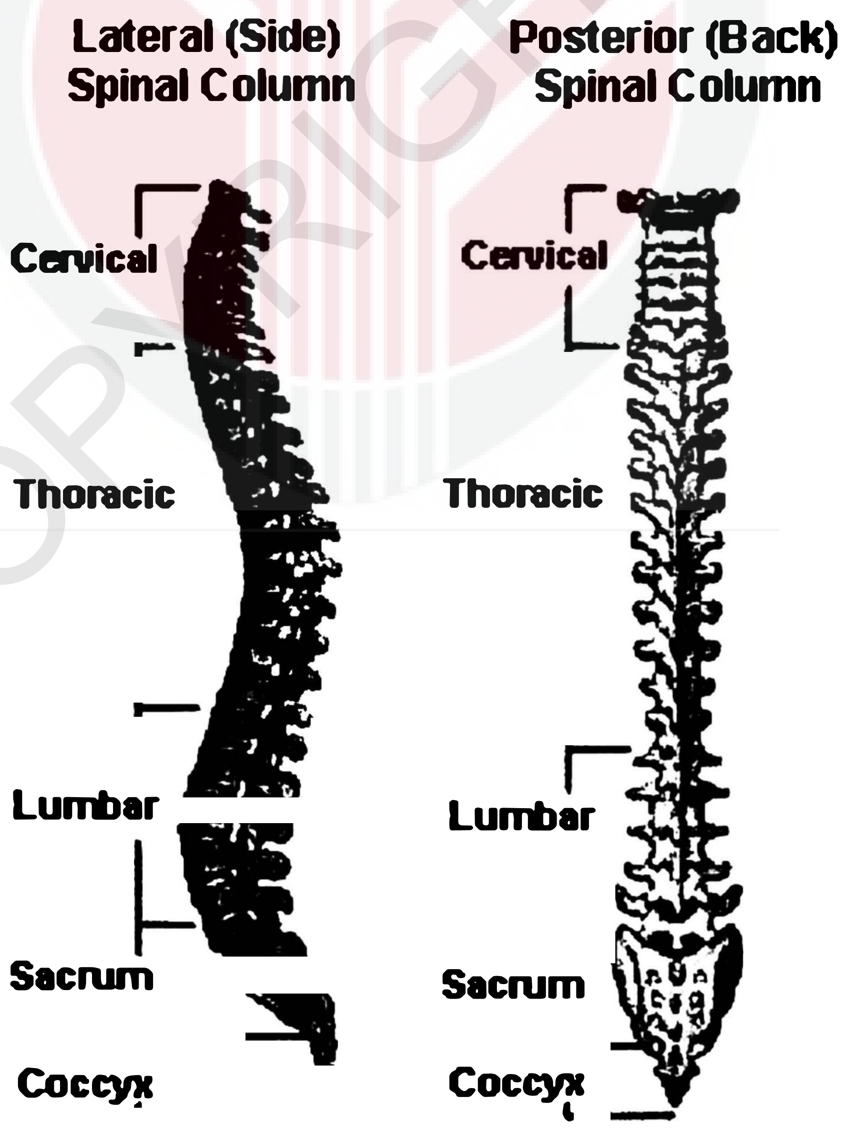


Figure 2.1 Spinal Columns

(Source: Bridwell, 2017)

2.1.2 Erector Spine Muscle

The erector spinae muscle is the largest muscular mass of the back. A contraction of both sides which is left and right from the spine, help to extend or bend body back. It forms a prominent bulge on either side of the vertebral column. It is main extensor of the vertebral column and consists of three groups which include iliocostalis (lateral), longissimus (intermediate) and spinalis (medial) (Martini et al., 2014). Erector spinae is covered in the lumbar and mainly stabilizes body spine and it is a bundle of muscles and tendons. In facts, this muscle mainly will contract or stress when lifting object conducted. Moreover, previous study have mentioned there is evidence that lumbar posture can significantly alter the functional role of the erector spinae when lifting and lowering and has implications for the loads that the spine must contend with (Mawston & Boocock, 2012).

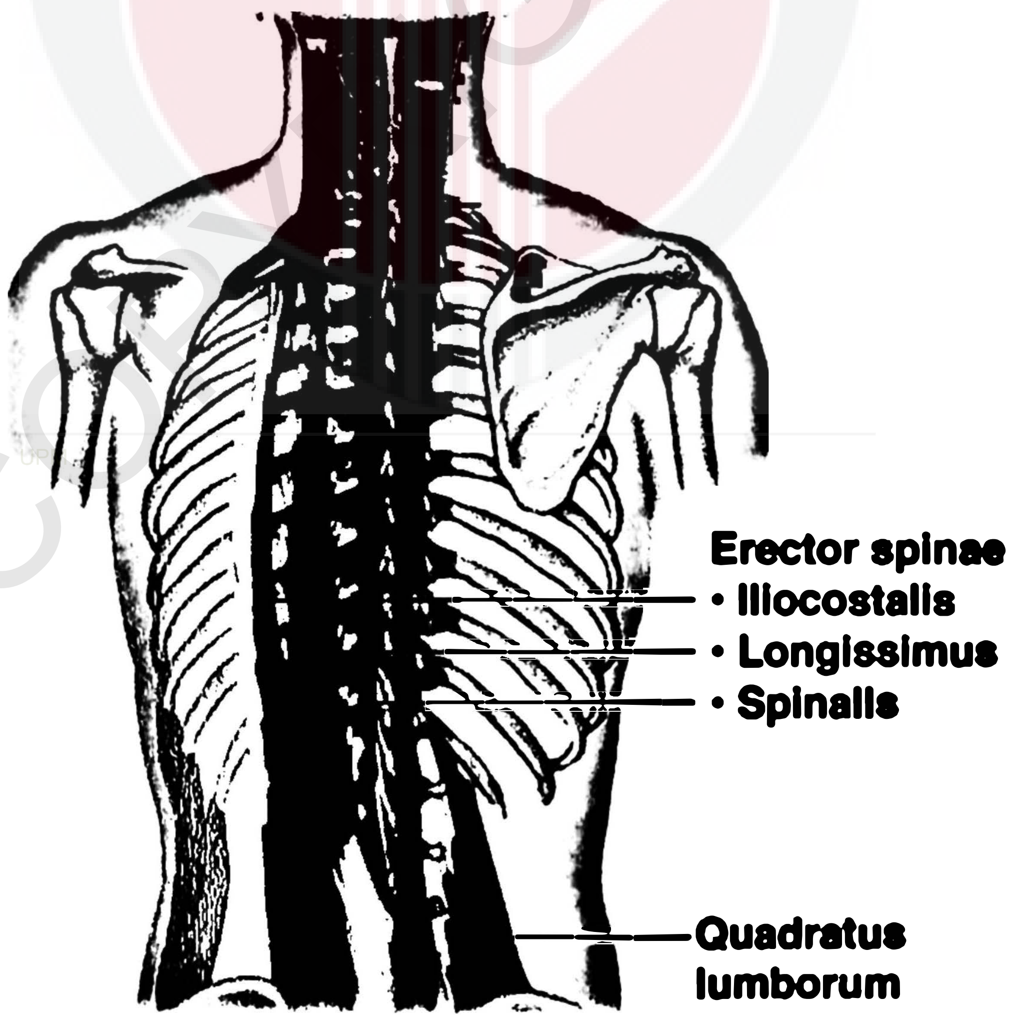


Figure 2.2 Erector Spine Muscle

(Source: Muscles Used, 2012)

2.2 Manual handling of load (MHL)

There are several risk factors that make MHL hazardous and thereby increase the possibility of pain. Particularly for back injury, they are related to four aspects of MHL (European Agency for Safety and Health at Work, 2000). The risk of back pain increases if the load is too heavy. There is no exact weight limit that is safe and a weight of 20–25 kg is heavy to lift for most people. In additions, too large, if the load is large, it is not possible to follow the basic rules for lifting and carrying to keep the load as close to the body as possible; thus, the muscles will get tired more rapidly. Furthermore, difficult to grasp, this can result in the object slipping and causing an accident; loads with sharp edges or with dangerous materials can injure workers. Next, unbalanced or unstable, this leads to uneven loading of muscles and fatigue due to the centre of gravity of the object being away from the middle of the worker's body. In facts, difficult to reach, reaching with outstretched arms, or bending or twisting the trunk takes greater muscular force. Lastly of a shape or size that obscures the worker's view, thus increasing the possibility of slipping/tripping, falling or collision (European Agency for Safety and Health at Work, 2000).

Next, the risk of back pain increases if the task is too strenuous. For example, it is carried out too frequently or for too long a time. Secondly involves awkward postures or movements, for example a bent and or twisted trunk, raised arms, bent wrists, over-reaching. Lastly, involves repetitive handling (European Agency for Safety and Health at Work, 2000).

In additions, characteristics of the work environment may increase the risk of back pain if insufficient space for MHL may lead to awkward posture and unsafe displacement of loads. Next, an uneven, unstable or slippery floor may increase the risk of accidents. In facts, heat makes workers feel tired, and sweat makes it hard to hold tools, meaning that more force must be used. And cold can make hands numb, making it hard to grip. And lastly, insufficient lighting may increase the risk of accidents, or force workers into awkward positions to see clearly what they are doing (European Agency for Safety and Health at Work, 2000).

Furthermore, some individual factors might affect the risk of back pain if lack of experience, training and familiarity with the job. Secondly age, the risk of low back disorders increases with age and with the number of years at work. Thirdly, physical dimensions and capacity factors such as height, weight and strength. And lastly, prior history of back disorders (European Agency for Safety and Health at Work, 2000).

2.3 Musculoskeletal Discomfort

Manual handling can cause muscle discomfort and weakness. Musculoskeletal discomfort is often related to tension, overuse or muscle injury from exercise or physically-demanding work. The pain or discomfort usually tends to involve specific muscles and starts, during or just after the activity (National Library of Medicine, 2014). On the other hand, in ergonomics fields, the terms comfort and discomfort are unique measurement because they involve the human perception (feedback) of the machine and work system environment (Karmegam, et.al, 2011).

2.4 Back Support Vest

One of the more controversial issues in occupational and also in sport sciences around the use of a device known as the lumbar support devices, back belts, back support or back support vests. Names depend on design but the main function is same to support lumbar spine. A recent survey of health club members determined that twenty seven percent were back support users. Ninety percent of those who used back support stated able to prevent injury, whereas twenty two percent back belt to improve performance (Finnie et al., 2003).

From previous studies have examined the incidence of injury with and without back support, as well as a cost analysis of injuries faced with or without using a back support (Kraus et al., 2002; Mitchell et al., 1994; & Wassell et al., 2000). Results demonstrate the use of the back support was either marginally effective at lowering the rate of injury (Kraus et al., 2002 & Mitchell et al., 1994) or had no effect (Wassell et al., 2000). According to Wassell et al. (2000), there were no statistically significant differences between those who did and did not wear back support. However, Mitchell et al. (1994) indicated that there were less injuries and lower costs per worker when the back support was not worn, even with a moderate decrease in overall rate of injury associated with back support use.

Back support seems to affect lumbar range of motion. In simulated industrial applications, altered range of motion may increase the likelihood that subject would use a squat-lifting technique, thus flexing more at the knees and hips to lift heavy objects (Giorcelli et al., 2001), which would seem desirable. By doing so, it is able to maintain neutral spine posture. Maintaining neutral spine posture is critical because it helps to distribute the weight of load when lifting so this position minimizes the stress on worker back and decreases worker chance of getting hurt (Leung, 2016).

Moreover, back support does not appear to reduce the lumbar fatigue during occupational activities (Ciriello & Snook, 1995; Majkowski et al., 1998). No studies have specifically evaluated the incidence of injury associated with back support use or non-use in strength and conditioning settings despite the fact that some evidence suggests that most wearers use them to prevent injury (Finnie et al., 2003).

Back support seem to have no negative affect on hemodynamic variables such as Heart Rate and Blood Pressure (Bobick et al., 2001), with the only exception occurring during a study of isometric deadlifts (Hunter, 1989), which are an unlikely exercise option in most strength and conditioning settings. As commonly believed, Intra-abdominal pressure increases with the use of the lifting belt, which most likely serves to reduce spinal compression during manual lifting (Aurslanian, 1994; Bourne & Reilly, 1991; Reilly & Davies, 1995).

The significance of the effect of the back support on motor unit recruitment as evidenced by changes in electromyography muscle activity. In occupational settings, less muscle activation may be desirable in order to reduce fatigue, therefore reducing joint reaction forces. Previous studies claims that back support use reduced the exercise effect of the trunk muscles (Chek, 1998; Fritz, 2000).

2.5 Localised musculoskeletal discomfort (LMD) scale

The LMD method (Grinten & Smith, 1992) was based on the Borg category ratio (CR-10) scale. Localized musculoskeletal discomfort rating includes sensations like tension, fatigue, soreness, heat, tremor, pain, and so on.

This localized musculoskeletal discomfort rating scale is based on Borg's category-ratio scale CR-10 (1982). And this rating scale uses a modified body map (Corlett & Bishop, 1976). This rating scale turned out to be feasible practical, reasonably sensible, and reliable for comparisons of relative low static loads (Vander Grinten & Smitt, 1992). Cameron (1996) reported that Borg's category-ratio scale CR-10 (1982) is a very precise measuring tool.

According to Reenen et al., (2008) the LMD method used both numbers and verbal intensity descriptors to rate the level of discomfort. The scale ranged from 0 (no discomfort at all) to 10 (extreme discomfort, almost maximum). Except for the rating of 0.5 or $^1/_2$ (extremely little discomfort), only round numbers were presented. However, respondent were free to choose any intermediate number using decimals.

2.6 Body Posture during Manual handling

Manual handling expose worker to low-back discomfort which can contribute to Musculoskeletal Disorders (MSDs). Back posture is considered to play an important role in low back injury (Mawston & Boocock, 2012). In order to continue a good quality of life, it is important that worker lifting load in ergonomically way for worker comfort. Thus, in attempts to solve the problem related to MSD form manual handling, ergonomics should be applied to the worker body posture and personal protective equipment.

According to Meksawi et al. (2012), physical ergonomic factor such as awkward working postures, heavy weight lifting, repetitive movement or monotonous work and also manual handling are associated with MSDs especially low back pain. Works associated with manual handling usually need more physical force to push, pull, lift and move the objects which eventually led to limitation of job duties, loss of work time and change to another work (Al-Eisa et al., 2012)

Ergonomic is concerned with the productivity of workers in their working condition since ergonomic itself is an applied science that focusing on designing procedures to improve efficiency and safety. To meet the needs of people, ergonomic will modifies the tasks instead of forcing people to accommodate the task. Appropriate ergonomic design is required in order to prevent any musculoskeletal symptoms, which can develop overtime and cause to long-term disability (Gopinadh et al., 2013).

A healthy back has three natural curves which is a slight forward curve in the neck (cervical curve), a slight backward curve in the upper back (thoracic curve), and a slight forward curve in the low back (lumbar curve). Good posture actually means keeping these three curves in balanced alignment (Brown, 2016).

