



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Ergonomics: A study of lifting device for palm fruit bunch

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ABSTRACT

This report is about a study in ergonomics. Ergonomics is a study field on human factors like biomechanics, work physiology, and stress and workload. This report is more concentrated in biomechanics that involve the low-back pain in lifting. This is because, the workers in the palm fruit palm always exposed to the low-back pain. The study goes on with the information searching on how a heavy lifting will affect to the low-back pain. The low-back pain seldom will affect the joint between the last lumbar vertebra and the first sacral vertebra also called L5/S1 in the human spinal because of the heavy lifting activities. Then, using a method in ergonomics, the force of heavy lifting is calculated and analyzed to determined whether the load that been lifted is suitable and not affect the human healthy by using several law and parameters given.

Study in ergonomics is important to improve human healthy and safety not only in the workplace, but also in house, factory, construction area and etc. Other than that, ergonomics also is been used to design a product that suits all the gender, ages, height, weight and people background by using the data that have been collected. The data than be analyzed and used to design a product that can suits and comfortable for most people. In this project, the data that will be collected is also will be used to design a lifting devices for palm fruit bunch.

ABSTRAK

Thesis ini menerangkan tentang kajian mengenai cara mengangkut kelapa sawit menggunakan alat mengangkut kelapa sawit dari sudut ergonomic. Kajian ini adalah berkaitan mengenai biomekanik, psikologi pekerjaan, daya, dan beban pekerjaan. Thesis ini lebih menumpukan kepada daya yang dialami oleh pekerja-pekerja lading kelapa sawit semasa menggunakan alatan mengangkut kelapa sawit didalam proses menaikkan kelapa sawit ke dalam lori. Kajian seterusnya diteruskan dengan mengkaji bagaimana perbuatan mengangkut tersebut boleh menyebabkan sakit belakang badan (tulang L5/S1). Data ergonomic yang dikutip digunakan untuk menganalisis samaada ia adalah selamat ataupun merbahaya menggunakan panduan mengangkut barangan NIOSH.

Kajian didalam ergonomic ini adalah bertujuan untuk meningkatkan lagi keselamatan dan kesihatan pekerja di tempat kerja mereka. Data yang dikutip juga adalah bertujuan untuk mereka barangan ergonomik yg boleh disesuaikan kepada semua pekerja.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Ergonomics (from the Greek word *ergon* meaning *work*, and *nomoi* meaning *natural laws*), is the science of refining the design of products to optimize them for human use. Human characteristics, such as height, weight, and proportions are considered, as well as information about human hearing, sight, temperature preferences, and so on. Ergonomics is the study of human characteristics for the appropriate design of the living and working environment. Ergonomic researchers strive to learn about human characteristics (capabilities, limitations, motivations, and desires) so that this knowledge can be used to adapt a human-made environment to the people involved. This knowledge may affect complex technical systems or work tasks, equipment, and workstations, or the tools and utensils used at work, at home, or during leisure times. Hence, ergonomics is human-centered, transdisciplinary, and application-oriented.[5]

Ergonomics is sometimes known as human factors engineering. Human factors is the study of how humans behave physically and psychologically in relation to particular environments, products, or services. The study on human factors than can make the products that will suits human physically. Design begins with an understanding of the user's role in overall system performance and that systems exist to serve their users, whether they are consumers, system operators, production workers, or maintenance crews. This user-oriented design philosophy acknowledges human variability as a design parameter.

The main goal of ergonomics is to make work safer that can increase human efficiency and the purpose of creating human well-being.[1]

1.2 Objectives

- To study the human factors study and analysis
- Identify the problem arise in palm fruit bunch lifting device
- Overcome the problem with a design

1.3 Scope of Study

The scope of the study will involve the understanding of human factors and find the cause of the low back pain among the workers in palm fruit farm. This is because the worker is not exposed to the ergonomic study and environment. The study will involve the study of human lifting posture that can cause the low back pain that related to biomechanics of work. After that, this study will continue with taking and analyzing ergonomics data.

1.4 Problem Statement

Normally workers and operators that involving heavy lifting will experienced the low back pain and this problem also been faced by the workers in palm fruit farm since long time ago. This is because they have to lift the palm fruit by themselves without using any device and safety equipment and the longer the time they work in this industries, the higher risk for them to get severe low back pain. The wrong of lifting posture also will affect to low back pain because a bunch of palm fruit is not a light weight for normal people to lift it. Although the palm fruit farm workers are provided with palm fruit lifting device, the device is not well design and can cause low back pain. The palm fruit farm workers should be introducing to the ergonomics study so they can practice healthier life.

