



UNIVERSITI PUTRA MALAYSIA

***DEVELOPING RECOMMENDED STANDARD FOR ACCEPTABLE
WEIGHT FOR LIFTING ACTIVITIES AMONG YOUNG ADULTS***

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WEIGHT FOR LIFTING ACTIVITIES AMONG YOUNG ADULTS**

BY

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**Thesis submitted in fulfilment of the requirement for the degree of Bachelor
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and Health Sciences, Universiti Putra Malaysia**

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ABSTRACT

DEVELOPING RECOMMENDED STANDARD FOR ACCEPTABLE WEIGHT FOR LIFTING ACTIVITIES AMONG YOUNG ADULTS

AHMAD SYAMIL MOHAMAD HAMID

INTRODUCTION: Currently, there is no standard for manual handling. Statement in Section 12, Factory and Machinery Act (1967) is too general regarding weight for lifting. Therefore, there is a need to consider a standard for manual handling. **OBJECTIVE:** This study aims to develop a recommended permissible weight standard for different types of lifting, horizontal distances, gender and body mass index (BMI) among young adults population. **METHODOLOGY:** This cross-sectional experimental study recruited 72 young adults using criteria of gender and BMI (underweight, normal and overweight). Two sessions were used 1) first session is to determine maximum lifting strength (MLS), 2) second session is to determine the maximum acceptable weight to lift (MAWL). Both sessions need the respondents of two-handed exertions in four lifting types (back lifting, upper-body lifting, arm lifting and shoulder lifting) across two horizontal distances (toes aligned with and posterior to the exerted handle). Total of 8 lifting tasks were performed by each of respondent in each session. Wilcoxon sign test was used to compare between MLS and MAWL and Kruskal-Wallis test to compare MLS and MAWL between 3 different BMI. **RESULT:** For all different types of lifting and horizontal distances shows that there is a significantly higher MLS compared to MAWL ($p < 0.05$). Male respondent had a significantly higher ($p < 0.05$) MLS and MAWL compared to female for all types of lifting and horizontal distances. Respondent with higher BMI had significantly higher ($p < 0.05$) MLS and MAWL compared to underweight and normal. The study showed that the maximum weight lifted and acceptable weight for lifting is at upper-body compared to back, arm and shoulder lifting types. The recommended acceptable weight to lift for male upper-body is 17.8 ± 3.5 kg and for female is 11.3 ± 4.0 kg. **CONCLUSION:** Recommended that lifting use acceptable weight limit compared to maximum weight limit. Permissible weight standard should consider gender, BMI, horizontal distances and lifting types.

Keywords: maximum lifting strength, maximum acceptable weight, lifting, lifting types, horizontal distances

ABSTRAK

MEMBANGUNKAN STANDARD UNTUK BERAT YANG DIBENARKAN BAGI AKTIVITI MENGANGKAT DALAM KALANGAN ORANG DEWASA

AHMAD SYAMIL BIN MOHAMAD HAMID

PENDAHULUAN: Tiada sebarang standard berkaitan pengendalian manual di Malaysia buat masa ini. Kenyataan pada Seksyen 12, Akta Kilang dan Jentera, (1967) adalah terlalu umum berkaitan berat untuk mengangkat. Oleh itu, standard untuk pengendalian manual perlu dipertimbangkan. **OBJEKTIF:** Kajian ini bertujuan untuk mendapatkan satu standard berat yang dibenarkan dalam kalangan orang dewasa dengan mengambil kira daripada pelbagai jenis mengangkat, jarak mendatar, jantina dan indeks jisim badan (BMI). **METODOLOGI:** Kajian eksperimen ini menggunakan kaedah keratan rentas dengan mengambil seramai 72 orang dewasa mengikut kriteria yang dikehendaki iaitu jantina dan BMI (kekurangan berat badan, normal dan berat badan berlebihan). Kajian ini melibatkan dua sesi 1) sesi pertama adalah untuk menentukan kekuatan mengangkat maksimum (MLS) 2) sesi kedua adalah untuk menentukan berat maksimum yang dibenarkan untuk mengangkat (MAWL). Kedua-dua sesi ini memerlukan responden untuk melakukan empat jenis mengangkat iaitu mengangkat aras lutut (back lifting), mengangkat hadapan (upper-body lifting), mengangkat aras siku (arm lifting) dan mengangkat aras bahu (shoulder lifting) pada dua jarak mendatar yang berbeza (jari kaki sejajar dengan dan menjauhi pada pemegang). Sebanyak 8 angkatan yang perlu dilakukan oleh responden pada setiap sesi. Ujian Wilcoxon digunakan untuk membandingkan antara MLS dan MAWL dan ujian Kruskal-Wallis untuk membandingkan antara tiga BMI yang berbeza pada MLS dan MAWL. **KEPUTUSAN:** Untuk kesemua jenis mengangkat dan jarak mendatar menunjukkan MLS signifikan lebih tinggi berbanding MAWL ($p < 0.05$). Responden lelaki mempunyai MLS dan MAWL jauh lebih tinggi ($p < 0.05$) berbanding responden perempuan bagi semua jenis mengangkat pada jarak mendatar yang berbeza. Responden dengan BMI yang lebih tinggi mempunyai MLS dan MAWL jauh lebih tinggi ($p < 0.05$) berbanding dengan responden kekurangan berat badan dan normal. Kajian ini menunjukkan berat maksimum dan berat yang dibenarkan untuk mengangkat adalah jenis mengangkat hadapan berbanding jenis mengangkat aras lutut, siku dan bahu. Berat yang dibenarkan untuk mengangkat yang dicadangkan bagi lelaki adalah 17.8 ± 3.5 kg dan bagi perempuan adalah 11.3 ± 4.0 kg. **KESIMPULAN:** Untuk aktiviti mengangkat, dicadangkan untuk menggunakan had berat yang dibenarkan berbanding had berat maksimum. Standard berat yang dibenarkan telah mengambil kira jantina, BMI, jenis mengangkat dan jarak mendatar.

Kata kunci: kekuatan mengangkat maksimum, berat maksimum yang boleh diangkat, jenis mengangkat, jarak mendatar, angkat

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LIST OF ABBREVIATIONS

MLS	Maximum Lifting Strength
MAWL	Maximum Acceptable Weight to Lift
BMI	Body Mass Index

CHAPTER ONE

INTRODUCTION

1.1 Study Background

Ergonomics or human factor is a branch of science and technology that include the understanding of interactions among human's behaviour, biological characteristics and other elements of a system. Ergonomics also is the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance and to enhance safe, effective and satisfaction of individuals, groups and organization (International Ergonomics Association, 2016).

Also according to International Ergonomics Association (2016), ergonomics consists of three main domains which are physical, cognitive and organizational ergonomics (Figure 1.1). Physical ergonomics is about the human body's responses to physical and physiological work demands. Repetitive strain injuries from repetition, vibration, force and posture are the main common types of issues. Cognitive ergonomics is concerned with the mental processes such as memory, reasoning and motor response as they affect interactions among humans and other elements of a system. The relevant topics are include mental workload, decision-

making, human-computer interaction, human reliability and work stress as these may relate to human system design. Organizational ergonomics is the optimization of sociotechnical systems including organizational structures, policies and processes.

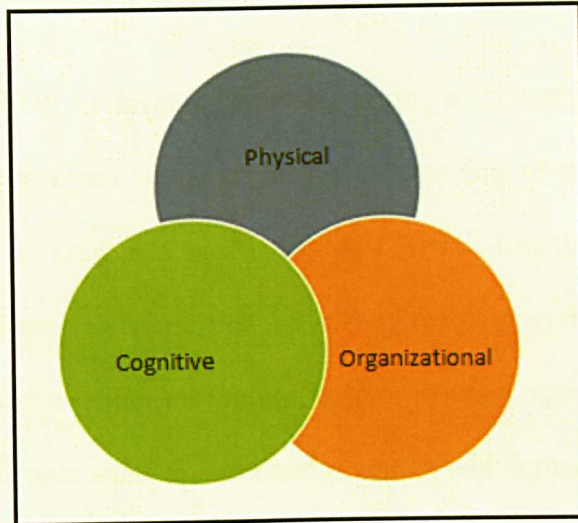


Figure 1.1: Domains in Ergonomics

There are three main focuses of ergonomics which are:

1. Performance or functional efficiency
 - Focus on extension of worker's abilities by improving output and reducing error.
2. Safety and health
 - Minimizing accidents, injuries and illnesses that may result from human limitation.
3. Ease of use, satisfaction and comfort
 - Actual design, products and systems are comfortable, satisfying and user friendly.

An ergonomics risk factor is any attribute, characteristic or exposure that may cause or contribute to a musculoskeletal injury. The mere presence of a risk factor may not in itself result in an injury. If two or more risk factors present at one time, therefore the risk of injury will increased.