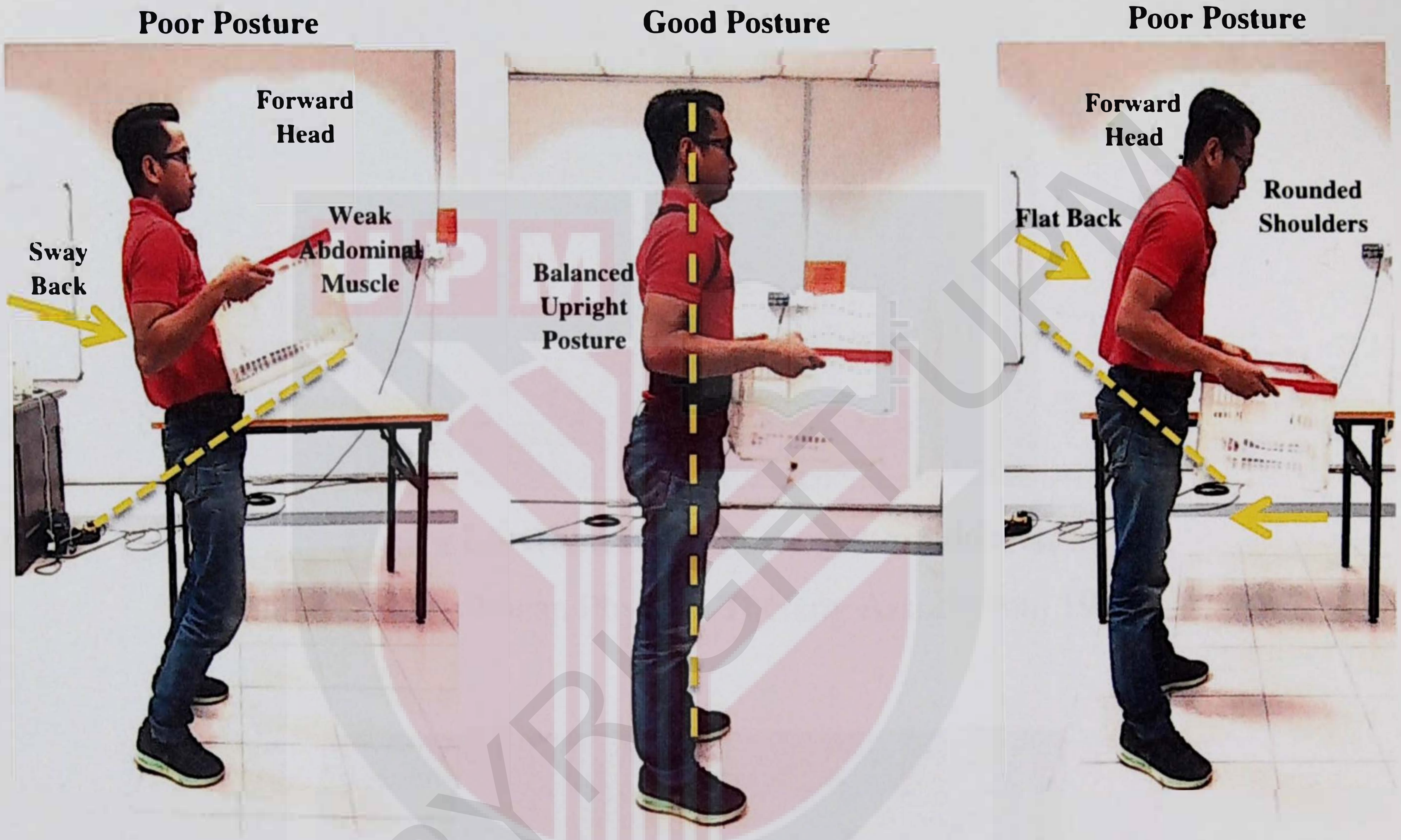


Figure 2.3 Good posture by supporting of back support vest and poor posture during manual handling.

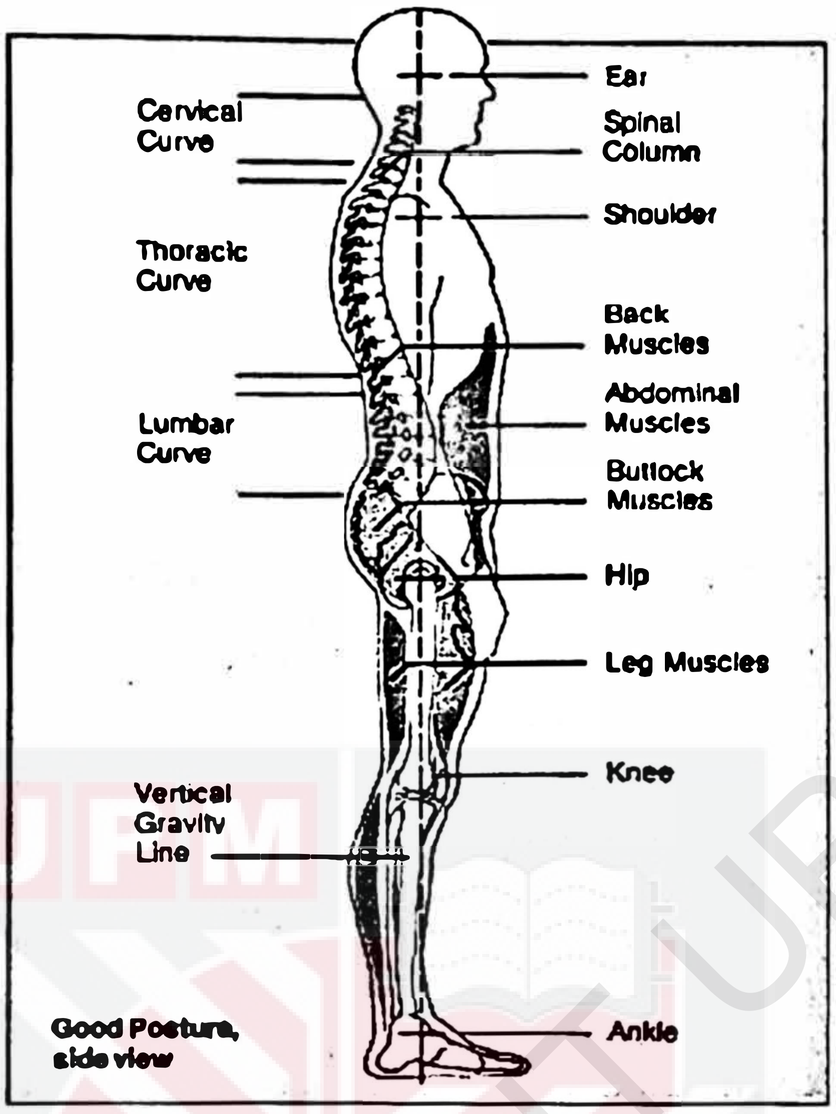


Figure 2.4 Good Body Posture from side view

(Source: The American Physical Therapy Association, 1998)

Figure 2.5 Back Posture Corrector Vest for Back Straightener

(Source: Walmart, 2017)

CHAPTER 3

RESEARCH METHODOLGY

3.1 Study Location

Due to logistical limitation, this study conducted at a Meeting Room of Taman Pertanian Universiti, Universiti Putra Malaysia (UPM). This location was chosen as it was the main assembly point for the potential respondent in this study.

3.2 Study Design

This was a pre-test and post-test experimental study designed to evaluate the effect of back support vest in reducing back pain due to manual handling. Respondents involved in this study were allocated into control or experimental group.

The basic form of this design was show as in Table 3.1. O_1 represents pre-test study which consider as baseline data. X represents the intervention giving to the respondents in experimental group only. Respondent in control group did not receive any intervention. O_2 represents post-test study which was the outcome of the intervention given.

Table 3.1 Pretest-Posttest Control Group Designs

GROUP	Pre-test	Intervention	Post-test
Experimental	O_1	X	O_2
Control	O_1		O_2

3.3 Sampling

3.3.1 Sample Population

Respodents were recruited among agricultural workers at Taman Pertanian Universiti (TPU) in University Putra Malaysia. Only 38 respodents was recruited because they age is between 18-35 years old among TPU workers. TPU's agricultural workers have been selected because they work have adapted to manual handling work task.

3.3.2 Sampling Frame

The sampling frame of this research was the list of agricultural worker currently employed by TPU. The name lists was obtained from administration unit in the TPU.

3.3.3 Sampling Unit

3.3.3.1 Inclusion Criteria

Selection of the respondent is based on random sampling. The criteria are

a) Male worker

b) Age between 18-35 years old

c) Normal BMI (18.5-24.9)

The above inclusion criteria were set as they are considered to active healthy population who was actively involved in manual handling.

3.3.3.2 Exclusion Criteria

The criteria are;

a) No immediate complaint of back pain

b) Taking medication

The reason workers with history of back pain were excluded was because these factors may affect the accuracy of the result obtained. Besides that, those who taking medication can disturb in the process of muscle recovery after certain kinds of damage, whether induced by exercise or injury (Dalttilo et al., 2011). Certain types of medication also can contribute to muscle weakness, fatigue and induce sleepiness such as muscle relaxants medication and cough medication.

3.3.4 Sample size

According to Hadi (2016) the prevalence of manual handling can cause low back pain in agricultural sector. Group comparison (2 groups) sample calculation is used:

$$\text{Formula: } n = \frac{\{z_{1-\frac{\alpha}{2}}\sqrt{2P(1-P)} + Z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\}^2}{(P_1-P_2)^2}$$

(Lameslow, Klar & Lawanga, 1990)

Where,

P = $(P_1+P_2)/2$

P_1 = estimated proportion (larger) = 0.81

P_2 = estimated proportion (smaller) = 0.642

Z1-α = Standard error associated with confidential interval

(Here we decide to choose 95% confidential interval= 1.96)

$Z_{1-\beta}$ = Standard error associated with power

(Here we decide to choose 80% of power = 0.842)

Calculation:

$$n = \frac{\{1.96\sqrt{2(0.726)(0.274)} + 0.842\sqrt{(0.81)(0.19)+(0.642)(0.358)}\}^2}{0.0282}$$

$$n = \frac{\{1.236+0.5216\}^2}{0.0282} = 109$$

n = 109 + 20% dropout rate

So, total sample was 131 respondents for both groups.

3.4 Variables

3.4.1 Dependent variables

- Level of muscle discomfort during manual handling

3.4.2 Independent variables

- Manual handling without back support vest
- Manual handling with back support vest

3.5 Instruments

The instrument used for this study include preliminary questionnaires and LMD's scale questionnaire discomfort ratings, measuring tape, weighing scale, table, plastic box, dumbbell and back support vest.

3.5.1 Questionnaires

The questionnaire consists of two parts which include preliminary questionnaire and LMD's scale measurement questionnaire. Preliminary questionnaires distributed before the test conducted while LMD's scale be administered after the experiment of manual handling completed by the respondents.

3.5.1.1 Preliminary Questionnaires

All respondent are requires to answers the preliminary questionnaire before they are chosen to participate in the study. The questions consist of their personal information (example; age, height and weight) and health information to meet the criteria of fit and healthy respondent. A set of the questionnaire used is as attached in Appendix 2.

3.5.1.2 Localised Musculoskeletal Discomfort's scale Discomfort Rating Questionnaires

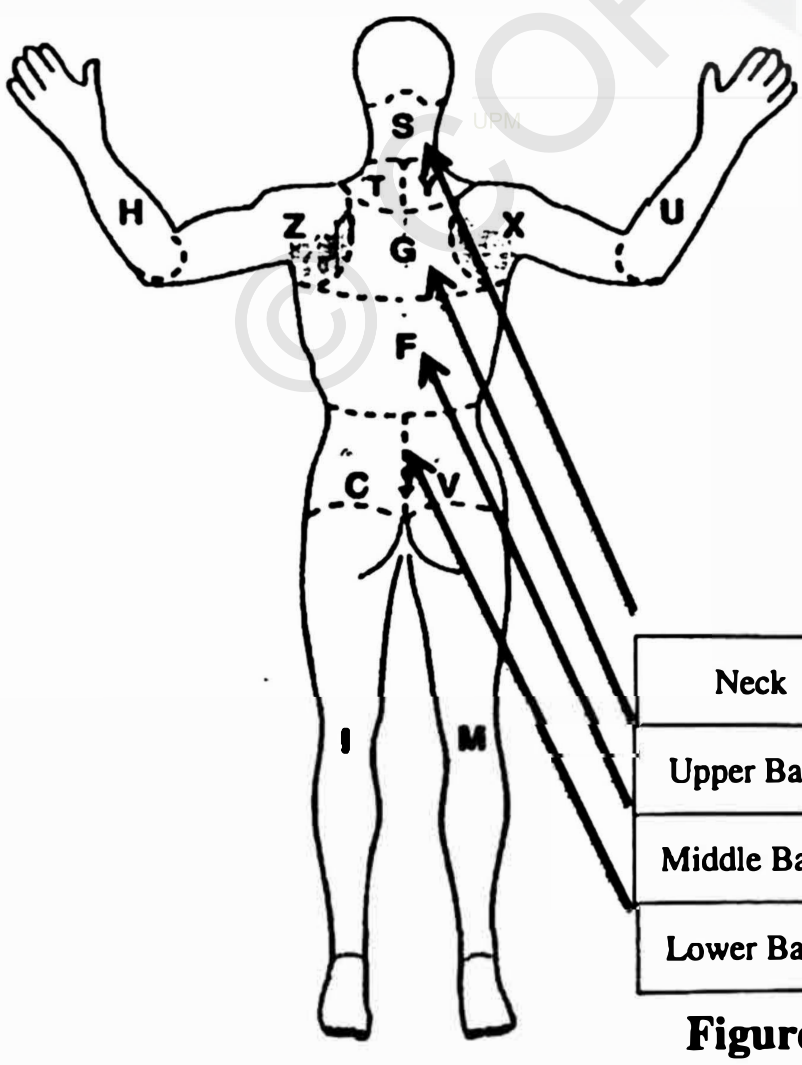
This scale used to assess the degree of subjective discomfort on various body parts, which was adapted from previous research by Reenen et al. (2008).

The level of discomfort rating scale only gives for neck, upper-back, middle-back and lower-back. This scale consist rating ranges from 0 (No discomfort at all) to 10 (Extreme Discomfort) (Grinten & Smitt, 1992). See Table 3.2.

Table 3.2 Level of Localised Musculoskeletal Discomfort's scale

INCREASING ↑

Rating	Definition
10	Extreme discomfort
9	↑
8	
7	Very high discomfort
6	↑
5	High discomfort
4	Somewhat high discomfort
3	Moderate discomfort
2	Little discomfort
1	Very little discomfort
$^1/_2$	Extremely little discomfort
0	No discomfort at all



	No discomfort at all	Extremely little discomfort	Very little discomfort	Little discomfort	Moderate discomfort	Somewhat high discomfort	High discomfort	-----	Very high discomfort	-----	-----	Extreme discomfort
	0	$^1/_2$	1	2	3	4	5	6	7	8	9	10
Neck												
Upper Back												
Middle Back												
Lower Back												

Figure 3.1 Localised Musculoskeletal Discomfort's scale

3.5.2 Measuring Tape and Weighting scale

The measuring tape that used to measure body height of the respondent is SECA Body Meter and body weight of the respondent measured by using SECA Weighting Scale.