CHAPTER 2

LITERATURE REVIEWS

2.1 Introduction to Palm Fruit Lifting Device

Palm fruit lifting device or normally called 'pemungkas' or 'dodos' among the palm fruit farm workers is a device that they use to lift the palm fruit bunch into a carrier truck. The device seems similarly to spear or sickle is been joint to an iron pipe or wood stick. The diameter of the palm lifting device holder is normally 4cm and the length is 1.5m long. To lift a palm fruit bunch, the workers will stab the palm fruit bunch using the device and swing it up into a carrier truck. This job is conventional and requires a lot of energies and besides, this stabbing and swinging action will somehow affect their back because of the forces and loads that bears to their body.



Figure 1: A farm worker lift a palm fruit bunch into a carrier truck

2.1.1 Effect of Lifting Palm Fruit bunch Activity

Palm fruit bunch lifting activity is considered as a very heavy task compared to the other tasks in the palm fruit farm. This is because of the load of the palm fruit bunch itself. A bunch of palm fruit load can reach up to 25 kilograms or more. A worker must lift a heavy palm fruit into a carrier truck that is 2 meters or more high. To lift such a heavy load to reach that height, it requires a lot of energy while the task is repetitive and monotonous. Because the heavy lifting activity is done repetitively, the worker's body will slowly receive the effects of their actions. First, they will undergo fatigue and lose a lot of energy. This fatigue will not be cured by resting all night, but it will continually affect their body until they are used to the work. Besides that, for a new worker, it is easy to feel exhausted and get pains in the shoulder, arms, and hands and any other health problems. And finally, for an experienced worker, they will get severe backaches. This backache is caused by their spine and more specifically the fifth lumbar and the first sacral vertebrae (called the L5/S1 lumbosacral disc). This case usually happens to industrial and farm workers whose jobs are related to lifting heavy materials and require them to squat, bend, kneel, and twist [13]. Some of the serious cases are when their L5/S1 has been discovered to have fractures.

2.1.2 Heavy Lifting Activity

Palm fruit farm work is hard work, and farm workers feel the results. Farm workers get backaches and pains in the shoulders, arms, and hands more than any other health problem. A third of the injuries that cause them to miss work are sprains and strains, and a quarter are back injuries. These are also the most common causes of disability [13]. Most of the palm fruit work requires them to lift the heavy palm fruit bunch using or without using a lifting device. This job has to be done to complete the quotation target that has been given to them.



Figure 2: A job in the palm fruit farm that requires heavy lifting

Below is the basic process flow of collecting the palm fruit bunch in the farm:

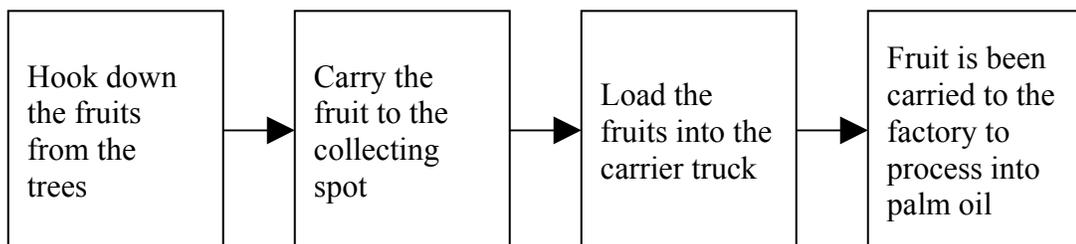


Figure 3: Palm fruit farm activity [14]

All the activity above, is consider as a risky activity that might cause them injury. The loading activity is consider as the most risky task because it requires workers to lift the palm fruit into the carrier truck using a hand made lifting device. Initially, the palm fruit lifting device is not designed by any designer, it is been used by all the workers in palm fruit farm all over the world [14]. The main purpose of the lifting device is to lift the palm fruit bunch as higher as it can to load it into the truck and

arranged the palm fruit position. The design of the lifting device was neglect the workers safety and health.



Figure 4: Palm fruit bunch lifting device is also used to arrange the fruits position

2.2 The musculoskeletal system

The musculoskeletal system is composed of the bones, muscles, and connective tissues, which includes ligaments, tendons, fascia, and cartilage. Bone can also be considered a connective tissue. The main function of the musculoskeletal system are to support and protect the body and body parts, to maintain posture and produce body movement, and to generate heat and maintain body temperature [10].

