

Khairulhelmy Hussain

SAVE YOUR BACK AND SQUAT: ERGONOMICS FOR  
PHYSIOTHERAPY STUDENTS IN MANUAL THERAPY

Degree Programme in Physiotherapy

2019

## SAVE YOUR BACK AND SQUAT: ERGONOMICS FOR PHYSIOTHERAPY STUDENTS IN MANUAL THERAPY

Hussain, Mohamad Khairulhelmy

Satakunnan ammattikorkeakoulu, Satakunta University of Applied Sciences

Degree Programme in Physiotherapy

November 2019

Number of pages: 24

Keywords: ergonomics, manual therapy, musculoskeletal load, pain, and physiotherapist

---

The aim of this thesis was to invite physiotherapy students into having a greater awareness of correct ergonomics in manual therapy. This thesis goes through detailed analysis of correct posture positioning, leverage, body positioning, angling, device use and other advantageous tools to provide both students and working professionals of physiotherapy in better ergonomics of manual therapy.

The objective of this thesis was to provide new physiotherapist students a simple form of guidance of ergonomics in regard to manual therapy in the working environment. By providing the knowledge of ergonomical advantages and alternative positions/tools, this thesis aims to prolong any possible work-related musculoskeletal injuries obtained from lack of or incorrect ergonomics in the working environment in regard to manual therapy.

This thesis evaluates use of manual therapy and ways the load on the musculoskeletal system can be reduced through ergonomics. It was a practice-based thesis where instructions and recommendations for physiotherapist students are provided to improve the efficiency of their work and reduce work-related injuries with the use of ergonomics. The theoretical background was obtained from books and published papers from online databases.

The theoretical background of this thesis was used to create an online guide/powerpoint to help students in preventing possible problems caused by improper ergonomics. It will be available for students to read and have a thought about their own ergonomics during the first few clinical practices.

## TABLE OF CONTENTS

1	INTRODUCTION.....	4
2	AIM & OBJECTIVES.....	5
3	ERGONOMICS.....	5
3.1	What is Ergonomics.....	5
3.2	Importance of Ergonomics.....	6
3.3	Goal of ergonomics.....	7
4	MANUAL THERAPY .....	9
4.1	Manual Therapy in Discipline of Physiotherapy .....	9
4.2	Massage.....	9
4.3	Stretching .....	10
4.4	Mobilization and traction.....	10
5	MUSCULOSKELETAL LOAD WHEN PERFORMING MASSAGE .....	11
5.1	Ergonomics of The Thumbs During a Massage Session .....	11
5.2	Ergonomics of The Low Back During a Massage Session.....	14
5.3	Ergonomics of the Neck During a Massage Session .....	16
6	MUSCULOSKELETAL LOAD WHEN PERFORMING STRETCHES.....	16
6.1	Ergonomics of the Low back During Assisted Stretching.....	16
6.2	Ergonomics of the Shoulders & Arm During Assisted Stretching .....	18
6.3	Ergonomics of Body Positioning .....	19
7	MUSCULOSKELETAL LOAD WHEN PERFORMING MOBILIZATION AND TRACTION.....	19
7.1	Ergonomics in Lumbar Mobilization.....	19
7.2	Ergonomics of Cervical traction .....	20
8	ONLINE READING GUIDE.....	21
9	THESIS METHOD .....	21
9.1	Thesis Method.....	21
9.2	Thesis Process.....	22
10	DISCUSSION .....	22
10.1	Personal Experience.....	22
10.2	Further Development .....	23
	REFERENCES.....	24
	APPENDICES	

## 1 INTRODUCTION

The ways of doing physiotherapy have developed over the years. It was thought that massage was the primary discipline where physiotherapy began. Now, it has evolved to include other forms of manual treatment in a therapeutic manner. Physiotherapists are required to learn and perform manual therapy as part of the profession. Various manual therapy techniques are taught and learnt that provide load onto the musculoskeletal system. (Porter, 2013)

Studies suggest that there is a high prevalence of long-term work-related musculoskeletal disorder (WMSD) in the field of physiotherapy. Injury concerning the low back was rated as the most frequently affected area. “Lifting, transferring, repetitive movements, awkward and static postures, physical load, treating a large number of patients in a single day and working while injured” were the common reason for WMSDs. Following the lower back, the neck, upper back, and shoulders were the next common areas regarding WMSDs. There is a “lifetime prevalence reported as 55-91%, and 12-month prevalence ranges 40-91.3%.” (Milhem, et. al., 2016, 735-747). The importance of this thesis is to provide a form of awareness for students before performing manual therapy during their first clinical practices. It is vital to be ahead of the issues and seek preventive care. In this instance, an available option of preventive care includes ergonomics.