After obtaining the weight and height measurement, the BMI calculated based on the formula below:

$$\text{BMI} = \frac{\text{Body weight (kg)}}{\text{Body height (m}^2\text{)}}$$

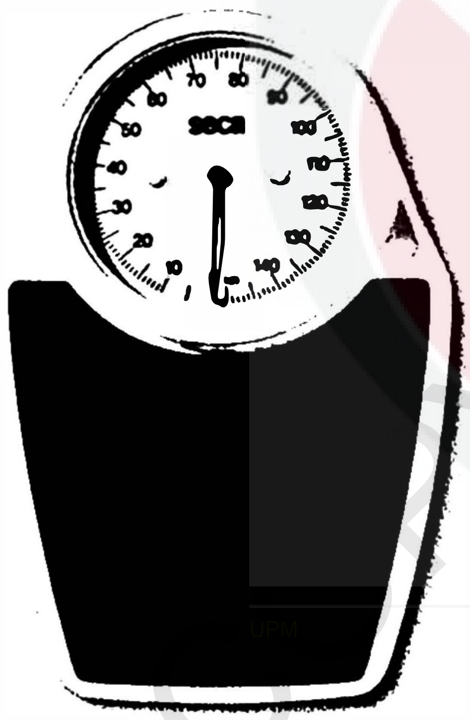


Figure 3.2 SECA Weighting scale

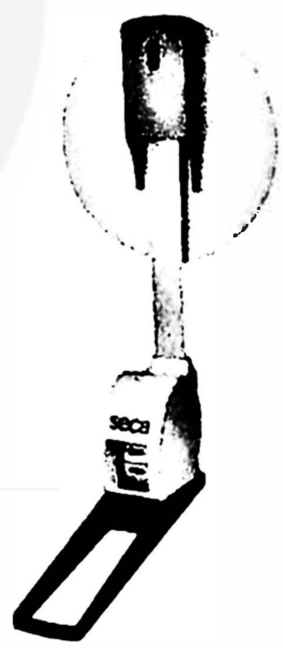


Figure 3.3 SECA Body meter

3.5.6 High Table, Plastic Box and Dumbbell

These instruments required for experimental design. The dimension of this table is (45cm Width x 140cm Length x 75cm high). The size of the plastic box is (35cm Width x 35cm Length x 25 High). Total weight of dumbbell plate is 19.4kg with several of proportions.

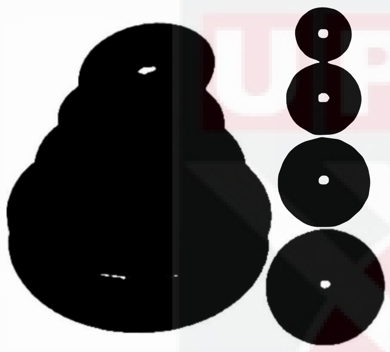


Figure 3.6 Dumbbell Plate

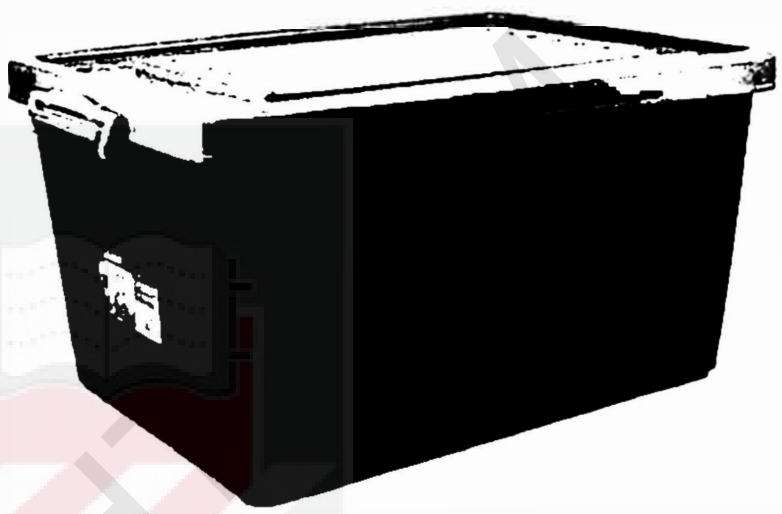


Figure 3.5 Plastic Box

Figure 3.4 High Table

3.5.7 Back Support Vest

To ensure correct usage, the back support vest was worn assisted by the researcher. This back support vest is ready-made product that gets it from the conventional market and it is designed to fit around the waist with adjustable clavicle straps. This comfortable back support's unique design discourages stooped shoulders and improves proper spinal alignment, stabilizing both the lumbar and abdominal regions. The adjustable clavicle straps criss-cross over the back.

And fabric materials made up from polyester because it durable, light weight, resistant to shrinking, stretching, and sun resistant. The adjustable elastic straps, covered with soft, cotton fabric to prevent pinching and binding. This back support vest is the posture corrector, the strong support for the back/shoulder/waist. It is quite helpful for recovering after injury, preventing the hunchback and posture correcting. Furthermore, this back supports vest it possible to be worn over or under clothing. Back support vest typically fit around waist and are secured with Velcro.

Product features:

- Anchors around the waist with an adjustable clavicle straps.
- Pieces of iron plate placed at area of lower back to give support at lumbar curved.
- Prevents stooped shoulders, reminding the wearer to maintain good posture.
- Adjustable clavicle straps are covered with soft, cotton fabric to prevent pinching or binding.
- Clavicle straps gently pull shoulders, spine, and lower back into neutral position, decreasing shoulder and back pain.

Figure 3.7 Back support vest features from posterior view

(Source: Walmart, 2017)

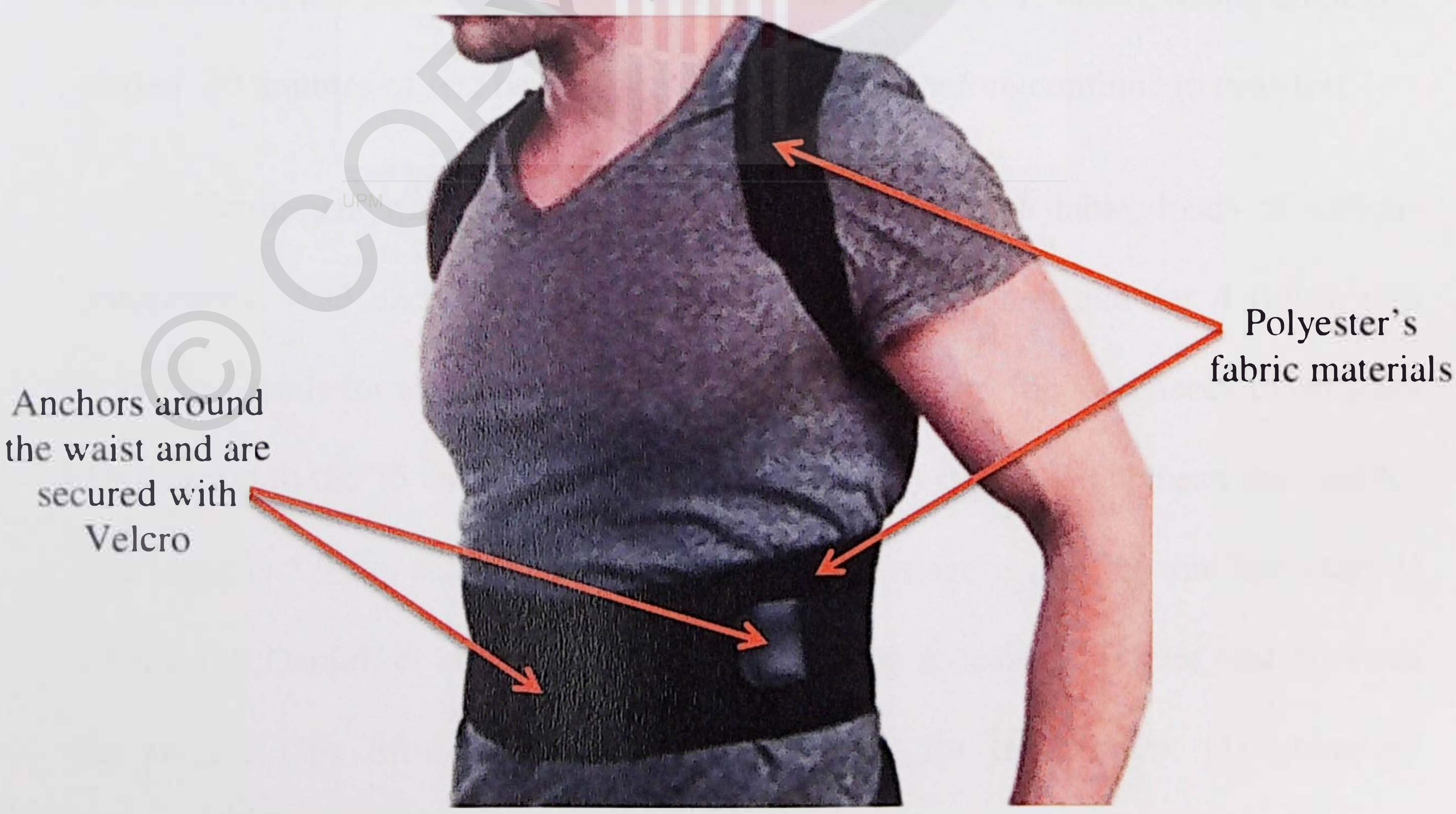


Figure 3.8 Back support vest features from anterior view

(Source: Walmart, 2017)

3.6 Design of Experiment

3.6.1 Assignment of Respondent

Respondent allocated into experiment and control group by random sampling. Respondent has been briefed and given a consent form. And then, all respondents asked to answer a preliminary questionnaire before they decided to voluntarily participate in this study. Before experimental session, the height and weight of respondents were measured to ensure they meet the inclusion criteria.

3.6.2 Experimental Design

At the beginning of lifting simulator be started, respondents were given a standardized safety lifting demonstration. This demonstration applies Progressive Isoinertial Lifting Evaluation (PILE) technique. The purpose of this method is to assess the respondent's ability to perform repetitive lifting within 20 second. PILE technique demonstration also was showed to the respondents before lifting simulator started. 20 minutes of rest be given to the respondent before continue to post-test.

Equipment needed is box to be lifted, 75 cm high table, loads of various proportions. And each respondent have to lift the box repeated for 4 times with difference loads for each stage. The box inserted with specific load needs to lift from the floor up to the 75 cm high table. And there have 4 stages which mean the load for first stage is 5.9 kg, second stage is 10.4 kg, third stage is 14.9 kg and last stage is 19.4kg (McDaniel. et al., 1994). Respondent given at least 2 minutes rest between the stages. This lifting has two possible criteria for termination: (1) voluntary termination due to fatigue, excessive discomfort, or inability to complete the specified lifting task; or (2) when the subject lifts a "safe limit" of 55%–60% of his body weight. This lifting simulator described here appears to have been remarkably free of injury. Isoinertial procedures have now been performed many thousands of times without report of verifiable injury (Mayer et al., 1988).The following list summarizes the recommendations made by McDaniel et al. (1994) for designing safe Isoinertial weight lift testing procedures:

1. Weight-lifting equipment should be designed so that the weights and handle move only in a vertical direction.
2. Sturdy shoes should be worn, or the subject may be tested barefoot. Encumbering clothing should not be worn during the test.
3. The initial weight lifted should be low.
4. The starting handle position should be 30 to 60 cm above the standing surface. If the handle is lower, the knees may cause obstruction. If the handle is too high, the subject will squat to get his or her shoulders under it before lifting. A gap between the handles allows them to pass outside the subject's knees during lifting, allowing a more erect back and encouraging the use of leg strength.
5. The recommended body orientation before lifting should be (a) arms straight at the elbow, (b) knees bent to keep the trunk as erect as possible, and (c) head aligned with the trunk. The lift should be performed smoothly, without jerk.
6. A medical history of the subject should be obtained. If suspicious physical conditions are identified, a full physical examination should be performed prior to testing.

7. All sources of over motivation should be minimized. Testing should be done in private and results kept confidential. Even the test subject should not be informed until the testing is completed.
8. The testing should always be voluntary. The subject should be allowed to stop the test at any time.

Squatting   Standing with the loads   Lowering the loads

Lifting simulator by using four different weights: 5.9 kg, 10.4 kg, 14.9 kg and 19.4kg repeated 4 times

Figure 3.9 PILE's method:
Respondent squatting from the floor, straight-up lifting and lowering the loads on the table

3.7 Data collection Procedure

This study collects data by using LMD's scale the respondent rated the effect of wearing back support vest by their own perceptions. The LMD method used both numbers and verbal intensity descriptors to rate the level of discomfort. The scale ranged from 0 (no discomfort at all) to 10 (extreme discomfort, almost maximum). Except for the rating of 0.5 or 1/2 (extremely little discomfort), only round numbers were presented. However, workers were free to choose any intermediate number using decimals. Respondent were asked to indicate their LMD ratings in 4 parts of the body using an adapted body map of the back of the body), the focus being on the neck, upper-back, middle-back, and lower-back.

This scale used to assess the degree of subjective discomfort on various body parts. Ratings of perceived discomfort recorded throughout the experimental session with measurement taken at every end lifting stages; and there have 4 stages. LMD's scale questionnaire data collected right after end of each stage completed. Researcher briefed again to the respondents if they faced any difficulties to rate the scale. Estimated time for all lifting conditions with 4 times repeats include rating LMD scale questionnaire is about 15 minutes.

3.7.1 Preparation of Respondent

Before lifting simulator be performed. Researcher gave a briefing on the method to rate the LMD's scale questionnaire to the respondent.

3.7.2 Pre-Experiment

A pre-experiment be carried out among 10% of the sample size of non-respondents with the same matching criteria to identify the limitation of the questionnaire. Questionnaire prepared in two languages which are English language and Malaysia language to facilitate the understanding of the respondent and form filling sessions using face to face questionnaire.

3.7.3 Experiment

Refer to 3.6.2 for experimental detailed. After completes data collected. This data be analysed by using SPSS to determine the significant of the results.

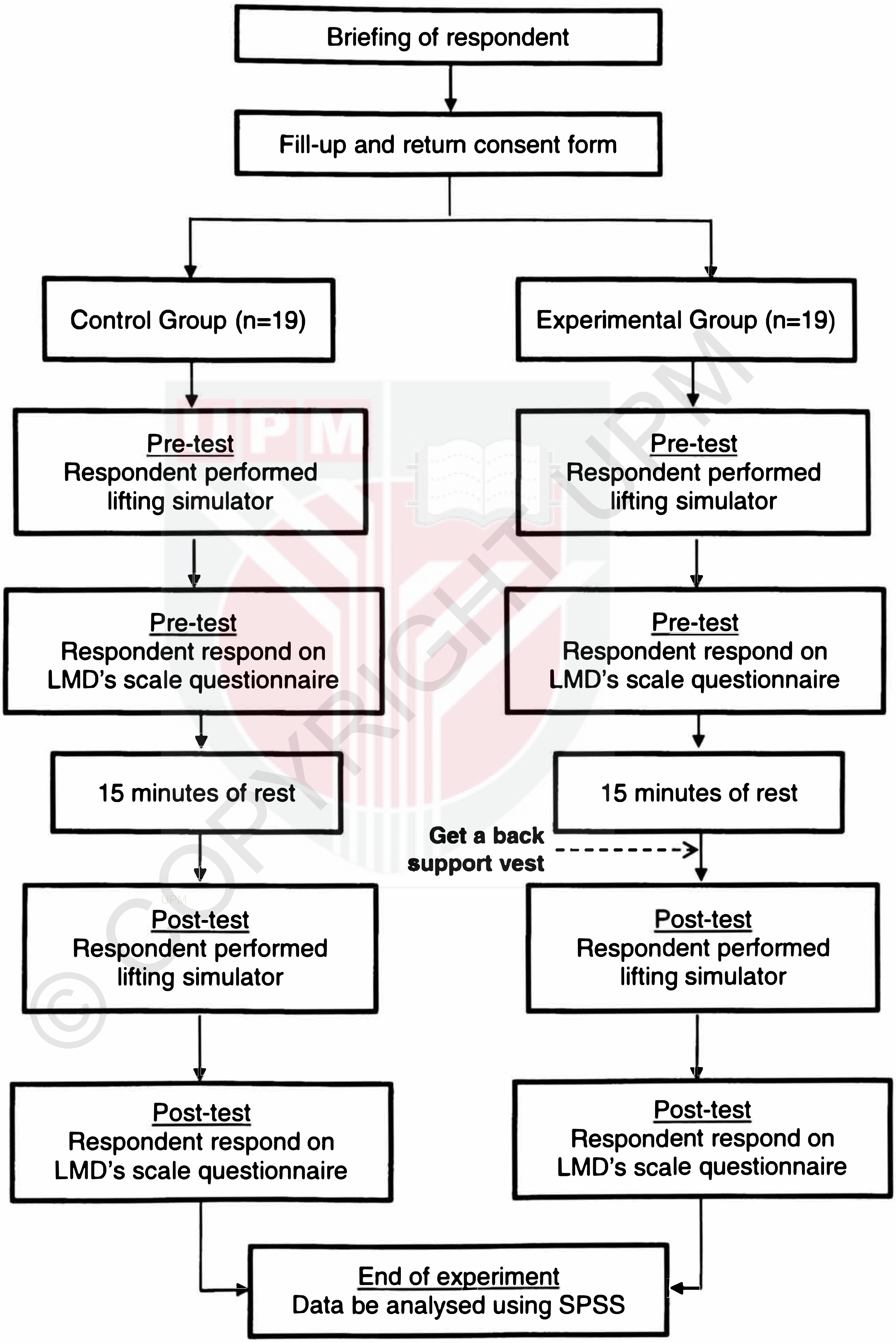


Figure 4.0 Flowchart of data collection

3.8 Data Analysis

Data collected was analysed using univariate and bivariate analysis. LMD's scale discomfort ratings data were analysed using SPSS Version 22.0. This study was conducted using 80% of power, 95% confidence level and standard deviation of $a \leq 0.05$, in which result of $p \leq 0.05$ was considered significant.