2.2.1 Bones and Connective Tissues

There are 206 bones in a human body, and they form the rigid skeletal skeletal structure, which plays the major supportive and protective roles in the body. The skeleton establishes the body framework that holds all other body parts together. Some bones protect internal organs from the outside. Some bones, such as the long bones of the upper and lower extremities, work with the attached muscles to support body movement and activities.

Each of the other four types of connective tissues has its own special functions. Tendons are dense, fibrous connective tissues that attached muscles to bones and transmit the force exerted by the muscles to the attached bones. Ligaments are also dense, fibrous tissues, but their function is to connect the articular extremities of bones and help stabilize the articulations of bones at joints. Cartilage is a translucent elastic tissue that can be found on some articular bony surfaces and in some organs, such as the nose and the ear. Fascia covers body structures and separates them from each other.

Bones change their structure, size, and shape over time as a results of the mechanical loads placed on them. There are suggestion that bones are deposited where needed and resorbed where not needed. However, the precise relationships between bone changes and mechanical loads remain unknown. More important, it should be realized that bones can fracture when they are exposed to excess or repetitive loading in the form of bending forces, torsional forces, or combined forces. The amount of load, the number of repetitions, and the frequency of loading are the three the most important factors that can cost the bone fracture. Further, bone is capable of repairing small fracture if adequate recovery time is given. Thus, the repetitions rate of manual exertions or the recovery period after exertions can become significant factors. Connective tissues may also be damaged after excessive or repeated use. For examples, heavy loads may increase tension in tendons and cause tendon pain. Excessive tendon uses also cause inflammation of tendons.[1]

2.2.2 Anatomy of the Spine

The vertebral column contains four distinct curves: the cervical, thoracic, lumbar, and sacral curves. The cervical vertebrae function to support and move the head. The thoracic vertebrae articulate with the ribs, which in turn make up the ribcage and also support the thorax, head, and neck. The large lumbar vertebrae are the foundation for attachments of muscles, and form a curve at the onset of walking in childhood. The sacrum, consisting of five fused vertebrae, joins with the ilium of the hip bone to create the sacroiliac joint. The fused coccyx attached to the lower end of the sacrum is commonly referred to as the tailbone. Each vertebra is made up of a body and a vertebral arch, which together form a passageway for the spinal cord.[11]

The vertebral column consists of 33 vertebrae separated into 5 distinct regions: 7 cervical vertebrae, 12 thoracic vertebrae, 5 lumbar vertebrae, 5 fused sacral vertebrae, and 4-5 fused coccygeal vertebrae. Vertebrae are held together by ligaments that function to provide stability and allow movements of the vertebral column within a safe range of motion, absorbing forces during normal and traumatic stress [8].