Manual handling or forceful exertion is one of the ergonomics risk factor. Manual handling is not just involves lifting or carrying of weight. According to Western Australian on Occupational Safety and Health Regulation (1996), manual handling means any activity requiring the use of force exerted by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain a person, animal or thing. Manual handling can also exist in sustained postures which place excessive force on joints and overload the muscle and tendons. Most manual task risk factors that present during works include:

- Handling heavy or bulky load
- Holding loads with arms away from trunk
- Twisting back, neck or upper body
- Reaching and load handling at low levels or above shoulder height
- Repetitive movement
- Strenuous lifting, lowering, carrying, pushing and pulling
- Load handling on one side
- Sustained and repetitive gripping
- Inadequate task variety or breaks
- Postural or movement constraints due to working in narrow or obstructed work areas

Musculoskeletal Disorders (MSD) affect musculoskeletal systems which are muscle, ligaments or other soft tissues of the body joints. The affected soft tissues included:

- i) Muscles – contractile tissue of the body, skeletal, cardiac or smooth muscle. The function is to produce force and cause motion.
- ii) Ligaments – connective tissue that joins one bone to another.
- iii) Tendons – similar to ligaments but tough fibrous connective tissue that connects muscle to bone.
- iv) Nerves – conduct sensory information. Spinal nerves connect through spinal column to spinal cord. Cranial nerves connect to brain stem.
- v) Spinal disc – associated pain include pinched nerve, herniated or bulging disc. Sometimes called slipped disc.
- vi) Bursa sacs – small sacs filled with synovial fluid and made of white fibrous tissue. It provides a cushion between bones and tendons and/or muscle a joint.

Other MSDs terms are Occupational Overuse Syndrome, Repetitive Strain Injury, Repetitive Stress Injury, Repetitive Motion Injuries, Cumulative Trauma Disorder, Upper Limb Disorders and Upper extremities Musculoskeletal Disorders (International Ergonomics Association, 2016).

Manual handling can cause many types of ergonomics injury especially sprains and strains. Institution of Occupational Safety and Health (IOSH), UK, defined MSDs as conditions that affect the nerves, tendons, muscles and supporting structures, such as the discs in the patient's back. According to Health and Safety for 2013/14 in Great Britain, manual handling caused nearly quarter (24%) of reported injuries and averages of 6.6 days were lost for each handling injury.

1.2 Problem Statement

According to Factories and Machinery Act 1967 on Section 12 had stated that no person shall be employed to lift, carry or move any load so heavy as to be likely to cause bodily injury to him. However, this statement is too general. What is meant by “load so heavy” in that statement? Is there any standard for acceptable weight to lift in Malaysia that all workers need to comply with?

Manual handling is one of the main causes of musculoskeletal injuries in the workplace. Based on Social Security Organisation (Socso) Annual Report (2014), numbers of cases of occupational diseases were increasing drastically from 2005 with 194 cases until 2014 had reached 3002 cases. Apart from that, 675 cases in 2014 were related to occupational musculoskeletal diseases.

Compensation of musculoskeletal diseases continues to be most costly injury in the industrial world (Webster and Snook, 1994). For 2014, the total compensation cost distribution by Socso had reached about RM 14,058,406.50 for occupational disease including the musculoskeletal disease's compensation cost was RM 3,940,486.61.

Socso's Health Screening Programme (HSP) medical officer Dr Mohd Faznin on The Borneo Post (2013) had admitted that MSD cases were on the rise nationwide, attributing it in part to the lack of safe work practice at the workplace. On the financial impact of MSDs, he bemoaned that the cost of treatment for MSDs was quite high.

1.3 Study Justification

Currently, there is no standard for manual handling. Therefore, there is a need to consider a standard for good technical practices to be used by the industry in reducing injuries related to manual handling (Raemy, 2015). A standard should consist of maximum acceptable weight for lifting, lowering, pushing, pulling and carrying activities that should be comply among Malaysian industrial population.

Thus, this study will acts as a pilot study in recommending acceptable weight for lifting activities. This study will be conducted among Universiti Putra Malaysia's undergraduate students which are in young adult's age range. Further research is need for developing a proper standard for manual handling that can be used by Malaysian population.

1.4 Study Objective

General Objective

To determine the recommended acceptable weight for lifting activities

Specific Objective

1. To determine maximum lifting strengths in four lifting types (back lifting, upper-body lifting, arm lifting and shoulder lifting) across two horizontal distance (align with and posterior to)
2. To determine maximum acceptable weight for lifting in four lifting types across two horizontal distance
3. To compare the different of maximum lifting strength and maximum acceptable weight for lifting
4. To compare the different between male and female respondents in lifting strength
5. To compare the different between male and female respondents in acceptable weight to lift
6. To compare the different between underweight, normal and overweight body mass index (BMI) respondents in lifting strength
7. To compare the different between underweight, normal and overweight body mass index (BMI) respondents in acceptable weight to lift
8. To compare the lifting strength and acceptable weight to lift in four lifting types across two horizontal distances
9. To recommend acceptable weight for lifting activities

1.5 Study Hypothesis

1. There is significant difference between maximum lifting strength and maximum acceptable weight to lift
2. There is significant difference between male and female with the lifting strength
3. There is significant difference between male and female with the acceptable weight to lift
4. There is significant difference between underweight, normal and overweight BMI ratio with the lifting strength
5. There is significant difference between underweight, normal and overweight BMI ratio with the acceptable weight to lift
6. There is significant difference between lifting strength of four lifting types across two horizontal distances
7. There is significant difference between maximum acceptable weight to lift of four lifting types across two horizontal distances

1.6 Research Question

1. What is the maximum lifting strength in four lifting types across two horizontal distances?
2. What is the maximum acceptable weight for lifting in four lifting types across two horizontal distances?
3. What is the recommended acceptable weight for lifting activities?

1.7 Conceptual Framework

According to Western Australian on Occupational Safety and Health Regulation 1996, manual handling means any activity requiring the use of force exerted by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain a person, animal or thing. However, focus only on lifting activities as this study aim to recommend a standard for acceptable weight to lift.

Many factors can affect lifting activities performance and which can divide into three main factors which are environment, task and individual itself. In environment factor, there are noise, space, temperature or heat stress and floor or slope factor. This factor had been controlled in this study. One previous study such as Hala and Ayoub (1991), acceptable weight to lift under condition heat stress significantly reduce the workplace overexertion and injury. The risk of low back pain and injury were increased when lifting activities is facing up or down an inclined surface (Wickel & Reiser, 2008).

Most of the study variables that took into consideration on this study were on the other two main factors which are task and individual. Examples under task factor are like one-handed and two-handed lifting activities (Shamsul & Tan, 2011), vertical height (Chen, Lee & Chen, 2011) and horizontal distance (Cheng & Lee, 2005). Individual factors such as age (Lemmer, Martel, Hurlbut & Hurley, 2007), gender (Cheng & Lee, 2005), body mass index (Singh, Park & Levy, 2009) and medical history (Rudy, Lieber, Boston, Gourley & Baysal, 2003).