3.8.1 Determination of Data Distribution

Kolmogorov-Smirnov test was used to test the normality of data distribution for each variable. If the p-value was more than 0.05, the normality of data distribution was assumed. Furthermore, skewness and kurtosis values also were considered to determine the normality of data distribution. The data assumed as normally distributed when the skewness and Kurtosis values are within ±2. Results found of the most variables were not normally distributed in LMD's scale discomfort ratings. Thus, non-parametric statistical was used for data analyses.

3.8.2 Univariate Analysis

Descriptive test was used to produce median value for respondent's background information such as age, weight, height, BMI, hours involving with heavy activities in a week and also hours playing sport in a week. Mann-Whitney U test was conducted to compare the median difference of the respondent's background information in control and experimental group. Besides that, the central tendencies median of LMD's scale was calculated using Univariate analysis.

3.8.3 Bivariate Analysis

As the data were not normally distributed, Wilcoxon Signed-rank test was used for comparing between pre-test and post-test outcomes within control and experimental group. And Mann-Whitney U test used for comparing between control and experimental group.

3.9 Quality Control

3.9.1 Pre-Test of Questionnaire

A pre-test was carried out among 10% of the sample size of non-respondents with the same matching criteria to identify the limitation of the questionnaire. Questionnaire prepared in two languages which is English language and Malaysia language to facilitate the understanding of the respondent and form filling sessions using face to face questionnaire.

3.9.2 Standard Operating Procedure (SOP)

SOP conducted for the every instrument used which include measuring tape and weight scale.

3.9.2.1 Measuring Tape and Weighing Scale

For measuring tape, SECA Body Meter had the accuracy of 0.1 cm and the reading taken two times when the average values a recorded. During the measurement, the respondents are not allowed to wear shoes or cap. For weighing scale, SECA Body Weight had the accuracy of 0.1 kg. The respondents asked to stand on weighing scale without wearing the shoes or carrying any loads. Two readings was been taken to obtain the average reading.

CHAPTER 4

RESULTS

4.1 Socio-demographic status of respondents in the control and experimental groups

Characteristic of respondents are presented in Table 4.1. Total number of respondents from both groups was 38, with 19 from control group and 19 from experimental group. A Mann-Whitney U test was conducted to compare the age, weight, height, BMI, amount of hour involving with heavy activities in a week and amount of hour playing sport in a week for respondents in control and experimental group. See Table 4.1.

There is significant difference of median age between control group and experimental group. In addition, there is no significant difference of median body weight between control group and experimental group. Moreover, there is no significant difference of median body height between control group and experimental group. Furthermore, there is no significant difference of median body mass index (BMI) between control group and experimental group. Next, there is no significant difference of median amount of hours involving with heavy activities in a week between control group and experimental group. And lastly, there is no significant difference of median amount of hours playing sport in a week between control group and experimental group

Table 4.1: Socio-demographic status of respondents in the control and experimental group

Variable	Median		Z	*P*
	Control n = 19	Experimental n = 19		
Age (years)	33.00	29.00	-2.860	0.004
Weight (kg)	70.00	75.00	-1.146	0.884
Height (kg)	170.00	170.00	-1.148	0.251
BMI (kg/m2)	23.50	25.35	-0.540	0.589
Involving with heavy activities in a week (hours)	14.00	15.00	-0.896	0.370
Playing sport in a week (hours)	2.00	2.00	-0.674	0.500

* Mann-Whitney U test

*Significant difference at p <0.05

4.2 Determination the level of musculoskeletal discomfort for control and experimental group respectively during manual handling.

The results of Localised Musculoskeletal Discomfort ratings on each of the body parts (neck, upper back, middle back and lower back) with four different loads were presented in Table 4.2 for control group and Table 4.3 for experimental. Meanwhile, the line graphs in Figure 4.1.1 to Figure 4.1.4 show the trend of workers discomfort rating on each body parts during manual handling. The line graphs compare the level of Localised Musculoskeletal Discomfort scale discomfort ratings in four groups (control pre-test, experimental pre-test, control post-test and experimental post-test).

Based on the comparison in, it can be seen that respondent discomfort increased on each body parts according to increase of each loads from lowest load (5.9 kg) to highest load (19.4 kg). Lower back part was the body part which experienced greatest discomfort compared to other body parts. Furthermore, in table 4.3 shows the percentage of improvement of discomfort ratings. The improvement can be seen for the all parts of back body region except for neck at load of 5.9kg, upper back at load of 5.9kg and middle back at load of 5.9kg.

From the graphs, discomfort ratings on each group show an upward. However, a discomfort rating in experimental post-test group was mostly at lower level than other groups. Overall, from the graphs it is clear that the highest peak of discomfort rating at the end of the experimental session was just over 1.429 of median value which was for lower back part. For the neck highest scale was 0.778, for middle back was also 0.778 followed by upper back was 0.423 in median value.

Table 4.2: Data distribution of Localised Musculoskeletal Discomfort's scale rating on each body parts among control group.

Body parts	Loads	Median ± IQR (Median[a])	
		Control Pre-test	Control Post-test
Neck	5.9 kg	0.0 ± 0.0 (0.079[a])	0.0 ± 0.5 (0.132[a])
	10.4 kg	0.0 ± 0.5 (0.158[a])	0.0 ± 0.5 (0.211[a])
	14.9 kg	0.0 ± 0.5 (0.235[a])	0.0 ± 1.0 (0.321[a])
	19.4 kg	1.0 ± 2.0 (0.778[a])	0.5 ± 1.0 (0.625[a])
Upper Back	5.9 kg	0.0 ± 0.0 (0.026[a])	0.0 ± 0.0 (0.079[a])
	10.4 kg	0.0 ± 0.0 (0.079[a])	0.0 ± 0.5 (0.139[a])
	14.9 kg	0.0 ± 0.5 (0.167[a])	0.0 ± 0.5 (0.219[a])
	19.4 kg	0.0 ± 1.0 (0.321[a])	0.0 ± 1.0 (0.286[a])
Middle Back	5.9 kg	0.0 ± 0.0 (0.026[a])	0.0 ± 0.0 (0.105[a])
	10.4 kg	0.0 ± 0.0 (0.111[a])	0.0 ± 0.5 (0.139[a])
	14.9 kg	0.0 ± 0.5 (0.235[a])	0.0 ± 0.5 (0.235[a])
	19.4 kg	0.5 ± 1.0 (0.455[a])	0.0 ± 0.5 (0.281[a])
Lower Back	5.9 kg	0.0 ± 0.0 (0.088[a])	0.0 ± 0.5 (0.200[a])
	10.4 kg	0.0 ± 0.0 (0.088[a])	0.0 ± 0.5 (0.267[a])
	14.9 kg	0.5 ± 0.5 (0.313[a])	0.5 ± 2.0 (0.625[a])
	19.4 kg	1.0 ± 2.5 (1.429[a])	1.0 ± 2.5 (1.167[a])

Median[a] = Calculated from grouped data.

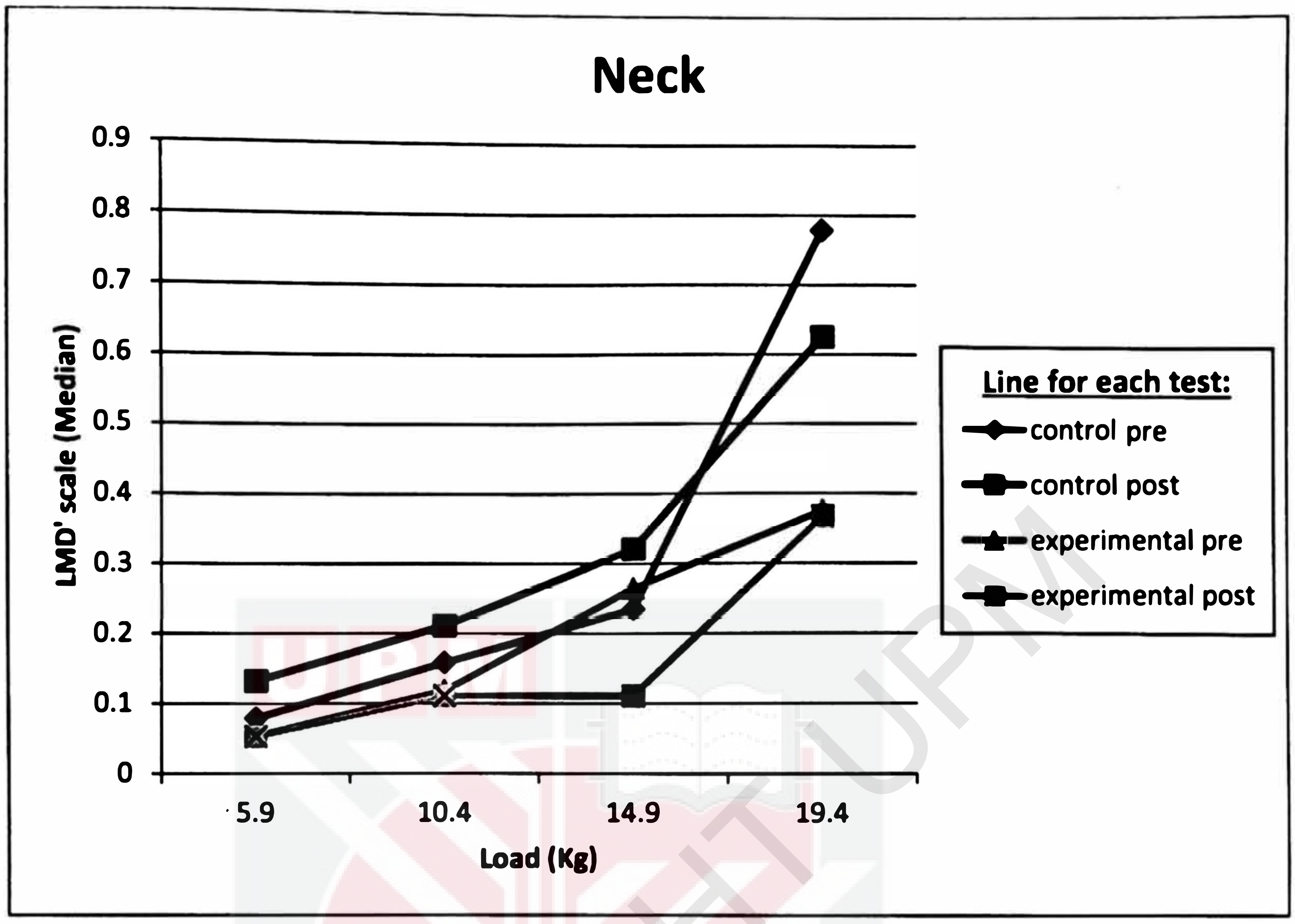
Table 4.3: Data distribution of Localised Musculoskeletal Discomfort's scale rating on each body parts among experimental group.

Body parts	Loads	Median ± IQR (Median[a])		Percentage of Improvement
		Experimental Pre-test	Experimental Post-test	
Neck	5.9 kg	0.0 ± 0.0 (0.053[a])	0.0 ± 0.0 (0.053[a])	0.00%
	10.4 kg	0.0 ± 0.0 (0.118[a])	0.0 ± 0.0 (0.111[a])	-5.93%
	14.9 kg	0.0 ± 0.5 (0.265[a])	0.0 ± 0.0 (0.111[a])	-58.11%
	19.4 kg	0.5 ± 0.5 (0.375[a])	0.5 ± 0.5 (0.367[a])	-2.13%
Upper Back	5.9 kg	0.0 ± 0.0 (0.000[a])	0.0 ± 0.0 (0.000[a])	0.00%
	10.4 kg	0.0 ± 0.0 (0.111[a])	0.0 ± 0.5 (0.083[a])	-25.23%
	14.9 kg	0.0 ± 0.5 (0.219[a])	0.0 ± 0.5 (0.167[a])	-23.74%
	19.4 kg	0.5 ± 1.0 (0.423[a])	0.0 ± 0.5 (0.300[a])	-29.08%
Middle Back	5.9 kg	0.0 ± 0.5 (0.000[a])	0.0 ± 0.5 (0.000[a])	0.00%
	10.4 kg	0.0 ± 0.5 (0.219[a])	0.0 ± 0.5 (0.139[a])	-36.53%
	14.9 kg	0.5 ± 1.0 (0.423[a])	0.5 ± 1.0 (0.250[a])	-40.90%
	19.4 kg	1.0 ± 1.0 (0.778[a])	0.0 ± 0.0 (0.556[a])	-28.53%
Lower Back	5.9 kg	0.0 ± 0.5 (0.139[a])	0.0 ± 0.0 (0.105[a])	-24.46%
	10.4 kg	0.0 ± 0.5 (0.300[a])	0.0 ± 0.5 (0.281[a])	-6.33%
	14.9 kg	0.5 ± 1.0 (0.600[a])	0.5 ±0.5 (0.400[a])	-33.33%
	19.4 kg	1.0 ± 1.5 (0.900[a])	0.5 ± 0.5 (0.679[a])	-24.56%