Ergonomics can provide a variety of aid in all aspects, whether it is work, sports or even daily life chores. It can be applied to any person of various age and experience. In an area where there is a possibility of risk of injury in the working environment, ergonomics can help create a safe space where the “guidelines” are there to reduce the risk. When it is required to perform a specific task repeatedly for an extended period of time, ergonomics can help with increasing comfort level or when performing every day activities like cleaning, ergonomics can help with the efficiency of the chores. (CIEHF website, 2017)

Ergonomics is individual and varies from person to person, depending on their needs and physical attributes. Techniques and body position are a part of how ergonomics can be utilized to benefit any individual. However, external assistance such as adjustability of the used tools is also a way of reducing the load. To dive deeper into common

injuries from performing manual therapy, this thesis provides aid that can benefit the longevity of injury prevention.

## 2 AIM & OBJECTIVES

The aim of this thesis was to invite physiotherapy students into having a greater awareness of proper ergonomics while performing manual therapy. This thesis will go through a detailed analysis of correct posture positioning, leverage, body positioning and other advantageous tools to provide the students with. By exploring and diving into the common problems caused by poor ergonomics, readers will understand and have the opportunity to correct any further problems.

The objective of this thesis was to provide new and remind older physiotherapist students a simple form of guidance of ergonomics in regard to manual therapy in the working environment. By providing the knowledge of ergonomically advantages alternative positions/tools, this thesis hopes to prolong any possible work-related musculoskeletal injuries obtained from lack of/bad ergonomics in the working environment in regard to manual therapy.

In the case of this thesis, the “client” is the physiotherapist themselves. Ergonomics applies to the design of anything that involves a person or a collective group of people (i.e. a group of working officers). In addition of this thesis, a power-point presentation will be created about information regarding ergonomics for students to read and consider during their first few clinical practices.

## 3 ERGONOMICS

### 3.1 What is Ergonomics

Merriam-webster dictionary describes ergonomics as “an applied science concerned with designing and arranging things people use so that the people and things

interact most efficiently and safely; called also biotechnology, human engineering, human factors.” (Merriam-Webster website, 2015)

According to the International Ergonomics Association (IEA), ergonomics is the “understanding of interaction among humans, and other elements of a system...to optimize human well-being and overall system performance.” They claim that there are three areas that ergonomics encompasses; that being, the physical, cognitive and organizational. The physical aspect of ergonomics takes respect to the anatomical and biomechanical characteristics in relation to physical activity. The cognitive aspect dives into mental processes in regard to how it affects us. Finally, organizational ergonomics attempts to optimize the sociotechnical system and processes. (IEA website, 2019)

From a physical standpoint, ergonomics is the creating and/or arranging workplaces, tools, products and systems and everything in between accordingly to fit the needs of the client. It focuses on areas such as workspaces, sports and leisure, as well as health and safety; this is done to create better environmental workspaces and reduction in any risk and injury. Ergonomics is a way to remodel one’s body position to refine it in a way that optimizes the human anatomy along with creating future preventive injury. Furthermore, ergonomics tackles into equipment that can be used to leverage oneself, either to aid or adjust minor positions. (Ergonomics Australia website, 2018)

### 3.2 Importance of Ergonomics

The United States Department of Labor has written “Implementing an ergonomic process is effective in reducing the risk of developing MSDs in high-risk industries as diverse as construction, food processing, firefighting, office jobs, healthcare, transportation and warehousing”, which can be applied directly down towards other professions such physiotherapy. (U.S. Department of Labor website, Occupational Safety and Health Administration)

The median time of a certified sickness is 14 days and according to an article written by Englund and Svärdsudd (2000, 81-86), with the most common reason for a sick leave being a musculoskeletal disorder (MSD). Another article written by Abaraogu, Ezema and Nwosu (2017, 404-409) determined that the low back was the most affected

area that had work-related musculoskeletal disorders in both long- and short-term periods. This is a continuous trend that can also be found in European countries. A study made in Greece shows that 89% of the study participants had a work-related musculoskeletal disorder and 32.2% obtained the injuries within the first 5 years of working. In this study, the most effected was again the lower back, followed by the upper back, shoulders and neck respectively. (Anyfantis & Biska, 2018, 314-318)