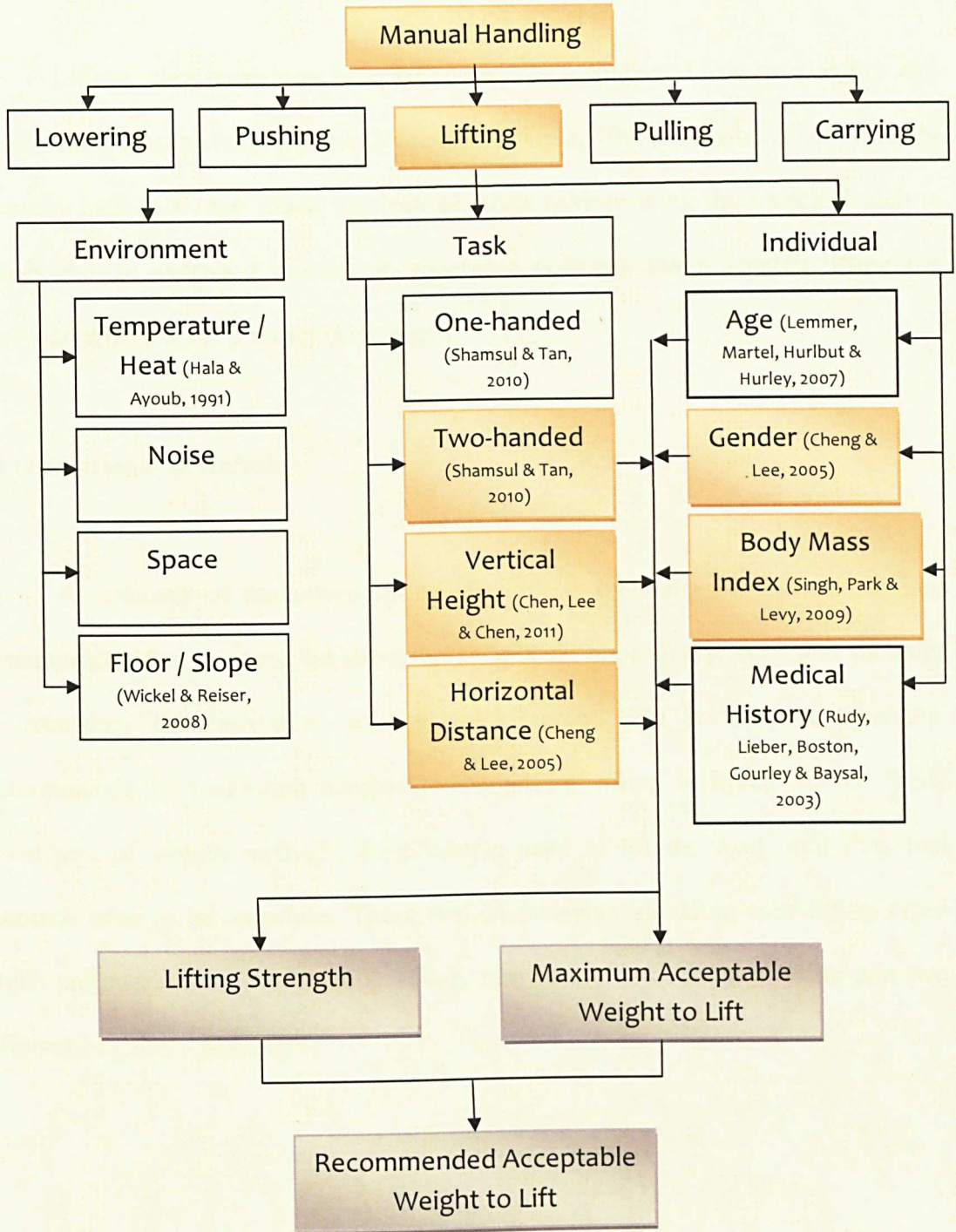
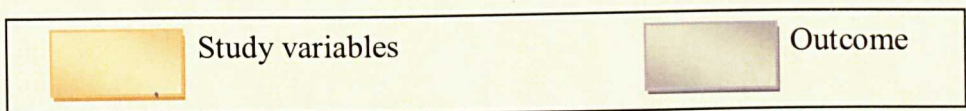


Figure 1.2: Conceptual framework



1.8 Conceptual Definition

Lifting tasks have long been recognized as a source of low back injury and various musculoskeletal problems (Marras and Mirka, 1992). Low back pain injuries normally happen by too much mechanical stress overstraining the muscle which is mainly due to awkward movement, repetitive postures and mismatch lifting the workload with worker's muscular strength.

1.9 Operational Definition

Assessment of maximum lifting strength is by using Arm, Back & Leg Dynamometer that measure the strength of the back, upper-body, arms and shoulder by recording the maximum reading in kilogram (kg) from three attempts. Determination of maximum acceptable weight for lifting is based on the "self-adjustment of weight method". Respondents need to lift the load until they feel uncomfortable to lift anymore. These two assessments including four lifting types which are back lifting, upper-body lifting, arm lifting and shoulder lifting and two different horizontal distances.

CHAPTER TWO

LITERATURE REVIEW

2.1 Anatomy of Musculoskeletal System

A skeletal muscle consists of a bundle of long fibre running parallel to the length of the muscle. Each fibre is a single cell with multiple nuclei, reflecting its formulation by the fusion of many embryonic cells (Campbell and Reece, 2005). Hedge (2011) stated that function of musculoskeletal system are to support and protect the body and its organ and provide motion. There are seven major substructures consist of tendons, ligaments, fascia, cartilage, bone, muscle and joints.

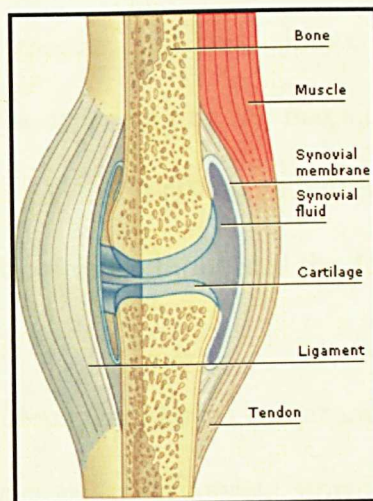


Figure 2.1: Structure of musculoskeletal system

2.2 Definition of Musculoskeletal Disorders (MSDs)

The disorder is referring to injuries and disorders of soft tissue which are muscles, tendons, ligaments, joints, and cartilage with nervous system. The symptoms of the disorders may include feel uncomfortable and pain to certain part of the body such as neck, shoulder, elbow, hand, lower and upper back, thigh, knee and feet. Occupational activity will causing lethargy and pressure to the musculoskeletal which will reduced muscle capability to receive force as stimulus (Occupational Biomechanics, 1999).

2.3 Mechanisms of Musculoskeletal Disorders (MSDs)

The European Agency for Safety and Health at Work (2013) explained that MSDs will occur when the external load and the capacity of the human body were mismatch to resist biomechanical and physiological strain. Excessive forces tend to have different pathophysiological mechanisms behind the symptoms on different body structure such as muscle, tendons, joints, bones and nerves. The pathophysiological effect was depending on the magnitude, duration and frequency of loading. National Research Council (1998) found that environmental, individual physical and psychological factors also influenced the development of MSDs.

Imposed loads of various magnitudes can change the form of tissues due to fatigue, work pattern or coactivation of muscle structures. If the load exceeds the

mechanical tolerance or individual ability, tissue damage such as inflammation or oedema will occur and thus give pain. Adaptation to a load might happen to some individual which will expose themselves to greater load. Repetitive loading might strengthen or weaken the tissue. Symptom such as swelling and increase lubricant production in joint can lead to functional impairment that might report as work-related MSDs which can considered disability or lost (Work-Related Musculoskeletal Disorders: A Review of the Evidence, 1998)

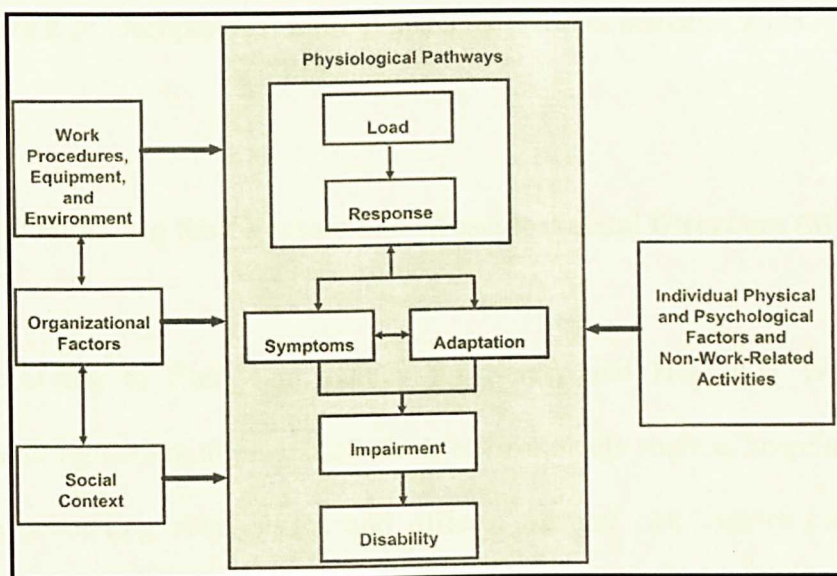


Figure 2.2: Physiological pathway to MSDs

2.4 Prevalence of Musculoskeletal Disease

Based on Socso Annual Report (2014), numbers of cases of occupational diseases were increasing drastically from 2005 with 194 cases until 2014 had reached 3002 cases. Apart from that, 675 cases in 2014 were related to occupational musculoskeletal diseases.

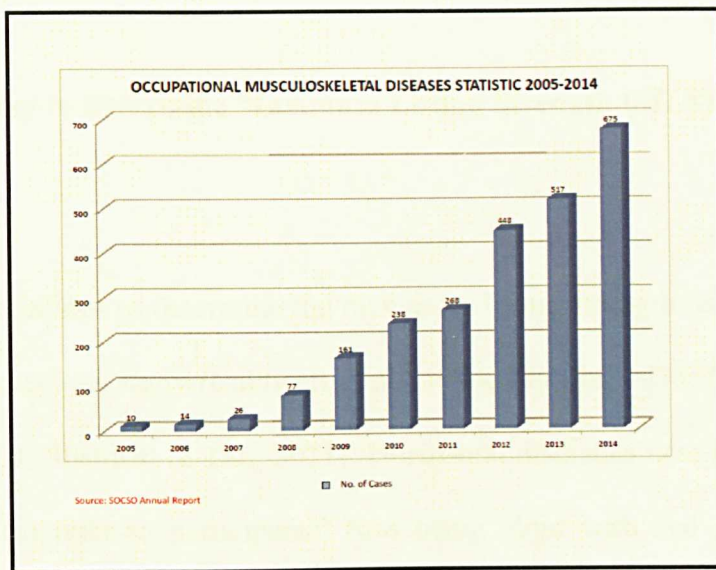


Figure 2.3: Occupational musculoskeletal diseases statistics 2005 – 2014

2.5 Manual Handling Risk Factors and Musculoskeletal Disorders (MSDs)

According to European Agency for Safety and Health at Work (2013), manual handling occurs in almost all work environments such as hospital, factories, warehouses, building sites, farms and offices. Several risk factors make manual handling of loads hazardous and increase the risk of musculoskeletal injury. Five main categories of risk factors that contribute to back pain which are the load, task, work environment, organisational and psychosocial factors and individual and lifestyle factors. Multiple risk factors present at the same time will increase the risk of MSDs. Studies on physical therapists shown incident rate of MSDs was 20.7%. Factors that increase the risk included patient transfers, patient repositioning, bent or twisted postures, joint mobilization, soft tissue work and job strain (Campo, Weiser, Koenig & Nordin, 2008).