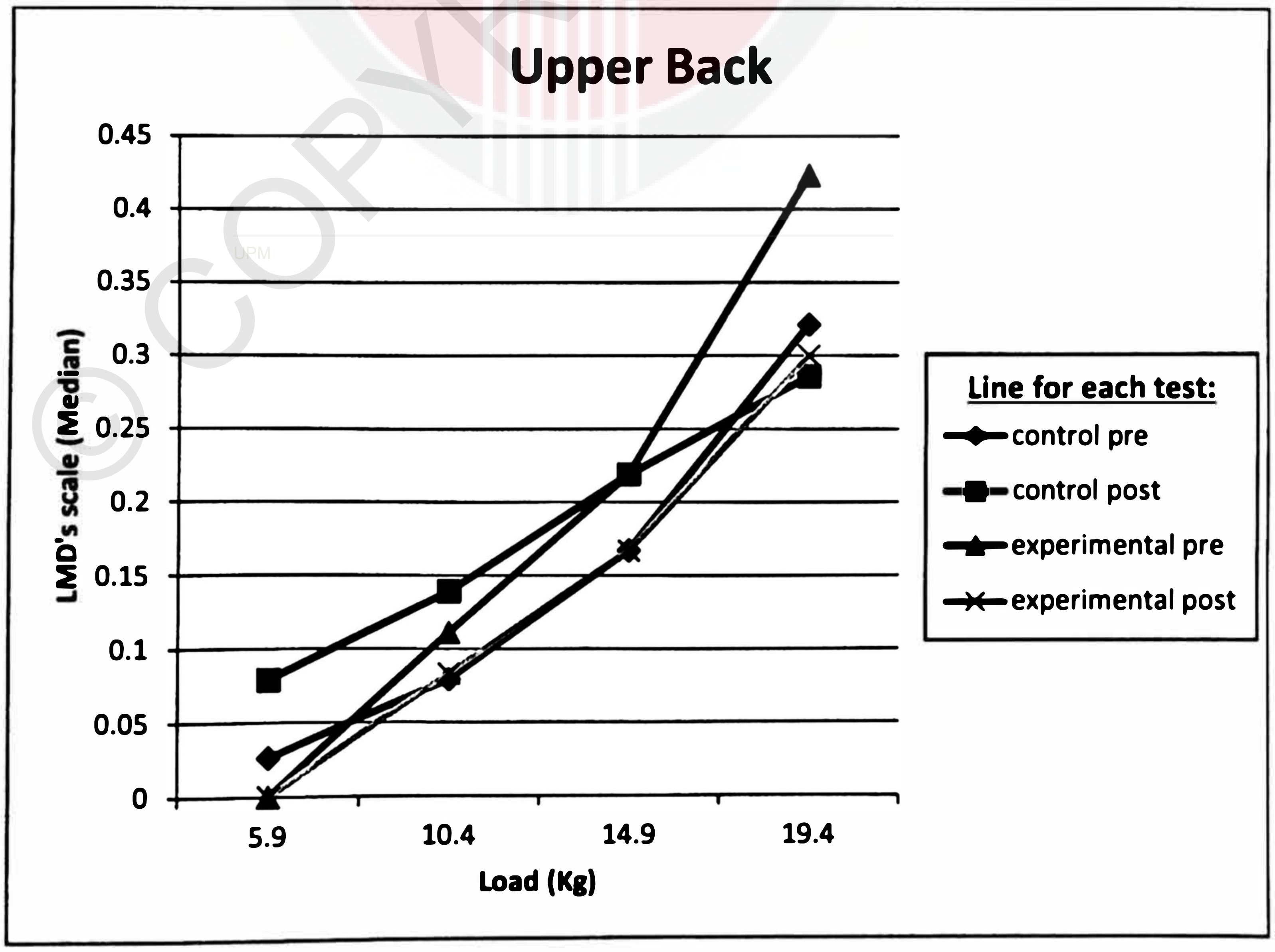
Median[a] = Calculated from grouped data

Note: The negative values in the percentage of improvement indicate a decrease of level musculoskeletal discomfort after the intervention (Microsoft, 2017).

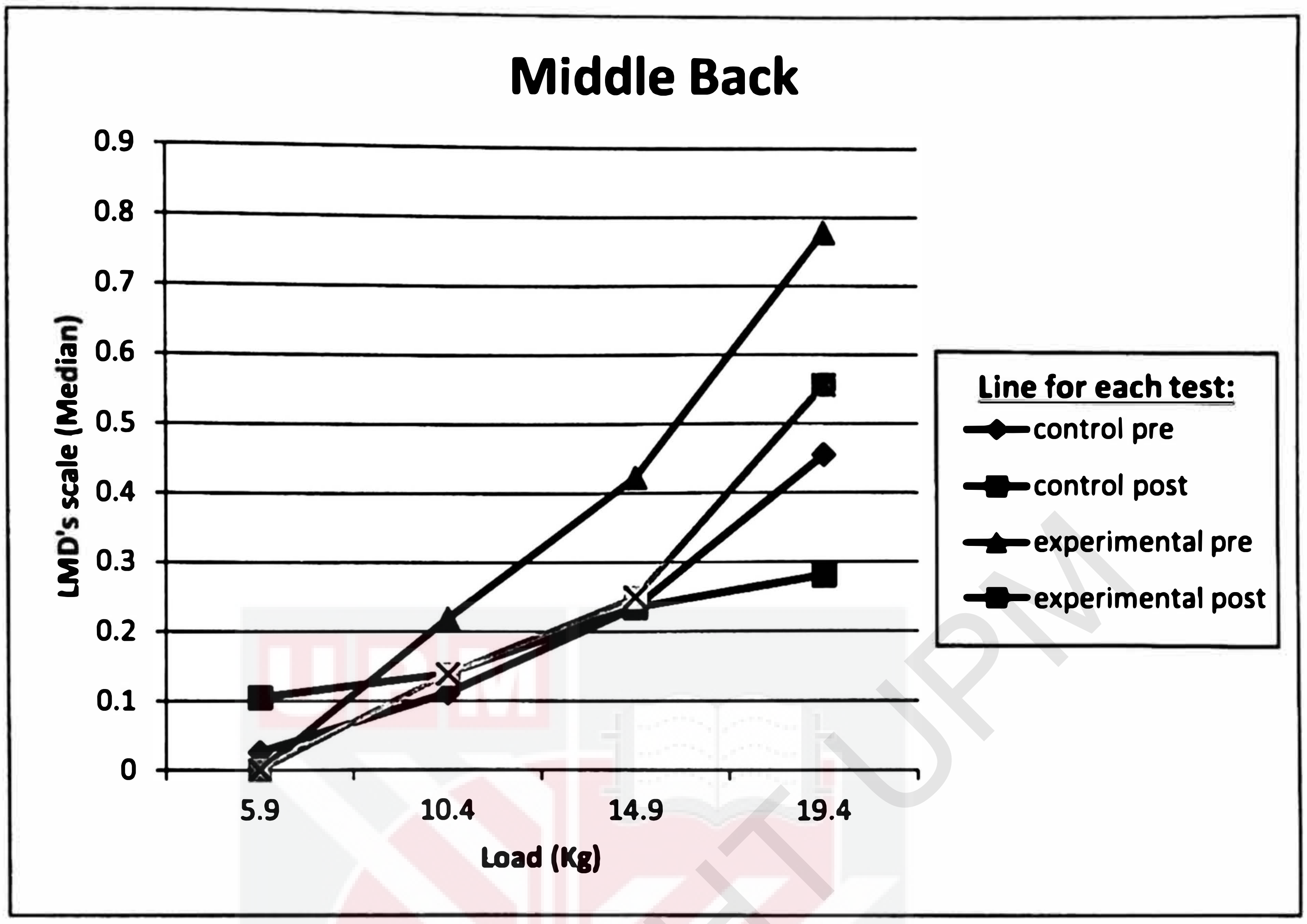
4.1.1 Neck



4.1.2 Upper Back



4.1.3 Middle Back



4.1.4 Lower Back

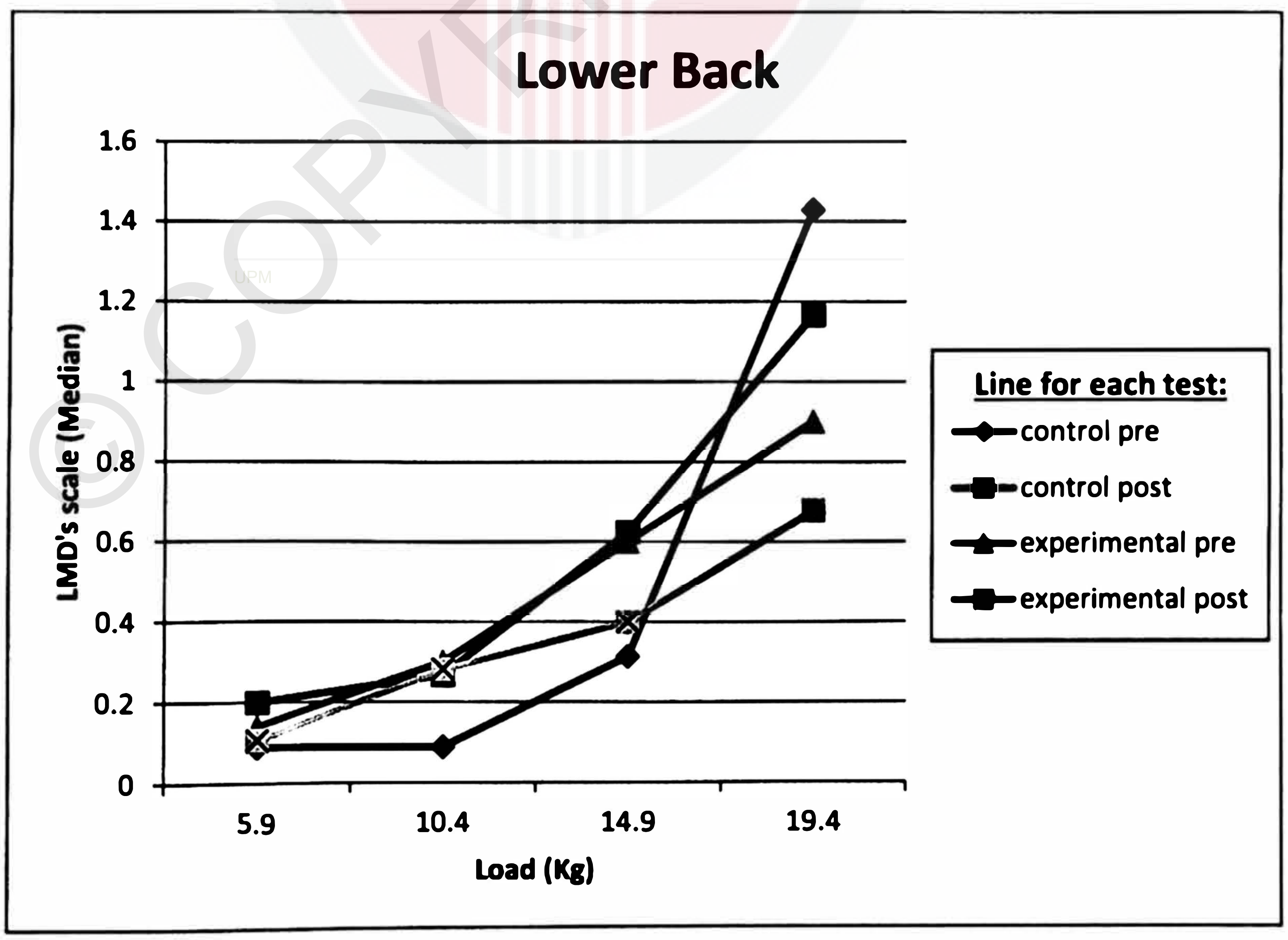


Figure 4.1.1 – 4.1.4: Graphs of LMD's scale ratings on each body parts.

4.3 Comparison the level of musculoskeletal discomfort within pre-test and post-test among control group and experimental group.

Table 4.4 and table 4.5 shows the comparison of Localised Musculoskeletal Discomfort's (LMD) scale ratings within pre-test and post-test study among control group and experimental group.

In table 4.4 was data for within pre-test and post-test among control group, the results obtained from Wilcoxon Signed-rank test revealed there was no significant reduction in the LMD's scale ratings within pre-test and post-test among control group. However, expect for lower back at 10.9 kg and 19.4 kg there was significant increase in the LMD's scale ratings from pre-test to post-test among control group.

In table 4.5 was data for within pre-test and post-test among experimental group, the results obtained from Wilcoxon Signed-rank test revealed there was significant reduction in the LMD's scale ratings only for neck at 14.9 kg, middle back at 14.9 kg and 19.4 kg; and for lower back at 14.9.

Table 4.4 **Median score of musculoskeletal discomfort ratings within pre-test and post-test among control group**

Body parts	Loads	Median ± IQR		Z	p-value
		Pre-test	Post-test		
Neck	5.9 kg	0.0 ± 0.0	0.0 ± 0.5	-1.414	0.157
	10.4kg	0.0 ± 0.5	0.0 ± 0.5	-1.000	0.317
	14.9kg	0.0 ± 0.5	0.0 ± 1.0	-1.265	0.206
	19.4kg	1.0 ± 2.0	0.5 ± 1.0	-1.382	0.167
Upper Back	5.9kg	0.0 ± 0.0	0.0 ± 0.0	-1.414	0.157
	10.4kg	0.0 ± 0.0	0.0 ± 0.5	-1.633	0.102
	14.9kg	0.0 ± 0.5	0.0 ± 0.5	-0.966	0.334
	19.4kg	0.0 ± 1.0	0.0 ± 1.0	-0.425	0.671
Middle Back	5.9kg	0.0 ± 0.0	0.0 ± 0.0	-1.732	0.083
	10.4kg	0.0 ± 0.0	0.0 ± 0.5	-0.276	0.783
	14.9kg	0.0 ± 0.5	0.0 ± 0.5	-0.365	0.715
	19.4kg	0.5 ± 1.0	0.0 ± 0.5	-1.581	0.114
Lower Back	5.9kg	0.0 ± 0.0	0.0 ± 0.5	-1.633	0.102
	10.4kg	0.0 ± 0.0	0.0 ± 0.5	-2.264	**0.024**
	14.9kg	0.5 ± 0.5	0.5 ± 2.0	-1.860	**0.063**
	19.4kg	1.0 ± 2.5	1.0 ± 2.5	-0.422	0.673

*wilcoxon signed-rank test
*significant difference at $p < 0.05$

Table 4.5 **Median score of musculoskeletal discomfort ratings within pre-test and post-test among experimental group**

Body parts	Loads	Median ± IQR		Z	p-value
		Pre-test	Post-test		
Neck	5.9 kg	0.0 ± 0.0	0.0 ± 0.0	0.000	1.000
	10.4 kg	0.0 ± 0.0	0.0 ± 0.0	-1.069	0.285
	14.9 kg	0.0 ± 0.5	0.0 ± 0.0	-2.264	**0.024**
	19.4 kg	0.5 ± 0.5	0.5 ± 0.5	-0.137	0.891
Upper Back	5.9 kg	0.0 ± 0.0	0.0 ± 0.0	0.000	1.000
	10.4 kg	0.0 ± 0.0	0.0 ± 0.5	-1.342	0.180
	14.9 kg	0.0 ± 0.5	0.0 ± 0.5	-1.518	0.129
	19.4 kg	0.5 ± 1.0	0.0 ± 0.5	-1.725	0.084
Middle Back	5.9 kg	0.0 ± 0.5	0.0 ± 0.5	0.000	1.000
	10.4 kg	0.0 ± 0.5	0.0 ± 0.5	-1.725	0.084
	14.9 kg	0.5 ± 1.0	0.5 ± 1.0	-2.140	**0.032**
	19.4 kg	1.0 ± 1.0	0.0 ± 0.0	-2.339	**0.019**
Lower Back	5.9 kg	0.0 ± 0.5	0.0 ± 0.0	-0.707	0.480
	10.4 kg	0.0 ± 0.5	0.0 ± 0.5	-1.020	0.308
	14.9 kg	0.5 ± 1.0	0.5 ±0.5	-2.069	**0.039**
	19.4 kg	1.0 ± 1.5	0.5 ± 0.5	-1.846	0.065

*wilcoxon signed-rank test
*significant difference at $p < 0.05$

4.4 Comparison the level of musculoskeletal discomfort ratings between control group and experimental group

Table 4.6 shows the comparison of Localised Musculoskeletal Discomfort's (LMD) scale ratings between control group and experimental group. The results obtained from Mann-Whitney U test revealed there was significant reduction in the LMD's scale ratings only for neck at 14.9 kg and middle back at 5.9 kg of load.