Manual therapy is a large aspect of physiotherapy. When a physiotherapist performs manual therapy, the musculoskeletal system is stressed from awkward positioning, extended load, or repetitive movement. As a result, there can be physical symptoms such as, pain, discomfort, fatigue, irritation, and others corresponding with incorrect ergonomics. The symptoms are greatly impacted in the longevity of the worker if needed adjustment is not performed. (Oregon Occupational Safety and Health website)

### 3.3 Goal of ergonomics

In regard to the working environment for a physiotherapist performing manual therapy, there are multiple goals that are associated with ergonomics. Table 1. below list the goals that are to be strived for when applying ergonomics in manual therapy.

Table 1. Goals of Ergonomics. (Oregon Occupational Safety and Health website)

<p>Increase the proficiency and effectiveness</p>	<p>Understanding the muscles and joints of the body is one thing. However, knowing how to affect these areas for rehabilitation treatment is another. When performing manual therapy on a person, there are multiple variables that have to be considered to obtain optimal ergonomics. Depending on the size of the patient, the size and strength of the therapist you are welcomed to adjust your stance, body position, and technique to optimize your</p>
---	--

	<p>therapeutic treatment. For example, having better ergonomics will allow an increase of force exertion if required when performing a massage.</p>
<p>Reduce injuries</p>	<p>Similar to the previous point, these two go hand in hand with one another. Having optimal technique might be an efficient way to perform an action. However, it might not always be the safest for your body. In certain circumstances you will have to think about the longevity of your own body. For example, performing traction in one position, although correct, might be more strenuous on your own body in comparison to another.</p>
<p>Increase comfort levels</p>	<p>In the long term, comfort should be present when thinking about ergonomics. Day in and day out, you are working for hours during the day. Being comfortable is something that your body does automatically. Whether it is slouching on a chair or leaning on a table, we adjust without thinking about it. Whether the adjustment is good for your body is another conversation. Ergonomics can help you reposition yourself to be more comfortable without risking any injury.</p>



## 4 MANUAL THERAPY

### 4.1 Manual Therapy in Discipline of Physiotherapy

According to American Academy of Orthopedic Manual Physical Therapist, manual therapy is a physical treatment using any “hands-on” interaction. (French, White, Brennan and Cusack, 2011, 109-177) Physiotherapists use manual therapy to treat musculoskeletal pain and disability. It includes kneading and manipulation of muscles, joint mobilization and manipulation to aid or regain movement. Other modalities are passive movement, stretching and specific soft tissue techniques. (Huijbregts, 2011, 573-596)

### 4.2 Massage

Massage is one of the forms of manual therapy used by physiotherapists. It can be used as a way to relax muscles or to increase blood flow. The effects of massage therapy have been debated back and forth in favour and against its effectiveness. Massage can be used as a physical and psychological form of rehabilitation. (Hilbert, Swensen and Sforzo, 2003, 72-75) Even though massage therapy may not always cause any physical improvements directly (Weerapong, Hume and Kolt, 2005, 235-256), there is evidence of its psychological aspect. (Chang, Chen and Wang, 2002, 68-73) However, it can provide pain reduction, comfort, and relaxation which are a few of the reasons why massage therapy is used in rehabilitation. (Yates & John, 2004)

Generally, a massage consists of manipulating soft tissue in the body by applying a specified force in a specified direction depending on the goals of the treatment. Various techniques are used across different massage styles but for physiotherapist the common application of techniques are performed by fingers, hands, and elbows. (Edinburg, 2013, 125-128) All the techniques can be performed in prone positioned massage where the patient lies facing down on a plinth or massage table. The position is most commonly used to massage the posterior parts of the body, including the calves, hamstrings, glutes, back, shoulder and neck areas. (Fritz, 2017, 332-347) The studies/survey show that there is a great deal of injury coming from the thumb/fingers and wrist, shoulder and neck, and the lower back while performing massage. (Albert, Wayne & Currie-Jackson, Nadine & Duncan, Carolyn, 2008, 86-93)