2.6 Methodology to Determine Maximum Lifting Strength (MLS)

The procedures to determine the maximum lifting strength have already been developed by previous study (Caldwell et al., 1974; Chaffin, 1975; Mital & Kumar, 1998; Lee, 2004; Shamsul & Tan, 2011). Horizontal distances near (align with) and far (posterior to) refer to participants' toes being align with and posterior to the vertical plane of the handle bar respectively as depicted in Figure 2.4. The one-fourth foot length for male and female participants is set according to the respondents' mean anthropometrical data.

The four lifting types were set and assessed according to the respondents' height as shown in Figure 2.5. Back lifting was characterized with two hands approximately at knee height and in stoop posture. Upper-body lifting was characterized with respondents stood erect with back, legs and elbow straight and placed two hands in front of the body at knuckle height. Arm lifting was characterized with respondents stood erect with back and legs straight and kept forearms horizontal. Shoulder lifting was characterized with respondents stood erect with back and legs straight and two elbows fully flexed in front of the body.

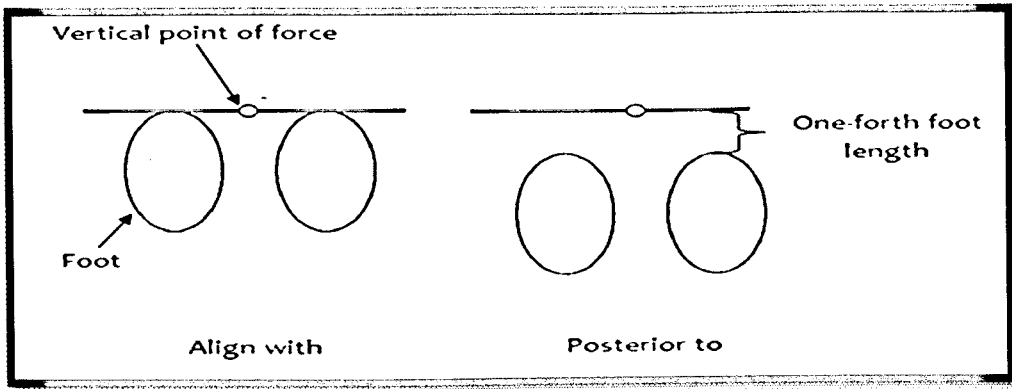


Figure 2.4: Two different horizontal distances

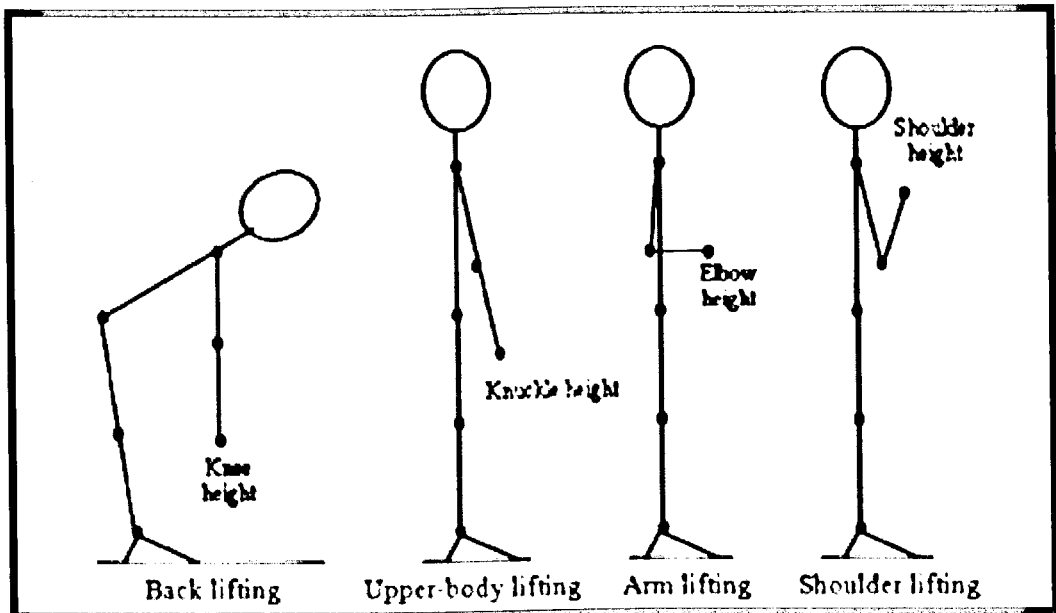


Figure 2.5: Lifting types

2.7 Methodology to Determine Maximum Acceptable Weight to Lift (MAWL)

Determined based on the “self-adjustment of weight method” used by Ciriello and Snook (1983). Instruments used were a box filled with loads by respondents until the weight was maximum for them can handle for 8 hours per day without perceiving any strain, overexertion, discomfort, tiredness, weakness or breathlessness (Snook & Ciriello, 1991).

2.8 Lifting and Gender

Lindbeck and Kjellberg (2001) had revealed that there are significant differences between men and women in several lifting parameters. This makes it reasonable to assume that movement patterns and the performance of a lift may be gender related. The majority of the countless lifting studies in the literature are on male participants and it is uncertain whether results can be extrapolated to be valid for women. Existing gender differences in anthropometrics and strength may explain differences in some variables even if precautions were taken to avoid such influences for example by using different box weights and by adjusting the height or horizontal distances of objects to be lifted. This finding was in agreement with previous study which is Cheng and Lee (2005). On recent study by Shamsul and Tan (2011) also found that women's lifting strength was much lower than men's with ranging from 56% to 72%.

2.9 Lifting and Body Mass Index (BMI) Ratio

According to study by Miyatake et al. (2000) found that muscle strength of obese was higher than that of normal BMI respondents. In addition, another study showed that there was a decrease in aerobic fitness and an increase in maximal static handling strength among adolescents and may have been due to increased body weight and BMI (Westersahl et al., 2003). Therefore, in this study there will be high

expectation that overweight participants have more ability to exert higher lifting strength compared to participants with underweight and normal BMI.

2.10 Lifting and Lifting Types / Vertical Distances

According to Lee (2004) also recommended that hand should place at higher position than back lifting position to lessen the lumbar strain. The result from Shamsul and Tan's (2011) study also showed that upper-body lifting has the highest reading. The strength of novice workers during lifting towards body consistently decreased with increased height of lifting (Chen, Lee & Chen, 2011).

2.11 Lifting and Horizontal Distances

Ciriello (2003) reported that maximum acceptable weight to lift was decrease with extended horizontal reach compared to lifting close to the body. Lifting strength decreased significantly as the toe position shifted from anterior to posterior of vertical plane of exerted handle. Beside, the strength between back and upper-body lifting also dependent on horizontal distance of object to be lifted (Cheng and Lee, 2005).

CHAPTER THREE

METHODOLOGY

3.1 Study Design

It was a cross sectional experimental study to determine the maximum lifting strength and maximum acceptable weight for lifting among young adults of undergraduate students in Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. This study was designed to enhance knowledge of the effects of different gender, body mass index (BMI), horizontal distances and vertical height on human lifting strength and their comfortability.

3.2 Study Location

This study was conducted at Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

3.3 Sampling

3.3.1 Sampling Population

The study population of the study was all male and female undergraduate students in Universiti Putra Malaysia.

3.3.2 Sampling Frame

The sampling frame of the study was the list of all registered undergraduate students of Faculty of Medicine and Health Sciences.

3.3.3 Sampling Unit

The sampling unit in this study was an undergraduate student of Faculty of Medicine and Health Sciences that will be selected based on inclusive criteria.

3.3.4 Inclusive Criteria

The inclusive criteria in this study include:

- Malaysian
- Age range is between 19 – 25 years old.
- No medical records on orthopaedic and cardiovascular problems.

3.4 Sampling Method

This study applied a non-probability sampling which is purposive sampling to fulfil with the inclusive criteria population in Faculty of Medicine and Health Sciences.