And for others body parts of LMD's scale ratings were not less than p-value 0.05 therefore there were no significant difference between the median of control and experimental group for the others body parts.

Table 4.6 Median score of musculoskeletal discomfort ratings between control group and experimental group

Body parts	Loads	Median ± IQR		Z	p-value
		Control (Post-test) N = 38	Experimental (Post-test) N = 38		
Neck	5.9 kg	0.0 ± 0.5	0.0 ± 0.0	-1.239	0.215
	10.4 kg	0.0 ± 0.5	0.0 ± 0.0	-1.226	0.220
	14.9 kg	0.0 ± 1.0	0.0 ± 0.0	-1.857	**0.063**
	19.4 kg	0.5 ± 1.0	0.5 ± 0.5	-1.208	0.227
Upper Back	5.9 kg	0.0 ± 0.0	0.0 ± 0.0	-1.781	0.075
	10.4 kg	0.0 ± 0.5	0.0 ± 0.5	-0.761	0.447
	14.9 kg	0.0 ± 0.5	0.0 ± 0.5	-0.488	0.626
	19.4 kg	0.0 ± 1.0	0.0 ± 0.5	-0.032	0.974
Middle Back	5.9 kg	0.0 ± 0.0	0.0 ± 0.5	-2.086	**0.037**
	10.4 kg	0.0 ± 0.5	0.0 ± 0.5	0.000	1.000
	14.9 kg	0.0 ± 0.5	0.5 ± 1.0	-0.149	0.882
	19.4 kg	0.0 ± 0.5	0.0 ± 0.0	-1.316	0.188
Lower Back	5.9 kg	0.0 ± 0.5	0.0 ± 0.0	-1.021	0.307
	10.4 kg	0.0 ± 0.5	0.0 ± 0.5	-0.016	0.987
	14.9 kg	0.5 ± 2.0	0.5 ±0.5	-1.205	0.228
	19.4 kg	1.0 ± 2.5	0.5 ± 0.5	-1.760	0.078

*Mann-Whitney U test
*significant difference at p <0.05

CHAPTER 5

DISCUSSIONS

5.1 Overview of the study

This study was carried out to assess the effect of back support vest in order to reduce discomfort during manual handling among male agricultural workers. For this purpose, the results of the experimental group which received back support vest intervention and control group which do not received the intervention were compared to draw conclusions on the dependent variables of the study.

In this study, there are 38 male agricultural workers were recruited in this experiment. This study used the pre-test and post-test control group design. The independent variables of this study were the back study vest used during manual handling. The experimental group was used back support vest but the control group was performed manual handling without back support vest. The effect of back support vest on workers discomfort was assessed by using Localised Musculoskeletal Discomfort ratings to determine the level of musculoskeletal discomfort.

Furthermore, in this study the total of weight manual handling is 19.4 kg and involved with 16 times manual lifting with various weight of loads. In another study done by Chen et al., (2006) also involved with 16 lifting task combinations with loads 16 kg to encounter respondents with muscle discomfort after lifting simulator be performed.

5.2 Level of musculoskeletal discomfort for control and experimental group respectively during manual handling.

In this study found that from four body parts, lower back was the most affected part which experience discomfort reported by male workers. This finding is similar with Hadi (2016), who reported that the most prominent body part affected during manual handling is back body especially lower back. Another study done by Yang (1997) also revealed that 46 industrial injury cases from 1527 workers were reported. From the total injury cases, 45.65% was identified as lower back pain, and the cases were due to repeated manual handling. This is because lumbar spine at lower back region is highly flexible bone providing for many movement including flexion, extension, bending, and rotation in manual handling (Martini et al., 2014).

However, based on Localised Musculoskeletal discomfort ratings, the highest median score recorded was just 1.429 which is considered as little discomfort. Even though the result of discomfort ratings was only 1.429 and less than 1.429, but it still become a concern because discomfort due to manual handling during working can lead to more serious impact such as musculoskeletal disorders. Moreover, respondent also tend to make biased evaluation of themselves for subjective measurement like Localised Musculoskeletal discomfort scale (Borg et al., 2014). Hence, in order to support the bias in subjective measurement, the objective assessment such as electromyography measurement should be used in measuring the muscle activity of discomfort level in this study.

5.3 Comparison the level of musculoskeletal discomfort within pre-test and post-test among control group and experimental group.

From the result, it was found that there was no significant different in the Localised Musculoskeletal Discomfort scale rating in control group. Except for lower back at 10.9 kg and 19.4 kg there was significant increase in median value from pre-test to post-test in control group. Possible explanation could be due to inadequate muscle recovery. This is because the experiment was done during working hour, so respondent lack of time to rest as soon as they need to get back to start their work. This factor might affect muscle performance and lead to tiredness during post-test. In addition, respondents in control group also were not received back support vest. As a result, respondent in control group experienced more muscle discomfort during post-test study compare to the pre-test study.

Furthermore, only certain body part with a certain weight show significant reduction this is because only that weight back support vest capable to support the body parts and that value is the limit back support vest capable to support. Shapiro (2017) had mentioned, even though the worker wearing back support, but they should know they physical limits to lift the load and do not exceed the limit to avoid from back injury to happen. Moreover, there was significant reduction in the LMD's scale ratings for neck at 14.9 kg, middle back at 14.9 kg and 19.4 kg; and for lower back at 14.9 from pre-test to post-test among experimental group. These findings in this study show that back support vest provide a positive effect in reducing discomfort during manual handling based on Localised musculoskeletal discomfort ratings.

According to Van et al. (2000), by wearing back support vest able to prevents stooped shoulders and reminding the worker to maintain proper posture because of decreased lumbar range of motion (ROM). When worker maintain proper posture when lifting, the discomfort can be reduced. Especially, during lifting load on the floor, worker need to squat to lift the load instead of bending the lower back forward due to back support vest limiting the lumbar movement from over bending forward and backward (Giorcelli et al., 2001). As a result, able to keep spine in balanced alignment and give proper posture (Brown, 2016).

In addition, an adjustable clavicle straps at back support vest pulled back spine straight and in neutral condition during lifting loads, so it is allow the intervention to give a significantly more comfortable support during lifting load (Sinaki, 1992). In facts, maintaining neutral spine posture is critical because it helps to distribute the weight of load when lifting so this position minimizes the stress on worker back regions and decreases worker chance of getting hurt (Leung, 2016).

In other studies, the function of back support vest is to reduced compressive loading of the lumbar spine by increase intra-abdominal pressure (Katsuhirra., et al 2008). Cousins (2017) mentioned that the compression on the abdomen means there's less pressure on worker lower back discs, ligaments, muscles and spine; as a result allow healing to occur.

Apart from that, a study done by Alexander et al. (1995) found differences suggesting that lumbar support or back support is not effectively helps in preventing or reducing lower back pain. However, it can be considered that the study was done by using difference type and design of back support and the workers lifting loads exceeding the recommended weight limit (RWL) or lifting with an awkward posture even though the worker worn back support.

On the other hand, numerous studies have attempted to explain the effectiveness of back support vest in workers discomfort. For example, in 2016 studies revealed that back support vest can provide short-term relief and useful for improving function and reducing pain among those suffering from sub-acute back pain (Castaneda, 2017).

5.4 Comparison the level of musculoskeletal discomfort between control group and experimental group

In this study found that all back body region shows reduction in musculoskeletal discomfort rating compared with and without intervention through graph figure and percentage of improvement data. However, after undergoes the nonparametric paired samples test, the p-value shows that there were not statistically significant enough between with and without back support vest. This is because the sample size used in this study was small; therefore these significant differences cannot be noticed (Verial, 2017). However, through this research it was found that there was significant reduction in the LMD's scale rating only on neck at 14.9 kg and middle back at 5.9 kg in experimental group from control group.

The facts could be back support vest able to immobilization and support on the lumbar spine (Orthopaedic Trauma Institute, 2011). Therefore, workers in experimental group feel more comfort conducting the manual handling. In other study mention that purpose of a back support is principally to support an unstable lumbar spine and reduce pain (Polastri & Romano, 2016). And from a previous survey of a health club in United State of America determined that 27% were back support users, 90 % of those who used a back support reported doing so to prevent injury, whereas 22% wore one to improve performance (Finnie, 2003).

The direct biomechanical benefits of back support are likely related to the mechanical stiffness of the lumbar support, leading to decreased lumbar range of motion (ROM) (Van et al., 2000), reduced stresses in the passive tissues of the posterior lumbar spine (McGill et al., 1994) and potentially to reduced compressive loading of the lumbar spine (Katsuhirra et al., 2008). Therefore, all these benefits have potential to reduce discomfort during manual handling.

CHAPTER 6

CONCLUSION, LIMITATION & RECOMMENDATION

6.1 Conclusion

This study an experimental research, two group pre-test and post-test design was conducted at Meeting Room, Taman Pertanian Universiti, Universiti Putra Malaysia (UPM) from Mac, 2017 until April 2017. It aimed to determine the effect of back support vest in reducing discomfort due to manual handling among male agricultural workers. 38 respondents were recruited in this study and inclusion criteria for sample selection were: 1) male worker, 2) age between 18-35 years old, 3) normal BMI (18.5-24.9), 4) no immediate complaint of back pain, and 5) no taking medication. The respondents were equally allocated into two groups (control and experimental group). The control group performed lifting simulator without back support vest intervention but the experimental group performed lifting simulator with back support vest intervention. Localised Musculoskeletal Discomfort's scale rating was used to assess the degree of subjective discomfort on various body parts. Descriptive statistical analysis that included median and interquartile range was used to describe respondents' background information. Wilcoxon Signed-rank test used to compares between pre-test and post-study outcomes and also Mann-Whitney U test was used to compares between control and experimental group.

The results of this study suggested that the beneficial effect of back support vest in improving comfort during manual handling was seen on certain worker's body parts. More importantly, lower back discomfort was significantly reduced after back support vest intervention. Moreover, almost all muscle discomfort measurements show significantly reduced between control and experimental group. In summary, this study accomplished the main objective as stated in the chapter one.

6.2 Study limitation

These listed limitations were considered as inevitable for this study:

i. This study is primarily limited to only male workers. So, it cannot be used to generalize to the whole population.

ii. Inadequate of respondents. Therefore, significant differences cannot be noticed.

iii. Study is conducted in artificial laboratory setting. Thus, the result may not be generalized to external settings.

iv. The range of ratings for Localised Musculoskeletal Discomfort's scale is difficult for certain respondents to distinguish. Therefore, it may increase the risk of misclassification.

v. Should use electromyography instrument in the study. Hence, able to get an objective measurement to measure the muscle activity of discomfort level.

6.3 Recommendation

After conducting this research, it is recommended that further research might include female workers in order to generalize the findings to the whole population. Even though majority manual handling in agricultural sector in Malaysia are male, discomfort among female workers also should be observed. So that, the differences in terms of subjective and objective measurements between male and female workers can be investigated.

Furthermore, the limitations created by a small sample size can have profound effects on the outcome and worth of a study. Therefore, study should involve with more respondent to increase the power of study and the significant differences can be noticed.

Moreover, since this experiment was conducted in artificial laboratory settings, it is strongly recommended that future research should be conducted in real work environment in order to generalize the findings to external settings. This is due to reason that worker discomfort can be influenced by environmental factor such as types of work condition and weather.

In addition, need to be considered the usage of Localised Musculoskeletal Discomfort's scale which would increase the risk of misclassification. Due to difficulty faced by some respondent to distinguish the range of scale ratings particularly at the lowest level, these scales should be clearly explained to the respondents before the experimental session. Also respondents should be given clear example in order to make sure they understand and able to differentiate the scale without ambiguity.

Other recommendation need to be considered for future research is related to use electromyography instrument in the study. Hence, able to get an objective measurement to measure the muscle activity of discomfort level, in order to support the bias in subjective measurement in Localised Musculoskeletal Discomfort's scale questionnaire.

REFERENCES

Al-Eisa, E., Buragada, S., Shaheen, A. A., Ibrahim, A., & Melam, G. R. (2012). Work related musculoskeletal disorder: causes, prevalence and response among Egyptian and Saudi physical therapists. *Middle-east J. Sci. Res,* 12(4), 523-9.

Aurslanian, D. B. (1994). Asymmetrical lifting using a weight belt. In: Microfarm Publications. Eugene, OR: University of Oregon.

Ammendolia, C., Michael, S., & Claire, B. (2005). Back Belt Use For Prevention Of Occupational Low Back Pain: A Systematic Review. *Journal of Manipulative and Physiological Therapeutics*, Volume 28, Issue 2, February 2005, Pages 128–134.

Bobick, T. G., Belard, J .L. Hsiao, H., & Wassell, J. T. (2001). Physiological effects of back belt wearing during asymmetric lifting. *Appl. Ergonomic.* 32:541-547.

Bourne, N. D., & Reilly, T. (1991) Effect of a weightlifting belt on spinal shrinkage. *Sports Med.* 25:209-212.

Brown, Q. R. (2016). Improve Your Posture: Learn the 3 Curves of the Spine. Retrieved from https://www.washington.edu/wholeu/2016/07/01/natural-posture/

Bridwell, K. (2017). Vertebral Column. *Spineuniverse.* Retrieved from https://www.spineuniverse.com/anatomy/vertebral-column

Chen, H. J., Lin, C. J., & Huang, C. H. (2006). Effects of a New Industrial Lifting Belt on Back Muscular Activity, Hand Force, and Body Stability during Symmetric Lifting. *Industrial Health* 2006, 44, 493–502.

Chek, P. (1998). Backstrong & beltless. Strength Cond. Coach. 5(4): 11-13.

Cameron, J. A. (1996). Assessing work related body-part discomfort: Current strategies and a behaviourally oriented assessment tool. *International Journal of Industrial Ergonomics,* 18, 389-398.

Corlett, E. N., & Bishop, R. P. (1976). A technique for assessing postural discomfort. Ergonomics, 19(2), 175-182.

Ciriello, V. M., & Snook, S. H. (1995). The effect of back belts on lumbar muscle fatigue. Spine. 20: 1271-1278.

Castaneda, R. (2017). Can Lumbar Support Devices Relieve Lower Back Pain? Retrieved from http://health.usnews.com/wellness/articles/2017-01-05/can-lumbar-support-devices-relieve-lower-back-pain

Cousins, C. (2017) cited in Castaneda, R. (2017) Can Lumbar Support Devices Relieve Lower Back Pain? Retrieved from http://health.usnews.com/wellness/articles/2017-01-05/can-lumbar-support-devices-relieve-lower-back-pain

Eben, D., (2013). Lumbar Spine Anatomy and Pain. Retrieved from http://www.spine-health.com/conditions/spine-anatomy/lumbar-spine-anatomy-and-pain

European Agency for Safety and Health at Work. (2007). Hazards and risks associated with manual handling of loads in the workplace. Retrieved from https://osha.europa.eu/en/tools-and-publications/publications/factsheets/73

Finnie, S. B., Wheeldon, T. J, Hensrud, D. D., Dahm, D.L., & Smith (2003) Weightlifting Belt Use Patterns Among A Population Of Health Club Members. *Strength Cond. Res.* 17:498-502.