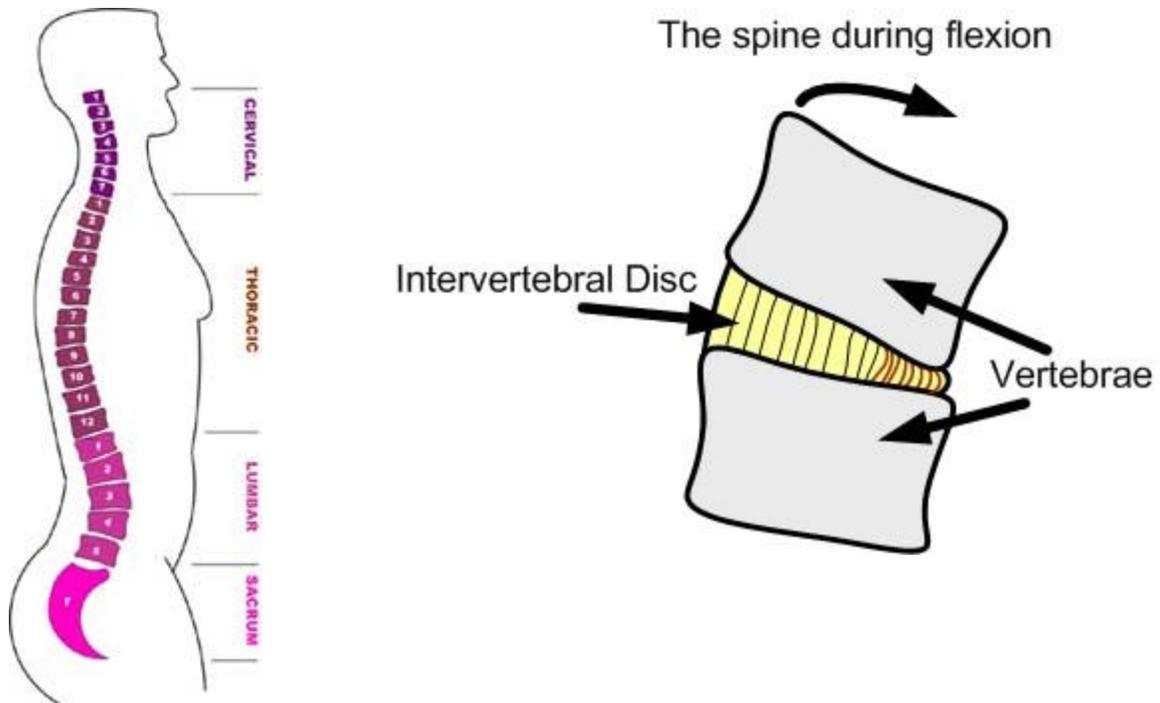


Figure 5: vertebral column

Between each vertebra is a “cushion” called the intervertebral disc, their function to absorb forces and restrict excessive motion of the vertebrae. The discs are composed of two regions: a gelatinous mass (nucleus pulposus) in the centre region of the disc, which allows for even distribution of pressure throughout the entire disc, and a fibrocartilage (the annulus fibrosus), which encircles the nucleus pulposus.

The vertebrae are designed to withstand certain compressive loads. They increase in size from top to bottom; the lumbar vertebrae are the biggest and are subject to the greatest compressive forces. The joint between the last lumbar vertebra and the first sacral vertebra (L5/S1) receives the greatest stress during lifting. When the spine is loaded, the discs are under compression, storing energy, and distributing the load. Constant stress applied to the intervertebral discs may contribute to the discs becoming thinner, drier, and less elastic, ultimately reducing their capability to withstand loads [8].

**Lateral (Side) View of
Normal Spinal Column**



Figure 6: Anatomy of the spine

2.3 Biomechanical models

Biomechanical models are mathematical models of the mechanical properties of the human body. In biomechanical modeling, the musculoskeletal system is analyzed as a system of mechanical links, and the bones and muscles act as a series of levers. Biomechanical models allow one to predict the stress levels. Biomechanical models allow one to predict the stress levels on specific musculoskeletal components quantitatively with established method of physics and mechanical engineering and thus can serve as an analytical tool to help job designers identify and avoid hazardous job situations [1].

The fundamental basis of biomechanical modeling is the set of three Newton's law:

- A mass remains in uniform motion or at rest until acted on by an unbalanced external force.
- Force is proportional to the acceleration of a mass
- Any action is opposed by reaction of equal magnitude.

When a body or a body segment is not in motion, it is described as in static equilibrium. For an object to be in static equilibrium, two conditions must be met: The sum of all external forces acting on an object in static equilibrium must be equal to zero, and the sum of all external moments acting on the object must be equal to zero. These two conditions play an essential role in biomechanical modeling.

2.3.1 Single –segment planar static model

A single-segment model analyzes an isolated body segment with the laws of mechanics to identify the physical stress on the joints and muscles involved. As an illustration, suppose a person holding a load of 20kg mass with both hand in front of his body and his forearms are horizontal. The load equally balanced between the two hands.

The distance between the load and the elbow is 36cm, as shown in the figure. Only the right hand, right forearm, and right elbow are shown in figure... and analyzed in the following calculations. The left hand, left forearm, and left elbow follow the same calculation method and yield the same results, because the load equally balanced between the two hands.

The force and rotational moments acting on the person's elbow can be determined using the laws of mechanics. First, load weight can be calculated with the equation [1]

$$W = mg$$

Where

W Is the weight of the object measured in Newton (N)

m Is the mass of object measured in kilograms(kg)

g Is the gravitational acceleration (a constant of 9.8 m/s²)