### 4.3 Stretching

In manual therapy stretching is used to relax and elongate muscles. Stretching has many forms and shapes including isometric/dynamic, passive/active, resisted, contraction/relaxation, and other techniques. Depending on the client and the goal, a physiotherapist can use a variety of different techniques. The most common stretch, in relation to manual therapy, is assisted passive stretching along with contraction-relaxation stretching. (Page, 2012, 109-119)

Assisted passive isometric stretching is applied onto a client by the physiotherapist without the client doing anything actively. The stretch is held on without any movement and the muscle is elongated with low force for a specified amount of time. The benefits include relaxation, elongation of muscle(s), maintaining/increasing range of motion, as well as decreasing stiffness and muscle strain. (Page, 2012, 109-119)

In assisted contraction-relaxation stretching the muscle that is being stretched is actively contract before the stretch. It is done repeatedly when the muscle is in the elongated state. The benefits of it are similar to the assisted passive isometric stretching, however, there is an added benefit of having a deeper stretch along with the increase of blood circulation in the muscle. (Page, 2012, 109-119)

### 4.4 Mobilization and traction

Mobilization is purposeful passive movement performed onto a client to increase or maintain range of motion and/or decrease joint related pain. It can be performed on various joints and joint capsules along the body depending on the client's needs. It aims at improvements in the clients' functional capabilities and is performed by aiding the correct movement patterns of the affected joint(s). (Mulligan, 2001)

For example, Maitland and Mulligan presented spinal segment mobilization techniques where a spinal segment is moved passively to achieve therapeutic effects and is used by physiotherapists. (Konin & Jessee, 2012, 74-88) (Rushton, Beeton, et al., 2016, 5-24) Traction is another technique used by physiotherapists. Traction provides an external passive movement of the joint where the "stretch" creates space be-

tween the joints. It is generally performed in an open packed position. It can be performed to decrease nerve pain by relieving the compression created in the lumbar joint, for instance. (Blomberg & Bronfort, 2006, 1591-1599)

Joint mobilization and traction are both manual therapy techniques that are performed at lower tempo in comparison to dynamic movements, for instance, and are generally performed passively on the treated area. They are performed to regain, improve, and/or maintain normal active joint range of motion. Finally, both of these techniques have different grades and levels of effort that can be applied depending on the desired outcome of the therapy. (Prentice, 2007)

## 5 MUSCULOSKELETAL LOAD WHEN PERFORMING MASSAGE

### 5.1 Ergonomics of The Thumbs During a Massage Session

For every pound of force applied by the tip of your thumb, there is ten to twelve pounds of force concentrated at the carpometacarpal (CMC) joint at the base of the thumb. (Neumann & Bielefeld, 2003, 386-399) As can be seen, a large amount of pressure is exerted into the CMC joint of the fingers in relation to its size during a massage, especially in a deep tissue massage. The amount of pressure should be considered especially when having hypermobility in the joints, because it can cause a plethora of risk conditions such as pain or stiffness, fatigue, overstretch, dislocation, and bone fragility amongst others. (Beighton, Grahame and Bird, 2012, 65-80) Generally, pain in the fingers while performing massage is due to improper technique. Using ergonomics, the load on the CMC joint of the fingers can be reduced. By increasing the proficiency of how to apply pressure, the risk of various conditions can be reduced. (Greene & Goggins, 2010)

To begin with, when massaging a large surface area, such as the back or legs, it is advised to use the thenar section of the palm. Applying pressure through the thenar section of the palm reduces any form of heavy joint exertion and it is easier to apply a heavy force from the palm in comparison to the fingers. When thinking about performing a push-up on the floor, performing it with fingertips only is harder than the entire

palm. This is a basic principle that is taught to physiotherapy students. (Fritz, 2017, 356-383)

However, the human body is complex and sometimes it is required to exert force on a small area, such as the gluteus muscles and the deeper muscles. In a case where there is a need to exert a high level of force to a small area, the optimal approach is to apply the force through the elbow, because the elbow has a tapered point which mimics the directional force applied through the thumb. In addition, having the elbow in a flexed position reaches a soft tissue approximation (soft end feel). (Massage therapy reference, 2018) This way, an increase of force does not increase the tension on the end feel of the joint itself, but rather the pressure on the bone. In comparison, when massaging with the thumb and fingers they are in an extended position with a “firm end feel” and due to this there is an increased risk of applying too much pressure towards the extended range of motion causing discomfort in the joints and pain in the long term. (Norkin & White, 2009)