3.5 Sampling Size

One-sample calculation was used.

$$n = \frac{\sigma^2 [Z_{1-\alpha} + Z_{1-\beta}]^2}{[\mu_0 - \mu_a]^2}$$

Where,

n = sample size

σ = standard deviation

$Z_{1-\alpha}$ = 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 = 0.84)

μ_0 = larger mean

μ_a = smaller mean

(Source: Lemeshow, S., Hosmer, D. K., Klar, J., & Lwanga, S. K. (1990). *Adequacy of Sample Size in Health Studies*. England: John Wiley & Sons Ltd.)

According to previous study on static lifting strength in different lifting postures (Shamsul and Tan, 2011), the mean for the maximum isometric lifting strengths are decrease from 47.1 kg to 43.8 kg with standard deviation 9.6 kg as increase in horizontal distance.

Therefore,

$$n = \frac{9.6^2 [1.96 + 0.84]^2}{(47.1 - 43.8)^2}$$
$$= 66.35 \approx 67$$

$$20\% \text{ of } 67 = 13.4 \approx 14$$

$$67 + 14 = \mathbf{81 \text{ respondents}}$$

The minimum sample size is 67 respondents. An additional 20% of minimum size was included to sum up a total of 81 respondents.

3.6 Data Collection and Study Instrumentation

3.6.1 Instrumentation

a) Arm, Back & Leg Dynamometer

This instrument was used to measure the strength of the back, legs and arms by recording the maximum reading in kilogram (kg). This dynamometer provides a base for footing, a large and easy-to-read LCD screen and adjustable hand grip chain to accommodate height differences.



Figure 3.1: Arm, back & leg dynamometer

b) Seca Body Meter and Seca Body Weight Scale

Seca Body Meter was used to measure the height of respondent while Tanita Weighing Scale was used for measuring the weight. Both measurements were calculated for body mass index (BMI) of respondents.



Figure 3.2: Seca body meter & Seca body weight scale

3.6.2 Method

a) Subjects

Name list of the undergraduate students were obtained from Bahagian Hal Ehwal Pelajar, Faculty of Medicine and Health Sciences. Purposive sampling was used to choose the sampling unit according based on inclusive criteria. The criteria

were examined by taking their height and weight measurements for BMI and medical history.

b) Experimental Workstation

This study was to examine the maximum lifting strength and maximum acceptable weight for lifting in four lifting types (back lifting, upper-body lifting, arm lifting and shoulder lifting) across two horizontal distances (toes are align with and posterior to the exerted handle bar). So basically there were two sessions in this study.

For the first session was to determine the maximum lifting strength have already been developed by previous study (Caldwell et al., 1974; Chaffin, 1975; Mital & Kumar, 1998; Lee, 2004; Shamsul & Tan, 2011). A digital arm, back & leg dynamometer provides with a base for footing, a large and easy-to-read LCD screen to measure subjects' lifting strength in kilogram (kg). Two handed handle bar is use for exertion in this study. The diameter for the two handed handle bar is approximately 3.5cm. A steel chain is use to connect the handle bar with the load cell and adjust the handle bar at the different lifting types.

The horizontal distance in this study was different in distance from the toes to the vertical plane of the handle bar which namely as align with (near) and posterior to (far) as depicted in Figure 3.3. Horizontal distances near and far refer to participants' toes being align with and posterior to the vertical plane of the handle

bar respectively. The one-fourth foot length for male and female participants is set according to the respondents' mean anthropometrical data.

The four lifting types were set and assessed according to the respondents' height as shown in Figure 3.4 to 3.7. Back lifting was characterized with two hands approximately at knee height and in stoop posture. Upper-body lifting was characterized with respondents stood erect with back, legs and elbow straight and placed two hands in front of the body at knuckle height. Arm lifting was characterized with respondents stood erect with back and legs straight and kept forearms horizontal. Shoulder lifting was characterized with respondents stood erect with back and legs straight and two elbows fully flexed in front of the body.

For the second session was to determine the maximum acceptable weight for lifting. Basically the experimental was quite similar with the first session which is still considering four types of lifting with two horizontal distances refer to Figure 3.8 until Figure 3.11. But the different in this second session was determined based on the "self-adjustment of weight method" used by Ciriello and Snook (1983). Instruments used were a box filled with loads by respondents until the weight was maximum for them can handle for 8 hours per day without perceiving any strain, overexertion, discomfort, tiredness, weakness or breathlessness (Snook & Ciriello, 1991).

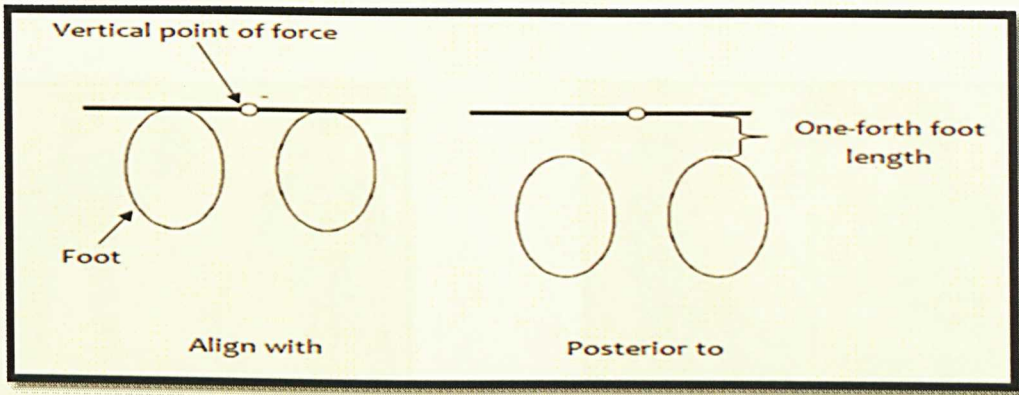


Figure 3.3: Two different horizontal distances



Figure 3.4: Back lifting



Figure 3.5: Upper-body lifting



Figure 3.6: Arm lifting



Figure 3.7: Shoulder lifting



Figure 3.8: Back lifting



Figure 3.9: Upper-body lifting

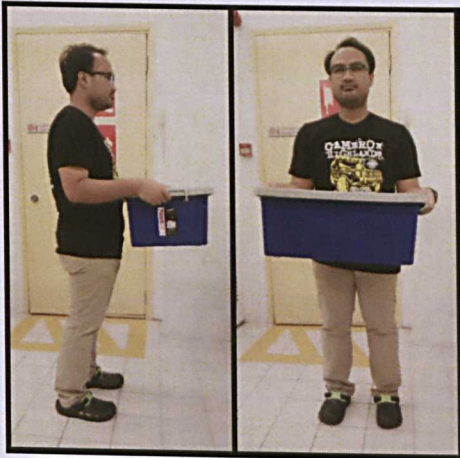


Figure 3.10: Arm lifting



Figure 3.11: Shoulder lifting

c) Quality Control

Subjects were given a standardized demonstration of the strength testing postures and procedures. They were also allowed to practice for familiarizing themselves with the strength testing postures and procedures before the formal experiment. Subjects were performed all eight lifting conditions (two horizontal distances x four lifting types) in a random order. Subjects were needed to do in bare

feet set parallel and exerting as hard as they could with their maximum voluntary efforts on the handle without jerking and maintained the maximal exertion for about 4 seconds. They were given at least two minutes rest between the tests. Each subject was needed to do in three attempts for all eight lifting tasks and the highest reading was measured. However, the second session test was conducted on the next day to eliminate any potential fatigue effects. No direct strength data feedback to subjects and absent of spectators to prevent isometric strength data contamination (Cheng and Lee, 2005).