Fritz, T. C. (2000). The weight belt: Fashionable, but not for building a strong waist. Muscle. Fitness. March:14.

Giorcelli, R. J., Hughes, R. E., Wassell, J. T. & Hongwei. H. (2001). The effect of wearing a back belt on spine kinematics during asymmetric lifting of large and small boxes. Spine. 26: 1794-1798.

Gopinadh, A., Devi, K. N., Chiramana, S., Manne, P., Sampath, A., & Babu, M. S. (2013). Ergonomics and musculoskeletal disorder: as an occupational hazard in dentistry. *J Contemp Dent Pract*, 14(2), 299-303.

Grinten, V. D., & Smitt, P. (1992). Development of a practical method for measuring body part discomfort. In S. Kumar (Ed.), *Advances in Industrial Ergonomics and Safety IV* (pp. 311-318).

Hadi, H. A. (2016) Prevalence And Factors Associated With Low Back Pain Among Tea Plantation Workers In Cameron Highlands, Malaysia. *Journal of Occupational Safety and Health,* June 2016, vol 13, No. 1.

Hunter, G. R. (1989). The effects of weight training belt on blood pressure during exercise. Appl. Sports Sci. Res. 3: I 3-18.

Karmegam, K., Sapuan, S.M., Ismail, M. Y., Ismail, N., & Shamsul Bahri, M. T. (2011). Conceptual design of motorcycle's lumbar support using motorcylists' anthropometric characteristic. *Maejo International Journal of Science and Techonology,* 5(1).

Kraus, J. F., Schahffer, T., Rice, J., Maroosis, & Harper. J. (2002). A field trend of back belts to reduce the incidence of acute low back injuries in New York City home attendants, *Int. Occup. Environ. Health.* 8(2):97- 104.

Lameslow, Klar & Lawanga, (1990) as cited in Aday, L. A., (2003). Designing and conducting health surveys: A comprehensive guide (3rd ed.). San Francisco, California: Jossey-Bass.

Leung, K. (2016). How to Keep A Neutral Spine When Lifting Weights. Retrieved from http://www.builtlean.com/2016/05/30/neutral-spine-posture/

Martini, F. H., Timmons, M. J., & Tallitsch. B. (2014). Human anatomy. 8th ed. Old Tappan, NJ: Pearson Education/Benjamin Cummings.

Mawston, G. A., & Boocock, M. G. (2012).The effect of lumbar posture on spinal loading and the function of the erector spinae: implications for exercise and vocational rehabilitation. *New Zealand Journal of Physiotherapy* 40(3): 135-140.

Ministry of Human Resource. (2016) Malaysia. Social Security Organisation Annual Report 2009 2015. Retrieved from http://www.perkeso.gov.my/en/report/annual-reports.html#startofpageid929

Meksawi, S., Tangtrakulwanich, B., & Chongsuvivatwong, V. (2012). Musculoskeletal problems and ergonomic risk assessment in rubber tappers: A community-based study in southern Thailand. *International Journal of industrial Ergonomics*, 42(1), 129-135.

McDaniel, J. W. (1994). Strength Aptitude Tests.Personal communication to Sean Gallagher, National Institute for Occupational Safety and Health/Pittsburgh Research Center.

Mayer, T. G., Barnes, N.D. Kishino, G. Nichols, R.J. Gatchell, H. Mayer, & Mooney, V. (1988) Progressive Isoinertial Lifting Evaluation — I. *A Standardized Protocol and Normative Database*. Spine 13(8):993–997.

Mayer, T. G., Barnes, G., Nichols, N.D., Kishino, K., Coval, B., Piel, D., Hoshino, & Gatchell, R.J. (1988). Progressive Isoinertial Lifting Evaluation — II. A Comparison with Isokinetic Lifting in a Chronic Low-Back Pain Industrial Population. Spine 13(8):998–1002.

McGill, S. M., Kippers, V. (1994). Transfer of loads between lumbar tissues during flexion-relaxation phenomenon. Spine. ;19:2190–2196. Retrieved from doi: 10.1097/00007632-199410000-00013.

Medlej, J. (2014). Human Anatomy Fundamentals: Flexibility and Joint Limitations. Retrieved from https://design.tutsplus.com/articles/human-anatomy-fundamentals-flexibility-and-joint-limitations--vector-25401.

Majkowski, G. R., Jovag, B.W., Taylor, B.T., Taylor, M. S., Allison, S.C., Sterrs, D. M. & Roderick, R. L. (1998). The effect of back belt use on isometric lifting force and fatigue of the lumbar paraspinal muscles. Spine. 23:2104-2109.

Microsoft (2017). Calculate percentages. Retrieved from https://support.office.com/en-us/article/Calculate-percentages-6b5506e9-125a-4aba-a638-d6b40e603981

Muscles Used. (2012). Erector Spinae. Retrieved from http://www.musclesused.com/erector-spinae-2/

Centers for Disease Control and Prevention (2014). Back Belts--Do They Prevent Injury?. Retrieved from https://www.cdc.gov/niosh/docs/94-127/

National Institute for Occupational Safety and Health (1998). Back Belts--Do They Prevent Injury?. DHHS (NIOSH) Publication Number 94-127

Nancy, C., Selby, & John, J. T. (2006). Manual material handling to prevent back injury. Spine-Health.com. Retrieved from http://www.spine-health.com/wellness/ergonomics/manual-material-handling-prevent-back-injury

National Library of Medicine. (2014). *Muscle aches*. Retrieved from http://www.nlm.nih.gov/medlineplus/ency/article/003178.htm

Orthopaedic Trauma Institute. (2011). Thoraco Lumbo Sacral Orthosis (TLSO). Retrieved from http://orthosurg.ucsf.edu/oti/patient-care/divisions/orthotics-and-prosthetics/thoraco-lumbo-sacral-orthosis-tlso/

Polastri, M. & Romano, M. (2016). Lumbar scoliosis: Reducing lower back pain and improving function in adulthood. A case report with a 2-year follow-up. *Journal of Bodywork & Movement Therapies*, Volume 21, Issue 1, Pages 81–85.

Reilly, T. & Davies, D.S. (1995). Effects of a weightlifting belt on spinal loading during performance of the dead lift. Sports Sci. 13:433.

Reenen, Heleen H., Hamberg, V., Van, D. B., Allard, J., Blatter, B. M., Van, D. G., Maarten, P., Van. M., Willem & Bongers, Paulien M. (2008) 'Does musculoskeletal discomfort at work predict future musculoskeletal pain?'. Ergonomics, 51:5, 637 – 648.

Stephen, H. H. (2008). Back Pain Risk Factors: What Can Increase The Potential for Back Problems? Retrieved from http://www.spine-health.com/conditions/lower-back-pain/back-pain-risk-factors-what-can-increase-potential-back-problems

Shapiro, R. (2017). Can Lumbar Support Devices Relieve Lower Back Pain?. Retrieved from http://health.usnews.com/wellness/articles/2017-01-05/can-lumbar-support-devices-relieve-lower-back-pain

The American Physical Therapy Association. (1998) The Secret of Good Posture. *A Physical Therapist's Perspective*. Retrieved from http: https://www.utmb.edu/rehab/outpatient/posture.pdf

Van, P. M., De, L. M,, Koes, B.W, Smid. T., & Bouter, L. M. (2000). Mechanisms of action of lumbar supports. A systematic review. Spine. ;25:2103–2113. Retrieved from doi: 10.1097/00007632-200008150-00016.

Verial, D. (2017). The Effects of a Small Sample Size Limitation. Retrieved from http://sciencing.com/effects-small-sample-size-limitation-8545371.html

Waters, T. R., Anderson, V. P., & Garg, A. (1994). Application Manual For The Revised NIOSH Lifting Equation. *U.S Department of Health and Human Services (NIOSH)Publication,* No. 94-110.

Walmart Stores, Inc. (2017). Posture Braces. Retrieved from https://www.walmart.com/c/kp/posture-braces?offset=80

Wassell, J. T., Gardner, L.L., Landsittel, D. P., Johnston, J.J., & Johnston, .M. (2000). A prospective study of back belts for prevention of back pain and injury. Am. Med. Assoc. 284: 2727-2732.

APPENDICES

APPENDIX 1

Respondent's Information and Consent Form

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

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN
Kesan vest sokongan belakang dalam mengurangkan ketidakselesaan semasa simulasi pengendalian beban secara manual di kalangan pekerja lelaki di Taman Pertanian Universiti, UPM.

2. PENGENALAN
Pengendalian beban secara manual berlaku dalam hampir semua persekitaran kerja dan para pekerja adalah kemungkinan besar akan terdedah kepada beban berat. Apabila pengendalian beban secara manual dilakukan dengan postur badan yang tidak betul dan berat beban berlebihan, tugas-tugas ini boleh mendedahkan pekerja kepada faktor risiko fizikal, ketidakselesaan dan kesakitan terutamanya pada tulang belakang. Dan para pekerja mengambil inisiatif untuk memakai vest sokongan tulang belakang untuk mengurangkan ketidakselesaan tetapi bukti keberkesanannya masih samar-samar dan masih kurangnya bukti-bukti mengenai keberkesanan intervensi ini. Selain itu, vest sokongan tulang belakang yang dipakai oleh para pekerja ini adalah rekaan terbaru dan berbeza daripada penyelidikan sebelum ini iaitu vest sokongan tulang belakang yang ditambah sokongan dibahu yang boleh dilaras. Oleh itu, adalah perlu untuk membuktikan secara saintifik berkenaan kesan memakai vest sokongan tulang belakang ini dalam mengurangkan ketidakselesaan untuk meningkatkan keselamatan, kesihatan dan tahap keselesaan pekerja.

3. APAKAH YANG PERLU ANDA LAKUKAN?
Anda perlu jawapan soal selidik ini dengan lengkap dan betul. Kemudian terlibat dengan eksperimen pengendalian beban secara manual iaitu anda perlu mengangkat beban seberat 5.9 kg, 10.4 kg, 14.9 kg dan 19.4 kg selama 20 saat untuk setiap peringkat beban dan perlu lakukan sebanyak 4 kali di setiap peringkat. Penyertaan anda akan membantu kami untuk mendedahkan kesan memakai vest sokongan tulang belakang dan membantu anda untuk mengetahui kesan pemakaian vest ini semasa pengendalian beban secara manual.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?
- Pekerja wanita.
- Pekerja yang berumur kurang atau lebih daripada 18-35 tahun.
- Pekerja yang mempunyai BMI yang tidak normal iaitu kurang atau lebih daripada 18.5-24.9.
- Pekerja yang mempunyai aduan sakit belakang yang terkini.
- Pekerja yang mempunyai tidur yang tidak mencukupi atau mengambil ubat.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) **KEPADA ANDA SEBAGAI PESERTA?**
Dengan menyertai kajian ini, anda akan mendapatkan maklumat yang sewajarnya mengenai kesan memakai vest sokongan tulang belakang ini.

b) **KEPADA PENYELIDIK?**
Sebagai penyelidik, saya akan memperolehi maklumat yang diperlukan bagi kajian saya di mana ia akan membantu saya untuk memberi maklumat mengenai kesan penggunaan vest sokongan tulang belakang semasa pengendalian beban secara manual yang sewajarnya.

6. ADAKAH IA BERISIKO?

Tiada sebarang risiko dengan menyertai kajian ini cuma anda akan merasai sedikit keletihan ketika mengangkat beban yang telah sediakan.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Maklumat dan identiti anda akan disimpan secara sulit dan tiada sebarang maklumat akan diterbitkan tanpa kebenaran dari pihak anda.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Penyelidik:-
Nama: Muhammad Zulhaily Bin Tajul Ariffin
E-mail: zulhaily.hse@gmail.com
No. Telefon: 017-2460050
Alamat:
Jabatan Kesihatan Persekitaran dan Pekerjaan,
Fakulti Perubatan dan Sains Kesihatan,
Universiti Putra Malaysia,
43400 Serdang,
Selangor Darul Ehsan,
Malaysia

Penyelia Utama:-
Nama: Dr. Ng Yee Guan
E-mail: shah86zam@upm.edu.my
No. Telefon: 03-89472396 Fax: 03-89472395
Alamat:
Jabatan Kesihatan Persekitaran dan Pekerjaan,
Fakulti Perubatan dan Sains Kesihatan,
Universiti Putra Malaysia,
43400 Serdang,
Selangor Darul Ehsan,
Malaysia.

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini ________

9. PERSETUJUAN

Saya.. No Kad Pengenalan. .... beralamat..

....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .... (*Responden*)

Tarikh :..

Tandatangan .... (*Saksi*)

Nama :..

No. K/P: ....

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh ....

Tandatangan .... (*Penyelidik*)

APPENDIX 2

Questionnaires Form

ID:

DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH

FACULTY OF MEDICINE AND HEALTH SCIENCE

UNIVERSITY PUTRA MALAYSIA

QUESTIONNAIRE FORM

TITLE OF STUDY:

EFFECT OF BACK SUPPORT VEST IN REDUCING DISCOMFORT FROM SIMULATED MANUAL HANDLING OF LOADS AMONG MALE WORKERS AT TAMAN PERTANIAN UNIVERSITI, UPM

All responses will be treated as confidential. There are **FOUR** sections in this questionnaire.

SURVEY QUESTIONNAIRE

This page contains questions that will provide your personal information. Please answer each question completely/ *Laman ini mengandungi soalan-soalan yang akan memberikan maklumat peribadi anda. Sila jawab setiap soalan sepenuhnya..*

SECTION A / *SEKSYEN* A: BACKGROUND INFORMATION/ *MAKLUMAT LATAR BELAKANG*

1. Mobile phone number/ *Nombor telefon bimbit:*____________________
2. Age/ *Umur* : __________________ year/ *tahun*
3. Weight/ *Berat* : _______________ kg
4. Height/ *Tinggi* : _______________ cm
5. BMI: __________________
6. Race/ Bangsa:

   ☐ Malay/ *Melayu* ☐ Chinese/ *Cina*

   ☐ Indian/ *India* ☐ Other/ *lain-lain:*__________

SECTION B / *SEKSYEN* B: DAILY ACTIVITIES/ *AKTIVITI- AKTIVITI HARIAN*

1. Are you involved with heavy work activities/ *Adakah anda terlibat dengan aktiviti-aktiviti kerja berat*?

   ☐ Yes/ *Ya* ☐ No/ *Tidak*

   If yes, how often do involved with heavy works activities in a week/ *Jika ya, berapa kerap terlibat dengan aktiviti-aktivit kerja berat dalam seminggu*?

   ___________ hour/ *jam*

2. Please describe the heavy works activities do you performed/ *Sila nyatakan aktiviti- aktiviti kerja berat yang anda dilakukan:*

____

3. Do you play sports/ *Adakah anda bermain sukan?*

☐ Yes/ *Ya* ☐ No/ *Tidak*

If yes, how often do you play sports in a week/ *Jika ya, berapa kerap anda bermain sukan dalam seminggu*? ____________ hours/ *jam*

SECTION C / *SEKSYEN* C: HEALTH INFORMATION/ *MAKLUMAT KESIHATAN*

1. Have you ever experienced any health problems that have been diagnosed by a doctor/ *Adakah anda pernah mengalami sebarang masalah kesihatan yang telah disahkan oleh doktor*?