The major downfall to this approach is the limited amount of feedback received through the elbow joint. Unlike the thumb or fingers, the elbow has a limited number of tactile sensory nerves, which is why it cannot detect fine details (Boron and Boulpaep, 2003, 352-358) and can cause discomfort to the client. For example, there are multiple receptors that detect the pressure that is applied; having a limited amount of feedback due to lack of the pressure sensing receptors can result in a pressure the client cannot tolerate. In addition to limited amount of feedback, it is harder to re-adjust the pressure and direction whilst using the elbow. This form of adjustment is intended for specific regions. In other words, micro adjustments performed by the elbow are not as accurate as ones performed by the thumb or fingers. Therefore, using an elbow is more appropriate when targeting a specific point on the body, e.g. a trigger point or a muscle knot. (Johnson, 2010)

Picture 1. below depicts the alternative massage techniques that can be performed to generate pressure on the affected area. All three techniques are ergonomically advantages approaches to avoid pain or other disability of the thumb and CMC joint.



Picture 1. Alternative ergonomic force during massage. (Fritz, 2017, 359)

The saying one is better than two can be applied in this situation. Using one arm to apply pressure can be effective when targeting a specific spot. However, the load in the finger joints increases with high pressure. A way to maintain a high pressure on soft or deep tissue while reducing pressure in the finger joints is to distribute the load. (Tamayo, 2017) In other words, by using two arms to apply the pressure, you are reducing the load on a single joint. (Yang, Lu, et al., 2016) To maintain pressure on a specific region, the recommended approach is to have one hand on top of the other to apply additional pressure onto the fingers/thumb. (Johnson, 2010)

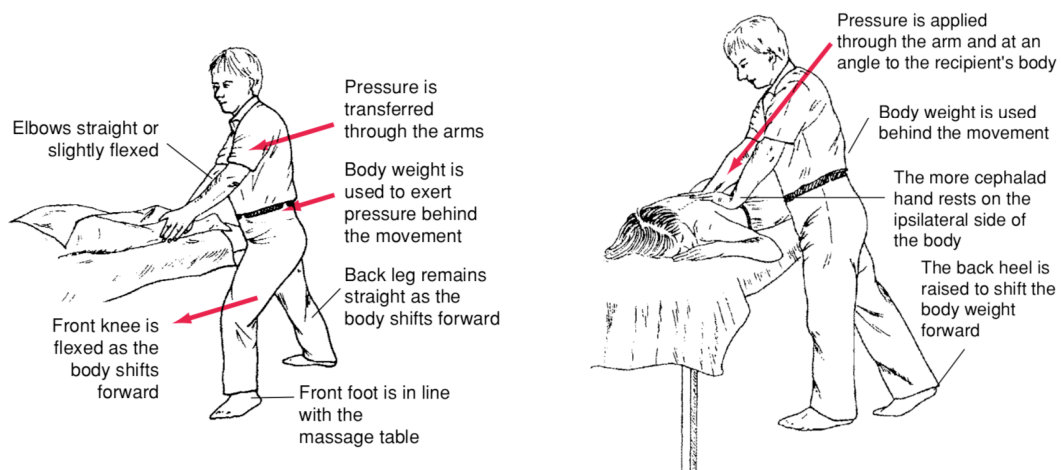
Larger groups and larger muscles generally can create a higher force. This is obvious in human anatomy, but sometimes we forget it. (Danion, Latash, Li and Zatsiorsky, 2001, 322-329) Using the intrinsic muscles to generate pressure on a specified spot is a way to fatigue the hand quickly and early when performing massage. To generate a high force, using the strength from the triceps and shoulders is a safe way to increase the pressure. It is done by having a firm position with the hands and applying a downward pressure with the shoulders and arms. Another alternative is to pressure passively by extending the elbows and use body weight in addition to gravity. (Fritz, 2017, 311-333)

## 5.2 Ergonomics of The Low Back During a Massage Session

The low back is the most affected area to sustain load and cause pain. There are various reasons to why there is load on the lower back; repetitive movements, awkward and static postures, and physical load are reasons to why there can be load onto the back. This area of the human body can utilize ergonomics to help reduce the load by different mean from adjustment to altering movement. (Milhem, et. al., 2016, 735-747)

When massaging a large area, instead of bending or reaching over to the area, body movement can be used to unload the low back. For example, when massaging the latissimus dorsi, the masseur should be located roughly in the middle of the contact area. Instead of using the back to bend over and reach, the better option is to shift weight back and forth on the legs. The weight shifts utilize larger muscle groups that aid in the movement of the arms. In addition, bending the legs applies force using the help of gravity. Lunging to save your back! The lunging technique is more advantageous when working on a single side of the client's body followed by moving to the corresponding side. (Fritz, 2017, 311-333)

Picture 2. below depict the alternatives that can be performed to generate pressure onto the affected area. These are the techniques that were previously mentioned above as a more ergonomically advantages approach to lower back pain/injury.