d) Flowchart of Study Method

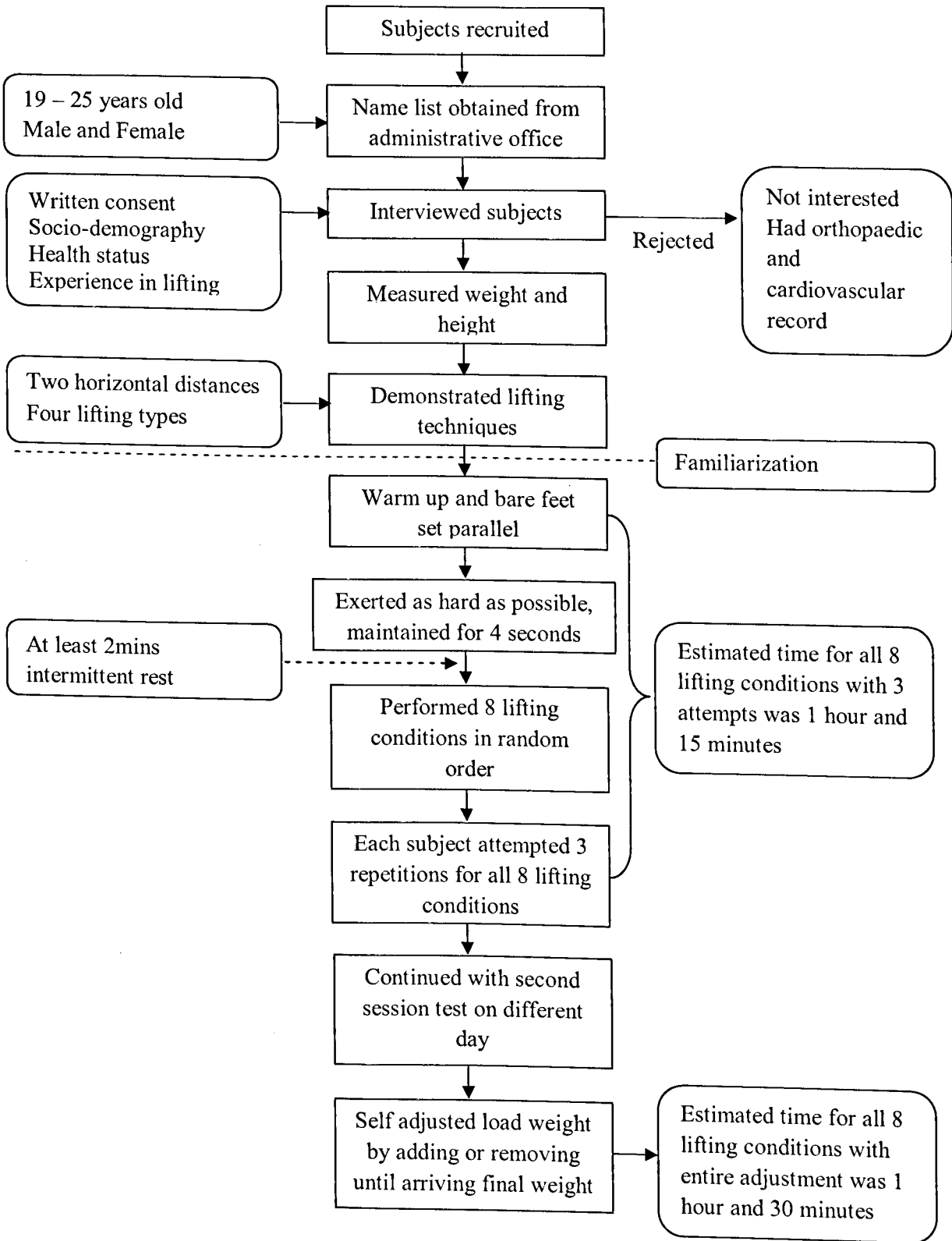


Figure 3.12: Procedures summary

3.7 Data Analysis

After considering Kolmogorov Smirnov test, skewness and outliers, the data were found that significantly different from normally distributed which means not normally distributed. So that, non-parametric test was used in this study.

Table 3.1: Data analysis

No.	Hypothesis	Non-parametric Test
1	There is significant difference between maximum lifting strength and maximum acceptable weight for lifting	Wilcoxon signed rank test
2	There is significant difference between male and female in lifting strength	Mann Whitney-U test
3	There is significant difference between male and female in acceptable weight to lift	Mann Whitney-U test
4	There is significant difference between underweight, normal and overweight BMI in lifting strength	Kruskal-wallis
5	There is significant difference between underweight, normal and overweight BMI in acceptable weight to lift	Kruskal-wallis
6	There is significant difference between lifting strength of four lifting types with two horizontal distances	Friedman statistics
7	There is significant difference between maximum acceptable weight to lift of four lifting types with two horizontal distances	Friedman statistics

3.8 Study Ethics

The Board of Ethics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia had given the permission to study of “Developing Recommended Standard for Acceptable Weight for Lifting Activities among Young Adults” where it did not involved any ethical issue.

CHAPTER FOUR

RESULT & DISCUSSION

4.1 Study background and selection of respondents

Data collection was started from 18th January 2016 until 4th March 2016 (7 weeks). A total of 72 respondents were recruited from Faculty of Medicine and Health Sciences to represent as young adult ages by using purposive sampling. There is no drop out respondents (100% response rate) in this study as all respondents had been chosen first by the inclusion criteria. From 72 respondents, 34 male and 38 female undergraduate students participated in this study. In term of body mass index (BMI), 20 respondents were underweight ($<18.5 \text{ kg/m}^2$), 28 normal BMI respondents ($18.5 - 24.9 \text{ kg/m}^2$) and 24 of them were overweight ($>25 \text{ kg/m}^2$). Each respondent was needed to undergo two session measurements which are lifting strength and acceptable weight to lift.

4.2 Demographic data of respondents

The average age of all 72 respondents in this study were 23.18 ± 0.92 . The average height of male respondents were 169.0 ± 5.0 cm and female respondents were 157.5 ± 5.2 cm. The average weight of male respondents were 66.2 ± 14.0 kg and female respondents were 55.7 ± 13.8 kg. The average body mass index (BMI) for male respondents were 23.06 ± 4.23 kg/m² and female respondents were 22.41 ± 5.33 kg/m².

Table 4.1: Demographic data of respondents (N = 72)

Demographic	Frequency (%)
Gender	
Male	34 (47.2)
Female	38 (52.8)
Body mass index	
Underweight	20 (27.8)
Normal	28 (38.9)
Overweight	24 (33.3)

4.3 Comparison of Lifting Strength and Acceptable Weight to Lift

Upper-body lifting type shows the highest lifting strength followed by back, shoulder and arm lifting. For maximum acceptable weight to lift, also upper-body lifting type give the highest weight can be lifted followed by back, arm and shoulder lifting. Both maximum strength and maximum acceptable weight to lift show near horizontal distance (align with) are higher than far horizontal distance (posterior to).

All maximum lifting strength in four lifting types across two horizontal distances are significantly higher than maximum acceptable weight to lift ($p < 0.001$). However, recommended that lifting use acceptable weight limit compared to maximum weight limit. Through the observation, none of the respondents could be lifted weight even nearly to their maximum strength. According to Mital, Kilbom and Kumar (2000), the low correlation between strength and lifting capability of individual did not permit the development of reliable and accurate lifting capability prediction model. The main reason and has been confirmed by many researchers the static strengths are failed to take into account for inertial forces resulting from the movement of the object and body segment.

The result for this first objective shows that all maximum lifting strength in four lifting types across two horizontal distances are significantly higher than maximum acceptable weight to lift ($p < 0.001$). Therefore, the first hypothesis in this

study which is there is significant different between maximum lifting strength and maximum acceptable weight to lift is not rejected.

Table 4.2: Comparison of maximum lifting strength and maximum acceptable weight to lift

Lifting Type – Horizontal Distance	Median (IQR)		Mean Rank	W	p-value*
	Maximum Strength (N = 72)	Maximum Acceptable (N = 72)			
Back – Align with	51.25 (42.25)	14.25 (7.50)	0.00 ; 36.50	-7.37	<0.001
Back – Posterior to	42.50 (30.25)	11.50 (6.25)	0.00 ; 36.50	-7.37	<0.001
Upper- body – Align with	53.50 (39.63)	14.50 (8.50)	0.00 ; 36.50	-7.37	<0.001
Upper- body – Posterior to	48.25 (28.63)	10.50 (6.19)	0.00 ; 36.50	-7.37	<0.001
Arm – Align with	31.00 (23.63)	12.50 (6.81)	0.00 ; 36.50	-7.38	<0.001
Arm – Posterior to	28.25 (14.00)	8.75 (6.94)	0.00 ; 36.50	-7.38	<0.001
Shoulder – Align with	34.00 (15.25)	11.25 (6.38)	0.00 ; 36.50	-7.38	<0.001
Shoulder – Posterior to	30.00 (14.88)	7.13 (5.00)	0.00 ; 36.50	-7.38	<0.001

*p-value significant at 0.05 level

4.4 Comparison of Lifting Strength and Acceptable Weight to Lift between Male and Female Respondents

Many previous studies had similar result with this study. According to Lemmer, Martel, Hurlbut and Hurley (2007), gender effect showed both men and women increased strength with the 24 weeks of training. However, upper-body exercises were resulted a greater increase in strength and shoulder press in men compared with women. For lower body exercises, men showing greater increased in strength for both leg press and knee extension machines. Thus, in that study showed that men compared with women demonstrated a greater increase in absolute total body score with training.

In other study, gender was found to be statistically significant with male participants reported larger maximum acceptable weight to lift (MAWL) than the female participants. The mean MAWL of the male and female participants were 22.2 kg and 15.9 kg respectively (Singh, Park and Levy, 2009). Similar study in static lifting strength by Shamsul and Tan (2011) also showed a significant difference in men's and women's lifting strength in all lifting condition. They reported that range of static lifting strength ratio for females to males were able to exert are about 56% to 72%.

The reason of higher strength of male lifting could be explained by previous finding on human muscle properties. Generally, males muscles are known to have a

higher capacity for anaerobic metabolism and generate a higher maximum power output than female muscles (Hakkinen, 1993; Linnamo et al., 1998; Fulco et al., 1999; Singh, Park & Levy, 2009). Study by Miller et al. (1993) explained that strength in male was due primarily to larger muscle fibers. The greater gender difference in upper body strength can attribute the fact that women tend to have lower proportion of lean tissue distributed in the upper body.