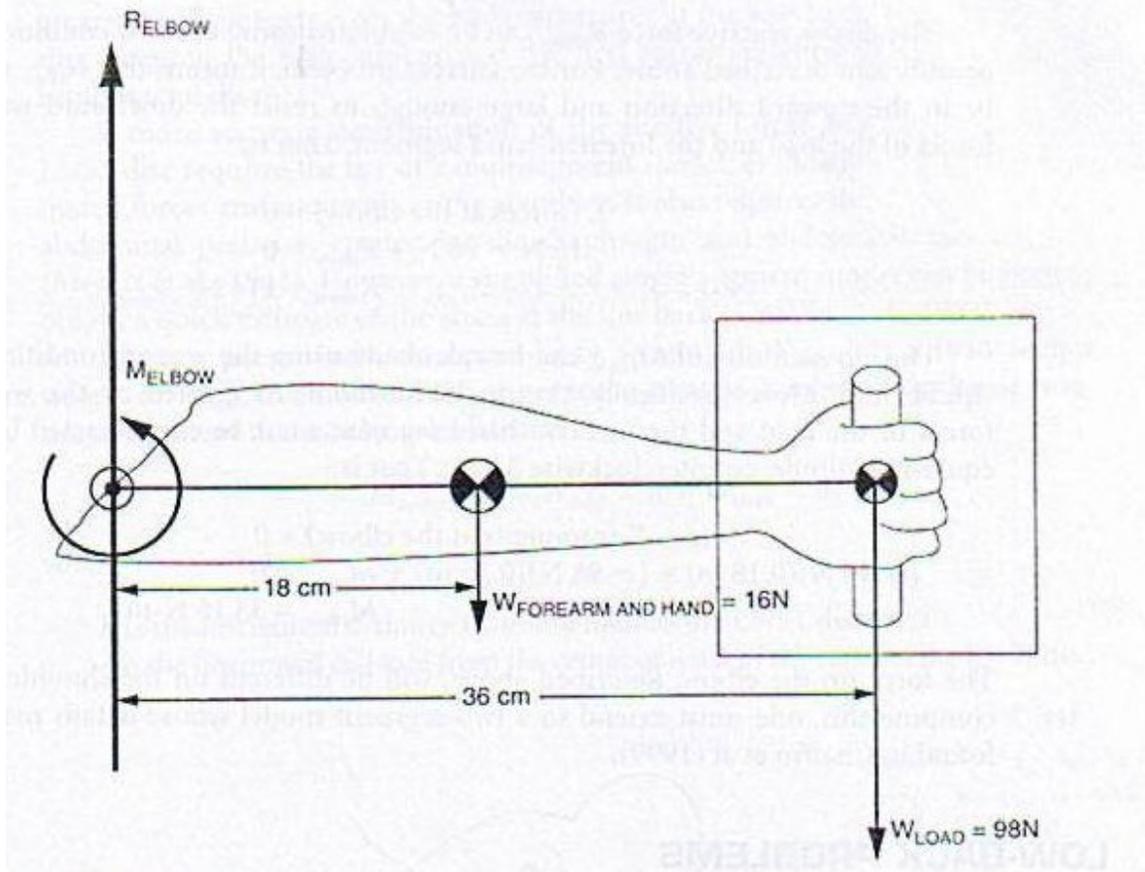


Figure 7: Single segment biomechanical model of a forearm and a hand holding a load in horizontal position

Figure... A single segment biomechanical model of a forearm an a hand holding a load in the horizontal position.

For the current problem, we have

$$W = 20\text{kg} \times 9.8 \text{ m/s}^2 = 196 \text{ N.}$$

When the center of the mass of the load is located exactly between the two hands and the weight is equally balanced between the two hands, each hand supports half of the total weight. We have

$$W_{on-each-hand} = 98 \text{ N}$$

Furthermore, for a typical adult worker, we assumed that the weight of the forearm-hand segment is 16N, and the distance between the center of mass of forearm-hand segment and the elbow is 18cm, as shown in figure....

The elbow reactive force R_{elbow} Can be calculated using the first condition of equilibrium described above. For the current problem, it means that R_{elbow} must be in the upward direction and large enough to resist the downward weight forces of the load and the forearm-hand segment. That is,

$$\Sigma (\text{forces at the elbow}) = 0$$

$$-16 \text{ N} - 98\text{N} + R_{elbow} = 0$$

$$R_{elbow} = 114\text{N}$$

The moment M_{elbow} can be calculated using the second condition of equilibrium. More specifically, the clockwise moments created by the weight forces of the load and the forearm-hand segment must be counteracted by an-equal-magnitude, counterclockwise M_{elbow} that is,

$$\Sigma (\text{moment at the elbow}) = 0$$

$$(-16 \text{ N})(0.18 \text{ m}) + (-98\text{N})(0.36 \text{ m}) + M_{elbow} = 0$$

$$M_{elbow} = 38.16 \text{ N-m}$$

The force on the elbow, described above, will be different on the shoulder.