☐ Yes/ *Ya* ☐ No/ *Tidak*

If yes, please answer the list below/ *Jika ya, sila jawab senarai di bawah ini:*

Illness is, as stated below/ *Penyakit adalah, seperti yang dinyatakan dibawah:*

(Can choose more than one illness/ *Boleh pilih lebih daripada satu penyakit*)

- Cardiovascular disease/ *Penyakit kardiovaskular* ☐
- Musculoskeletal disease/ *Penyakit Muskuloskeletal* ☐
- Others: Please state/ *Lain-lain: Sila nyatakan* : ________________

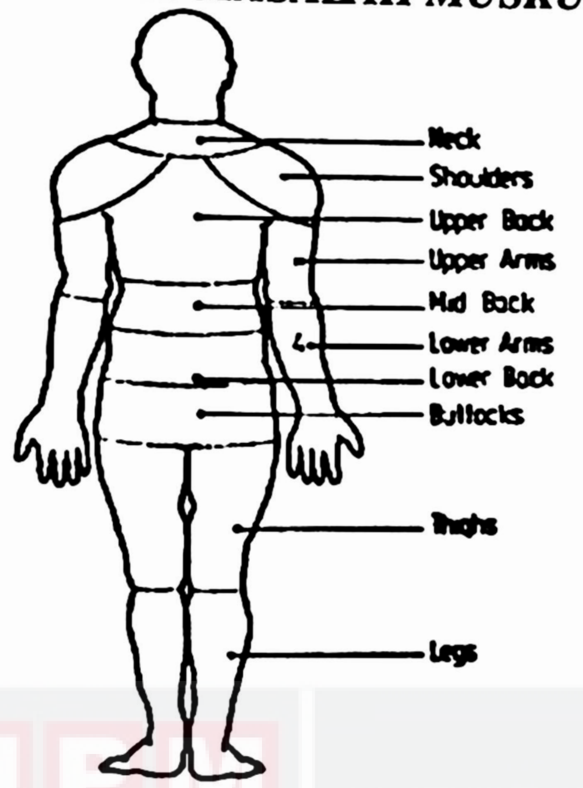
2. At present, do you take any medical treatment from doctor/ *Pada masa ini, adakah anda mengambil sebarang rawatan perubatan daripada doktor*?

☐ Yes/ *Ya* ☐ No/ *Tidak*

If yes, please specify the type of medicine below/ *Jika ya, sila nyatakan jenis ubat di bawah:*

____

SECTION D / *SEKSYEN* D: MUSCULOSKELETAL DISORDERS INFORMATION/ *MAKLUMAT MASALAH MUSKULOSKELETAL*



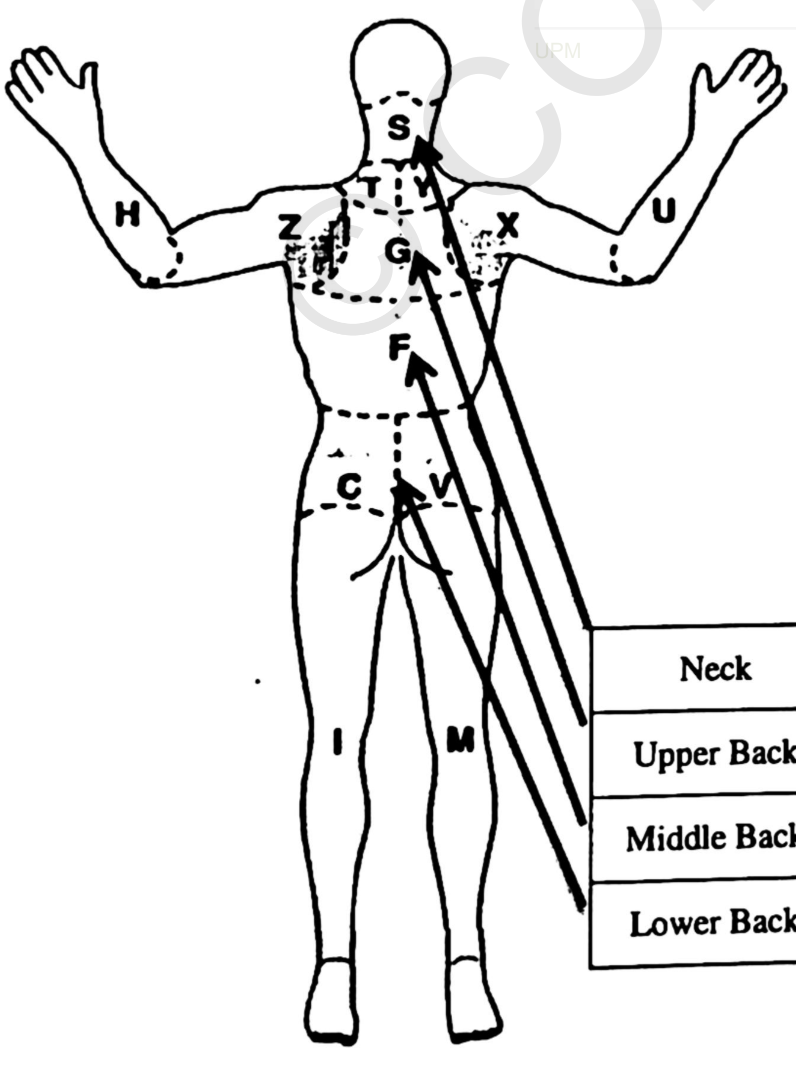
Parts of body/ *Bahagian badan*		Question/Soalan (a) Do you ever feel pain, aches, burning or discomfort on the part of the body below/ *Adakah anda pernah berasa sakit, lenguh, pedih atau rasa ketidakselesaan di bahagian badan di bawah?*	Question/Soalan (b) Do you ever feel pain, aches, burning or discomfort on the part of the body within 7 days lately/ *Adakah anda pernah berasa sakit, lenguh, pedih atau rasa ketidakselesaan pada bahagian badan dalam masa 7 hari kebelakangan ini?*
1.	Neck/ *Leher*	Yes/Ya ☐ No/Tidak ☐ If yes, answers question (b)/ *Jika ya, sila jawapan soalan (b).*	Yes/Ya ☐ No/Tidak ☐
2.	Upper back/ *Belakang atas*	Yes/Ya ☐ No/Tidak ☐ If yes, answers question (b)/ *Jika ya, sila jawapan soalan (b).*	Yes/Ya ☐ No/Tidak ☐
3.	Middle back/ *Tengah belakang*	Yes/Ya ☐ No/Tidak ☐ If yes, answers question (b)/ *Jika ya, sila jawapan soalan (b).*	Yes/Ya ☐ No/Tidak ☐
4.	Lower back/ Bawah belakang	Yes/Ya ☐ No/Tidak ☐ If yes, answers question (b)/ *Jika ya, sila jawapan soalan (b).*	Yes/Ya ☐ No/Tidak ☐

Please indicate level of discomfort at your body parts based on scale the provided/ *Sila nyatakan tahap ketidakselesaan di bahagian-bahagian badan anda berdasarkan skala yang disediakan.*

Localised Musculoskeletal Discomfort's scale/*Skala Ketidakselesaan Muskuloskeletal Berpusat* (DISCOMFORT RATING/ *KADAR KETIDAKSELESAAN*)

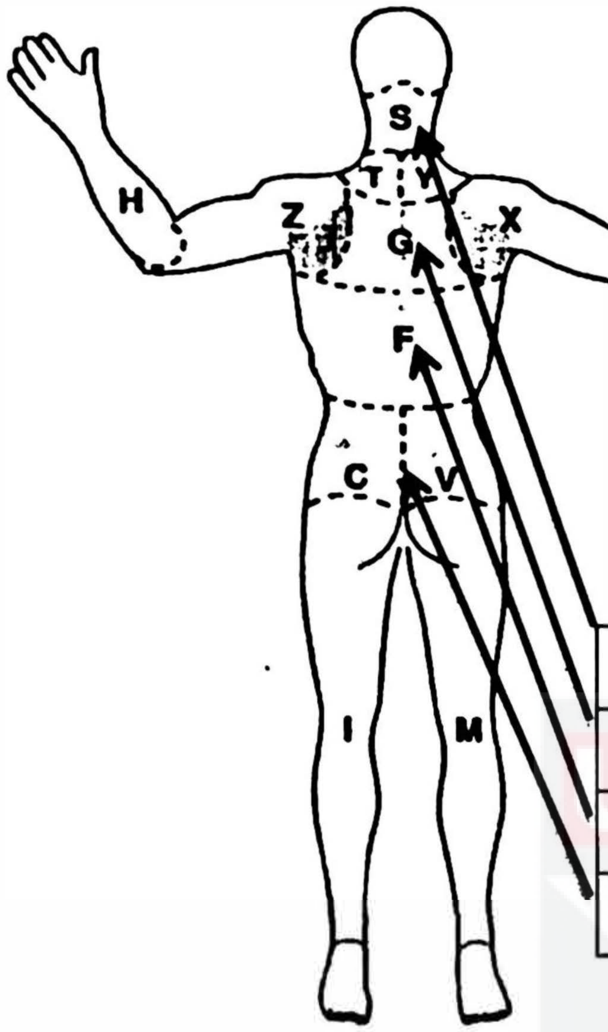
Rating/ *Kadar*	**Definition/ Definisi**
10	Extreme discomfort (almost maximum)/ *ketidakselesaan yang ekstrem*
9	↑
8	
7	Very high discomfort/ *ketidakselesaan yang sangat tinggi*
6	↑
5	High discomfort/ *ketidakselesaan tinggi*
4	Somewhat high discomfort/ *ketidakselesaan agak tinggi*
3	Moderate discomfort/ *ketidakselesaan sederhana*
2	Little discomfort/ *Ketidakselesaan sedikit*
1	Very little discomfort/ *ketidakselesaan sangat sedikit*
$^1/_2$	Extremely little discomfort/ *ketidakselesaan amat sedikit*
0	No discomfort at all/ *Tiada ketidakselesaan langsung*

First Stage/ *Peringkat pertama*: 5.9 kg



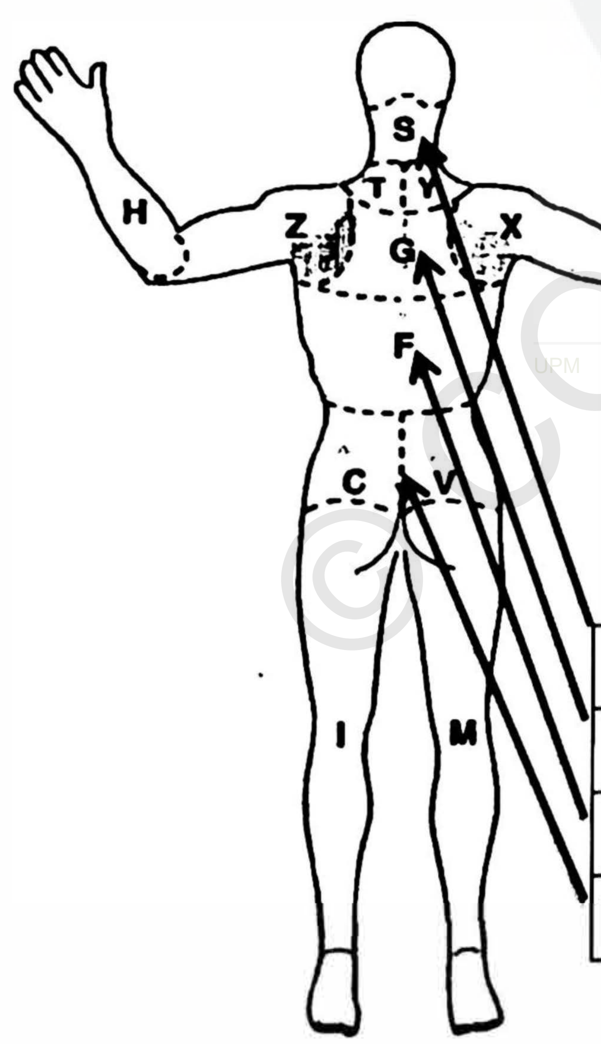
	No discomfort at all	Extremely little discomfort	Very little discomfort	Little discomfort	Moderate discomfort	Somewhat high discomfort	High discomfort	-----	Very high discomfort	-----	-----	Extreme discomfort
	0	$^1/_2$	1	2	3	4	5	6	7	8	9	10
Neck												
Upper Back												
Middle Back												
Lower Back												

Second stage/ *Peringkat kedua*: 10.4 kg



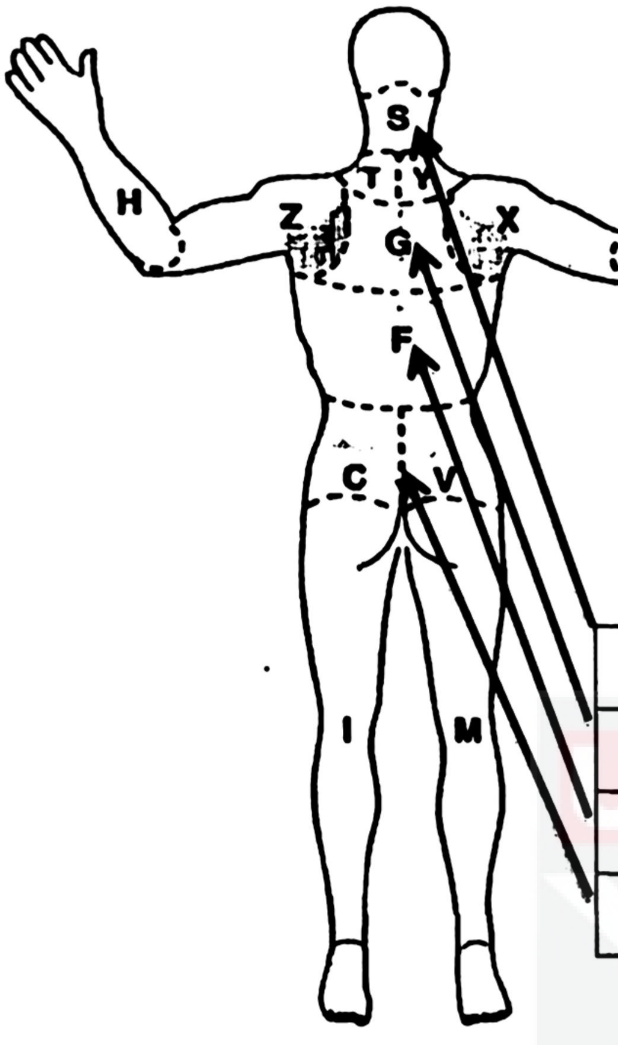
	No discomfort at all	Extremely little discomfort	Very little discomfort	Little discomfort	Moderate discomfort	Somewhat high discomfort	High discomfort	-----	Very high discomfort	-----	-----	Extreme discomfort
	0	½	1	2	3	4	5	6	7	8	9	10
Neck												
Upper Back												
Middle Back												
Lower Back												

Third stage / *Peringkat ketiga*: 14.9 kg



	No discomfort at all	Extremely little discomfort	Very little discomfort	Little discomfort	Moderate discomfort	Somewhat high discomfort	High discomfort	-----	Very high discomfort	-----	-----	Extreme discomfort
	0	½	1	2	3	4	5	6	7	8	9	10
Neck												
Upper Back												
Middle Back												
Lower Back												

Last stage/ *Peringkat terakhir*: 19.4 kg



	No discomfort at all	Extremely little discomfort	Very little discomfort	Little discomfort	Moderate discomfort	Somewhat high discomfort	High discomfort	-----	Very high discomfort	-----	-----	Extreme discomfort
	0	1/2	1	2	3	4	5	6	7	8	9	10
Neck												
Upper Back												
Middle Back												
Lower Back												