The results showed that there is significant higher for both in lifting strength and acceptable weight to lift among male respondents compared to female respondents in all lifting types across two horizontal distances. Thus, the second and third hypothesis of the study that stated there is significant different between male and female in lifting strength and acceptable weight to lift also not rejected.

Table 4.3: Comparison of maximum lifting strength between male and female respondents

Lifting Type – Horizontal Distance	Median (IQR)		Mean Rank	U	p-value*
	Male (N = 34)	Female (N = 38)			
Back – Align with	84.75 (60.50)	41.25 (43.50)	23.13 ; 51.44	-5.73	<0.001
Back – Posterior to	64.50 (46.50)	34.75 (42.00)	21.72 ; 53.01	-6.34	<0.001
Upper- body – Align with	79.25 (59.00)	38.25 (47.50)	22.78 ; 51.84	-5.89	<0.001
Upper- body – Posterior to	62.00 (44.00)	34.00 (32.50)	22.42 ; 52.24	-6.04	<0.001
Arm – Align with	48.75 (77.50)	26.50 (34.00)	21.55 ; 53.21	-6.41	<0.001
Arm – Posterior to	37.50 (39.50)	23.75 (19.00)	21.03 ; 53.79	-6.64	<0.001
Shoulder – Align with	39.50 (52.00)	29.50 (33.50)	26.51 ; 47.66	-4.28	<0.001
Shoulder – Posterior to	37.00 (41.00)	26.25 (24.00)	25.54 ; 48.75	-4.71	<0.001

*p-value significant at 0.05 level

Table 4.4: Comparison of maximum acceptable weight to lift between male and female respondents

Lifting Type – Horizontal Distance	Median (IQR)		Mean Rank	U	p-value*
	Male (N = 34)	Female (N = 38)			
Back – Align with	17.50 (13.50)	11.75 (19.75)	28.95 ; 44.94	-3.24	<0.001
Back – Posterior to	14.50 (14.25)	8.88 (13.50)	26.08 ; 48.15	-4.47	<0.001
Upper- body – Align with	18.50 (15.50)	10.63 (16.25)	23.43 ; 51.10	-5.61	<0.001
Upper- body – Posterior to	13.75 (17.50)	7.50 (10.75)	22.76 ; 51.85	-5.90	<0.001
Arm – Align with	15.00 (10.50)	8.75 (11.25)	20.87 ; 53.97	-6.71	<0.001
Arm – Posterior to	12.38 (11.25)	5.50 (7.50)	21.26 ; 53.53	-6.54	<0.001
Shoulder – Align with	13.50 (10.50)	7.38 (8.25)	22.91 ; 51.69	-5.84	<0.001
Shoulder – Posterior to	10.00 (10.00)	5.00 (7.50)	22.54 ; 52.10	-6.02	<0.001

* p-value significant at 0.05 level

4.5 Comparison of Lifting Strength and Acceptable Weight to Lift between Underweight, Normal and Overweight Respondents

The sixth and seventh objective in this study is to compare the lifting strength and acceptable weight to lift between body mass index (BMI). Respondents were categorized as underweight ($<18.5 \text{ kg/m}^2$), normal ($18.5 - 24.9 \text{ kg/m}^2$) and overweight ($>25 \text{ kg/m}^2$).

There are discrepancies in studies between body mass index (BMI) with strength. According to Hulen et al., (2001) revealed that there was a low positive correlation between BMI and fat mass with strength measures but Apovian et al., (2002) reported that seems BMI did not have any association with levels of coordination or strength.

However, there also have studies that in line with this study finding. According to Singh, Park and Levy (2009) study, the mean maximum acceptable weight to lift (MAWL) of moderate and extremely obesity were not significantly different but still had significantly larger than non-obese group. The comparison between lifting strength with normal and abnormal BMI respondents showed significant difference in all lifting types and horizontal distances (Shamsul and Tan, 2011).

From biomechanical and physiological point of view found that obesity does not reduce MAWL. This is because obesity would most likely increase biomechanical and physiological stresses during lifting motions or manual activities because of the extra fat mass in the obese body. Other study found that muscle strength of obese person was higher than non-obese (Miyatake et al., 2000). Besides, there was a decrease in aerobic fitness and increase in maximal static lifting strength among adolescents and may due to increased body weight and BMI (Westersahl et al., 2003).

The result shows there are significant difference between maximum lifting strength and maximum acceptable weight to lift with BMI respondents in four different lifting types across two horizontal distances. So that, the fourth and fifth hypothesis in this study are fail to reject.

Table 4.5: Comparison of maximum lifting strength between underweight, normal and overweight respondents

Lifting Types	Horizontal Distances	Median (IQR)		χ^2 (df)	p-value*	
		Underweight (N = 20)	Normal (N = 28)			Overweight (N = 24)
Back	Align with	41.50 (29.50)	53.75 (76.50)	61.75 (58.50)	19.59 (2)	<0.001
	Posterior to	37.50 (29.00)	48.50 (64.00)	54.50 (56.50)	11.81 (2)	0.003
Upper-body	Align with	38.50 (44.50)	55.25 (81.00)	68.50 (67.50)	16.57 (2)	<0.001
	Posterior to	34.25 (38.00)	52.75 (65.00)	55.00 (63.50)	14.65 (2)	0.001
Arm	Align with	26.75 (23.00)	31.50 (83.00)	42.25 (55.00)	9.61 (2)	0.008
	Posterior to	24.00 (19.50)	27.25 (43.00)	31.50 (30.50)	6.18 (2)	0.045
Shoulder	Align with	29.25 (18.00)	31.00 (54.00)	41.75 (50.50)	13.55 (2)	0.001
	Posterior to	27.00 (17.00)	27.50 (43.50)	37.00 (46.50)	8.86 (2)	0.012

*p-value significant at 0.05 level

Post-hoc analysis (Mann-Whitney test with Bonferroni correction) show there are significant difference in median of maximum strength between underweight and overweight in all lifting types and between underweight and normal in back and upper-body lifting. There are no significant difference ($p > 0.05$) in median of maximum strength between normal and overweight in all lifting types and between underweight and normal in arm and shoulder lifting.

Table 4.6: Comparison of maximum acceptable weight to lift between underweight, normal and overweight respondents

Lifting Types	Horizontal Distances	Median (IQR)		χ^2 (df)	p-value*	
		Underweight (N = 20)	Normal (N = 28)			Overweight (N = 24)
Back	Align with	11.50 (10.00)	15.00 (17.25)	17.50 (19.75)	8.51 (2)	0.014
	Posterior to	9.25 (12.25)	11.25 (13.75)	14.88 (18.50)	12.00 (2)	0.002
Upper-body	Align with	10.63 (13.50)	15.00 (15.75)	16.63 (19.25)	13.89 (2)	0.001
	Posterior to	7.50 (12.50)	10.00 (11.25)	12.88 (18.75)	16.41 (2)	<0.001
Arm	Align with	8.75 (11.25)	12.50 (16.25)	15.00 (14.75)	10.72 (2)	0.005
	Posterior to	5.88 (8.50)	8.50 (13.25)	10.25 (14.00)	9.87 (2)	0.007
Shoulder	Align with	7.50 (7.50)	10.88 (13.25)	12.50 (12.00)	12.71 (2)	0.002
	Posterior to	5.00 (7.50)	6.25 (10.25)	9.88 (11.50)	10.11 (2)	0.006

* p-value significant at 0.05 level

Post-hoc analysis (Mann-Whitney test with Bonferroni correction) there are significant difference in median of maximum acceptable weight to lift between underweight and overweight in all lifting types, between underweight and normal in back and upper-body lifting and between normal and overweight in posterior to for upper-body and shoulder lifting. There are no significant difference in median of maximum strength between normal and overweight in all lifting types except in posterior to for upper-body and shoulder lifting and between underweight and normal in arm and shoulder lifting.

4.6 Comparison of Lifting Strength and Acceptable Weight to Lift in Four Lifting Types across Two Horizontal Distances

The eighth objective in this study is to compare the four different lifting types across two horizontal distances in maximum lifting strength and maximum acceptable weight to lift.

From the findings, the highest to lowest order for maximum lifting strength in four lifting types were upper-body lifting, back lifting, shoulder lifting and arm lifting. Meanwhile, for maximum acceptable weight to lift in four lifting types from highest to lowest order were upper-body lifting, back lifting, arm lifting and shoulder lifting. Lifting types significantly determined the vertical location of the hand and lifting strength. The vertical location of the hand is one of the main factors in NIOSH lifting equation in which a height of 75cm (upper-body lifting) suggested to be the

highest lifting strength. According to Lee (2004), even though his study recognized 45cm (back lifting) as the highest strength, he recommended that hand should place at higher position to lessen the lumbar strain.