2.3.2 Using lever concept to calculate force

The human body is composed of a series of levers that move under the influence of both internal and external forces. Muscles create internal forces and gravity creates external forces. The levers are the bones and the fulcrums (pivot points) are the joints. There are three types of levers (first, second, and third class) that influence the forces that the muscles must exert to control the different loads. [10]

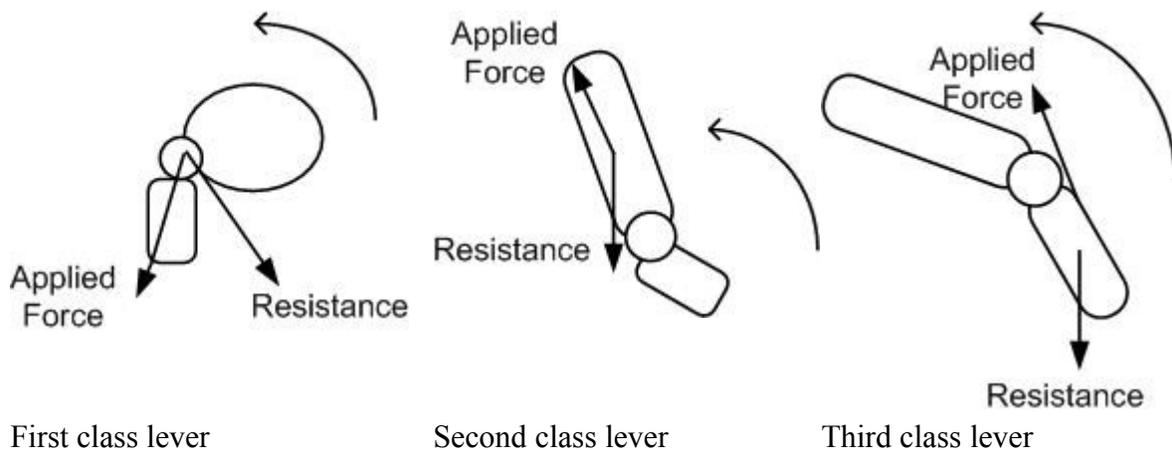


Figure 8: Types of lever in human body

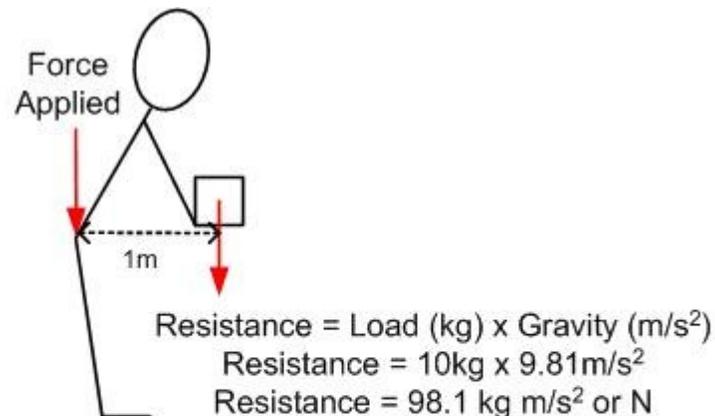
- First-class levers are usually described as seesaws, where the fulcrum is in between the applied force and the resistance. The seesaw analogy is not quite accurate as an example of a first-class lever in the human body. There are few first-class levers in the human body, for example when extending the neck up. In this example the head is the resistance (load) and the applied force is the force generated by the contracting neck muscles.
- Second-class lever has the resistance located between the applied force and the fulcrum. The common example used is that of a wheelbarrow. This is an effective system whereby a smaller applied force can balance a larger resistance (load); however the speed and distance the load has traveled is less. As with first-class levers, the human body has only a few second-class levers, e.g. when pointing

your foot upwards, your calf muscles are applying a force that is acting around the ankle (fulcrum).

- Third-class levers are the most common levers in the human body. Here the force applied is located between the fulcrum and the resistance. In this case the force that must be applied to move the load is higher but the advantage is that the speed and the distance traveled are also increased. An example of a third-class lever in the body is straightening your leg by extending your lower leg from a flexed position. The quadriceps muscles are contracting at a point lower than the knee joint in order to lift the lower leg (resistance or load). However, the distance from the load to the fulcrum is relatively larger than in second-class levers, muscles in second-class levers are able to balance larger loads.

The examples below illustrate the importance of holding a load as close as possible to the body using the concepts of levers and forces described above. The applied muscle force multiplied by the horizontal distance to the fulcrum must equal the resistance (load x gravity) multiplied by the horizontal distance to the fulcrum in order to balance the load. A force multiplied by a distance produces a moment; therefore the moments acting at a fulcrum (joint) must be equal in order to maintain balance. The horizontal distance from the applied muscle force to the fulcrum at the centre of the spine is approximated as 0.05m.

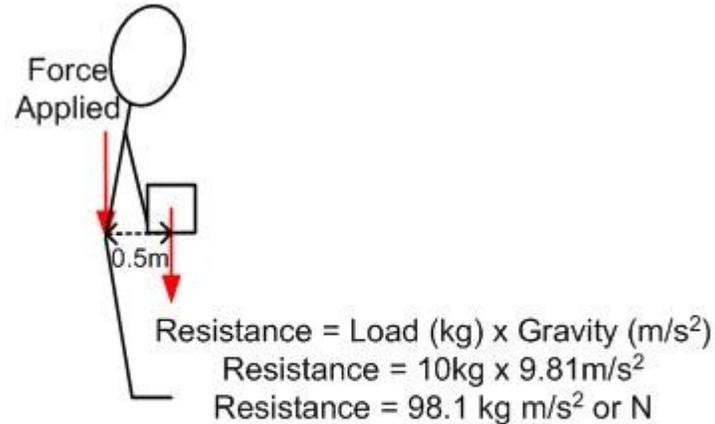
In Figure 7, the person is holding a load (10kg) at a position of 1m away from the centre of the spine (fulcrum) [10].



$$\begin{aligned} \text{Force applied} \times \text{Distance to fulcrum} &= \text{Resistance} \times \text{Distance to fulcrum} \\ \text{Force applied} \times .05\text{m} &= 98.1 \text{ N} \times 1\text{m} \\ \text{Force applied} &= 98.1/.05 \\ \text{Force applied} &= 1962 \text{ N} \end{aligned}$$

Figure 9: Load holding away from body

In Figure 8, the person is standing more upright and is holding the same load (10kg) closer to their body at a distance of .5m.



$$\begin{aligned} \text{Force applied} \times \text{Distance to fulcrum} &= \text{Resistance} \times \text{Distance to fulcrum} \\ \text{Force applied} \times .05\text{m} &= 98.1 \text{ N} \times 0.5\text{m} \\ \text{Force applied} &= 49.05 / .05 \\ \text{Force applied} &= 981 \text{ N} \end{aligned}$$

Figure 10: holding load near body

Force is expressed in Newtons (N) but it can also be more easily understood as kg of force. In figure A the applied muscle force is 1962 N (200 kg-force) and in figure B the force that the muscle applies on the lower back is 981 N (100kg-force). The muscular force applied on the lower back in figure B is half of that in figure A demonstrating that the spine is under far less strain when the load is closer to the body when lifting or carrying. Lowering the force acting on the vertebral column helps to reduce stress on the spine and thus reduce the potential for MSI. It is important, therefore, to always remember to lift the lightest load possible, to keep the load as close to the body as possible, and to use proper lifting techniques.

The intervertebral discs of lower back are under a number of other stresses apart from the applied muscular force. Compressive, tension, shear and torsional forces also act

to add to the total force applied to the spine. The National Institute of Occupational Safety and Health (NIOSH) in the US states that the maximum recommended weight is only 23kg (225N) under the most favourable conditions.

2.4 Low-back problems

Manual material handling involving lifting, bending, and twisting motions of the torso are a major cause of work-related low-back pain and disorders, both in the occurrence rate and the degree of severity. However, low-back problems are not restricted to these situations. Low-back pain is also common in sedentary work environments requiring a prolonged, static sitting posture. Thus, manual handling and seated work become. Two of the primary job situations in which the biomechanics of the back should be analyzed [1].

Low back pain (LBP) and related disorders are multi-factorial, meaning that there are often many contributing factors. LBP has been characterized as having non-specific symptoms and often being persistent and recurring. LBP is more often part of widespread musculoskeletal pain, rather than localized back pain. Localized back pain and widespread pain, including LBP, may be two different disorders or two stages of the same disorder. Localized back pain is more often episodic whereas widespread pain tends to be chronic with more severe longer lasting symptoms. [2]

2.4.1 Sources of low-back pain

The lower back is composed of many interacting structures, and damage more often than not occurs to the soft tissue of muscle, ligaments and tendons. However other structures have also been the source of LBP. [2]