The order for horizontal distances for both maximum strength and acceptable weight were near horizontal distance (align with) and far horizontal distance (posterior to). This finding was in agreement with Ciriello (2003) reported that maximum acceptable weight to lift was decrease with extended horizontal reach compared to lifting close to the body. As shown by NIOSH lifting equation (1994), horizontal distance also as one of the main factors in estimating the relative risk of lifting heavy load. Lifting with near horizontal distance (align with) will give more strength because the body's centre of gravity will be closer and thus lesser the shoulder angle in upper extremities (Cheng and Lee, 2005).

The result shows that all different types of lifting are significantly difference across the two horizontal distances in both maximum lifting strength and maximum acceptable weight to lift. Therefore, for the last hypothesis in this study also fail to reject.

Table 4.7: Comparison of maximum lifting strength in four lifting types across two horizontal distances

Horizontal Distance	Lifting Types	Median (IQR)	Mean Rank	χ^{2F} (df)	<i>p</i> -value*
Align with	Back	51.25 (42.25)	3.53	134.91 (3)	<0.001
	Upper-body	53.50 (39.63)	3.21		
	Arm	31.00 (23.63)	1.58		
	Shoulder	34.00 (15.25)	1.68		
Posterior to	Back	42.50 (30.25)	3.35	127.56 (3)	<0.001
	Upper-body	48.25 (28.63)	3.35		
	Arm	28.25 (14.00)	1.47		
	Shoulder	30.00 (14.88)	1.83		

**p*-value significant at 0.05 level

Post-hoc analysis (Wilcoxon test with Benferroni correction) there are significant difference between back and arm lifting, back and shoulder lifting, upper-body and arm lifting and upper-body and shoulder lifting in both horizontal distances. The back and upper-body lifting is shown no significant differences.

Table 4.8: Comparison of maximum acceptable weight to lift in four different lifting types across two horizontal distances

Horizontal Distance	Lifting Types	Median (IQR)	Mean Rank	χ^{2F} (df)	<i>p</i> -value*
Align with	Back	14.25 (7.50)	3.05	93.28 (3)	<0.001
	Upper-body	14.50 (8.50)	3.22		
	Arm	12.50 (6.81)	2.34		
	Shoulder	11.25 (6.38)	1.40		
Posterior to	Back	11.50 (6.25)	3.44	143.34 (3)	<0.001
	Upper-body	10.50 (6.19)	3.20		
	Arm	8.75 (6.94)	2.13		
	Shoulder	7.13 (5.00)	1.22		

**p*-value significant at 0.05 level

Post-hoc analysis (Wilcoxon test with Benferroni correction) there are significant difference between back and arm lifting, back and shoulder lifting, upper-body and arm lifting and upper-body and shoulder lifting in both horizontal distances and back and upper-body lifting in posterior to horizontal distance.

CHAPTER FIVE

CONCLUSION

5.1 Conclusion

This study had shown that the maximum lifting strength is higher than maximum acceptable weight to lift in all lifting types across two horizontal distances. However, recommended that lifting should use acceptable weight limit compared to maximum weight limit.

The result in this study revealed that gender had given significant difference. Male respondent had a significantly higher than maximum lifting strength and maximum acceptable weight to lift compared to female respondent for all types of lifting and horizontal distances.

Body mass index (BMI) also reported has significant difference in this study. Respondent with higher BMI ($>25 \text{ kg/m}^2$) have significantly higher maximum lifting strength and maximum acceptable weight to lift compared to underweight (<18.5

kg/m²) and normal BMI (18.5 – 24.9 kg/m²) in all lifting types across two horizontal distances.

The result in this study also showed that all different types of lifting are significantly difference across the two horizontal distances in both maximum lifting strength and maximum acceptable weight to lift. The study showed that the maximum weight lifted and acceptable weight for lifting is at upper-body compared to back, arm and shoulder lifting with the near horizontal distance (toes align with).

Lastly, suggested that the recommended standard for acceptable weight for lifting activities among young adults from this study is as follow:

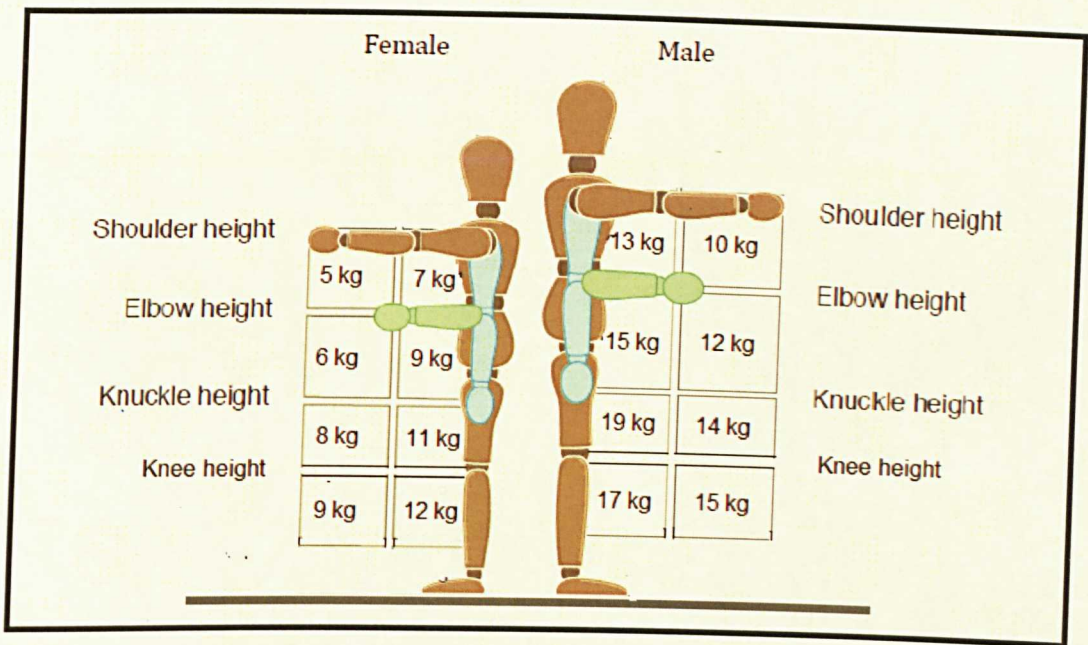


Figure 5.1: Recommended standard for lifting activities

5.2 Limitation and recommendation for future study

This cross-sectional experimental study was done only at Universiti Putra Malaysia. It cannot be generalised towards all young adults in Malaysia. Therefore, further study need to be conducted at any other various places to get more significant standard for acceptable weight for lifting activities that can be use throughout this country.

The discrepancy between in this study and other studies should need further discussed and explored. This study performed only took variables such as gender, body mass index (BMI), lifting types and horizontal distances. There are still some other variables that need to be in further consideration such as the frequencies of lifting, size and handling position of the box that to be lifted.

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APPENDIX I:

Ethical Approval from The Board of Ethics, Faculty of Medicine and Health
Sciences, Universiti Putra Malaysia.

APPENDIX II:

Respondent's Information Sheet and Consent



UPM
UNIVERSITI PUTRA MALAYSIA

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

FORM B1: RESPONDENT'S INFORMATION SHEET AND CONSENT

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE

Developing a Recommended Standard for Acceptable Weight for Lifting Activities among Young Adults.

2. INTRODUCTION

This study act as pilot study that aims to develop a recommended standard for acceptable weight for lifting activities. In order to do that, this study needs to determine the maximum lifting strength and maximum acceptable weight to lift.

3. WHAT WILL YOU HAVE TO DO?

Respondent needs to undergo two experimental sessions. Both sessions need the respondent to two-handed exertions in four lifting types (back lifting, upper-body lifting, arm lifting and shoulder lifting) across two horizontal distances (toes aligned with and posterior to the exerted handle). Total of eight lifting tasks will be perform each session.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

- a) Other than Malaysian.
- b) Age below 19 and above 25 years old.
- c) Have medical records on orthopaedics and cardiovascular problems.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

Subject will contributing data in determination of maximum lifting strength and maximum acceptable weight for lifting that will be used to develop recommended standard for acceptable weight for lifting activities.

(b) TO THE INVESTIGATOR?

Data collected can be used in developing recommended standard for acceptable weight for lifting activities.

Please initial here if you have read and understood the contents of this page 1 – 2.

9. CONSENT

I Identity Card No.
address.....
.....hereby voluntarily agree to take part in the research stated
above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature Signature
(Respondent) (Witness)
Date : Name :
I/C No. :

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date Signature
(Researcher)

Respondent:

Height:

Weight:

BMI:

First Session: Determination of Maximum Lifting Strength

Lifting Types	Align with (near)	Posterior to (far)
Back lifting		
Upper-body lifting		
Arm lifting		
Shoulder lifting		

Second Session: Determination of Maximum Acceptable Weight to Lift

Lifting Types	Align with (near)	Posterior to (far)
Back lifting		
Upper-body lifting		
Arm lifting		
Shoulder lifting		