- **Facet pain:** Facet joints are found between the vertebrae in the back. A system of nerve fibres, nerve endings, and mechanoreceptors within the vertebrae responds to the inflammatory chemicals that are produced when a structure is repetitively stressed, causing back pain. The loading on the facets is largely determined by the posture of the spine while lifting. The posture adopted while handling patients and the repetitive nature of a nursing aide's job are common precursors to low back disorders.
- **Muscle strain:** Forceful, repetitive, and/or static muscular contractions cause the tendons to stretch which then causes compression of the tendons' microstructures thus reducing the flow of blood and oxygen and causing inflammation in the muscle. The result is damaged muscle fibres that require adequate rest for recovery.
- **Disc degeneration:** Repeated bending and/or excessive loading of the back, as is common in the central supply department, causes the intervertebral discs located between the vertebrae of the spine to wear down. At first only the tough outer layers of the discs are affected and it is painless, but with further degeneration and scar tissue formation the outer ring loses water and nutrients and becomes brittle and fragile. As the disc becomes flatter the mechanics of the spine are compromised, leaving it open to severe damage such as disc protrusions, disc herniation and instability. Sedentary workers, exposed to prolonged static muscle contractions, have a higher risk of disc injury than those exposed to moderate loading and the risk increases significantly when loading is greater than the moderate level. Moreover, administrative, desk-bound jobs, and those with heavy lifting are most at risk of suffering a low back disorder, whereas those with less lifting are less at risk.
- **Disc herniation:** A sudden compression force, which may occur when trying to catch a falling patient, may cause the gel-like centre of the already degenerated

disc to rupture and exert pressure on the spinal cord or surrounding nerves. The pain can be attributed to pressure on the nerves, muscles, and ligaments of the spine. Disc herniation and subsequent nerve entrapment accounts for less than 5% of all cases of low back pain.

- Damage to the longitudinal ligaments: These ligaments are located along the length of the vertebral column in the back. Extremely fast movements, such as those found during a slip or fall, can cause the ligament to tear away from its attachment to the bone.
- Sciatica: compression on the sciatic nerve can be due to disc herniation or other disc abnormalities.
- Anatomical abnormalities: scoliosis (lateral spine curvature), spondylolisthesis (one vertebrae slides forward on another), spondylolysis (spondylolisthesis along with a tiny defect or bone fracture at the back of the vertebra), and kyphosis (exaggerated curve that results in a rounded or hunched back) are all painful conditions.
- Spinal stenosis: Narrowing of the spinal canal (the space surrounding the spinal cord) may be caused by calcium deposits in ligaments, degenerative joint disease or disc disease, or it may be present since birth. Any of these problems alone or in combination can put pressure on the spinal cord or a nearby nerve, causing low back pain.
- Inflammatory arthritis: Although relatively rare, sacroiliitis (inflammation of the sacroiliac joint, which connects the spine and pelvis) or spondylitis (inflammation of the joints between the vertebrae) may cause low back pain, especially in young adults.
- Tumour: Cancer is a rare cause of low back pain. It can start in the structures of the lower back, including bones or the spinal cord.
- Chronic pain syndrome: condition in which chronic pain has substantially interfered with a person's ability to function in normal life roles, and has eroded the pain sufferer's self-esteem, well-being, and relationships.

2.4.2 Risk factor

While no specific risk factors have been identified that are consistently associated with the development of low back disorders. Most low back disorders are associated with occupational factors. That being said, it has been accepted that the physical load being handled is a risk factor for low back pain, but only 20% of cases of low back pain have been attributed to the physical load. The other 80% are categorized into different classes of risk factors [3]:

1. Personal Factors

- Age: highest frequency of symptoms occurring between 35 and 55 years with the number of cases increasing with age
- Less work experience: new employees are often more likely to suffer from LBP than experienced workers
- Low household income: due to the manual nature of most low paying jobs the incidence of LBP is bound to be higher
- Smoking: can induce malnutrition of the discs due to impaired circulation and subsequently make them more vulnerable to mechanical stress. In addition, nicotine's pharmacological effects on the nervous system can inhibit the pain-modulating systems of the brain. Finally, an elevated risk of osteoporosis among smokers could also be related to back pain
- Genetics: Both disc herniation and disc protrusion have a genetic association
- Reduced vertebral canal size: increases the risk of nerve impingement
- Experiencing frequent headaches

2. Physical Factors

- Poor muscle strength: related to a reduced capacity of passive lower back structures to withstand the load
- Endurance strength
- Weight handling skill: poor technique (e.g. patient handling)
- Dehydration of intervertebral discs causes them to be brittle and fragile

3. Work Exposure Factors

- Manual handling tasks: lifting, bending, pulling, pushing, carrying, and twisting
- Heavy physical work
- High frequency of manual handling tasks (repetitive)
- Work postures: awkward, static (sedentary), bent over
- Whole body vibration due to driving trucks and lifting machines
- Extended duration of exposure to risk factors
- Unpredictable loads (e.g. patients with seizures, spasms, rigidity and erratic behaviour)
- Large horizontal and vertical distances when handling loads
- Large workload (e.g. simultaneously caring for many patients)
- Jerky uncontrolled movements

4. Psychological Factors

- Depression
- Stressful life events
- A Feeling of not being in control of one's health
- Fear: anxiety, being afraid, and worry