Picture 2. Applying lunging Pressure (on the left) and a to-and-fro posture (on the right). (Cassar, 2005, 28-30)

Using an adjustable plinth can enhance the ergonomics of manual therapy. Generally, the plinth should be adjusted to the level of the waist or where the hands lay, but the client and the muscle group being massaged should be considered when adjusting the height. The preferred height for low pressure massage can have the area of contact at around wrist height, whereas for high pressure massage, it is advised to have the plinth a few inches lower to utilize the entire body weight. Understandably, it is not always possible to have an adjustable plinth at your disposal. The best alternative when looking for a new plinth is to have the table at a comfortable height where it resembles close to the optimal ergonomics that was mentioned previously. (Greene & Goggins, 2010)

When applying downward pressure is not required, why stand? It sounds simple but sitting on a chair can release the load on the back. Even a short sitting break of 5-10 minutes can give the legs and back time to relax and recover for the next massage session. A study by Waters (2015, 148-165) found “ample evidence showing that prolonged standing at work leads to adverse health outcomes.” The study continues by stating that the use of interventions such as sit-stand chairs amongst other can help with reducing the risks caused by prolonged standing. For instance, if massaging the trapezius, shoulder area or even the hands, sitting can alleviate any unnecessary load on the legs and back from continuously standing or bending over. (Waters, 2015, 148-165)

### 5.3 Ergonomics of the Neck During a Massage Session

There is a tendency to look down when massaging, perhaps due to inexperience and uncertainty. (Passer & Smith, 2004) However, with time and experience physiotherapists know the muscles they are following and are able to feel the points that are tight and require more attention. To avoid having to look down when performing a massage, the patient should be palpated to an extent where the problem can be 'felt'. For example, stiff and tight muscles can be felt being rigid and hard while inflamed area can be felt being hot as well as tender with build-up of liquid. (WebMD website) In addition, having a good understanding of human anatomy, such as muscle origin and insertion, helps to follow the muscles and massage the body without the need of reference. (Ankrem & Nemeth, 2000, 565-568) Having the neck in constant flexed position for a prolonged period of time can cause increased pain. Therefore, if possible, it is better to look straight ahead and maintain a neutral neck position. (Ariens, Bongers, Douwes, et al., 2001, 200-207)

## 6 MUSCULOSKELETAL LOAD WHEN PERFORMING STRETCHES

### 6.1 Ergonomics of the Low back During Assisted Stretching

Perhaps not as difficult, from a technical standpoint, as other muscle groups for stretching, the hamstrings is one of the most common muscle groups that are stretched by a physiotherapist. When performed passively, the hamstring stretch is usually done with the patient in a supine position while the physiotherapist attempts to lift the target leg up by flexing the hip until a stretched position is reached. (Ylinen, 2018, 215-270)

The hamstring stretch is most likely performed either on the floor on a mat or on a plinth. When performing the stretch on the plinth the client is already up and above the floor, which helps the physiotherapist to create leverage. In this position, there is no need to bend forwards as much as when performing the stretch on the floor and the legs can be incorporated to do the heavy lifting instead of the back. (Ylinen, 2018, 215-270)



An option is to be located near the lateral side of the leg and place one hand under the heel and the other on the knee. This way the leg can be lifted by flexing the elbows and using the bicep and shoulder muscles. This variation is good for creating small and accurate movement of the leg while maintaining control over the knee. It is similar to performing the *Single Leg Raise Test* and the limiting factor is how much weight can be controlled. When there is additional force, for example when using the contraction-relaxation technique, it is harder to create a strong resistance in comparison to the latter technique. (Willhuber & PiuZZi, 2019)

Picture 3. below depict the alternatives that can be performed to raise the leg when performing a hamstring stretch, by ways similar to the Single Leg Raise Test. This technique was mentioned above as a more ergonomically advantageous approach to low back pain and injury prevention.

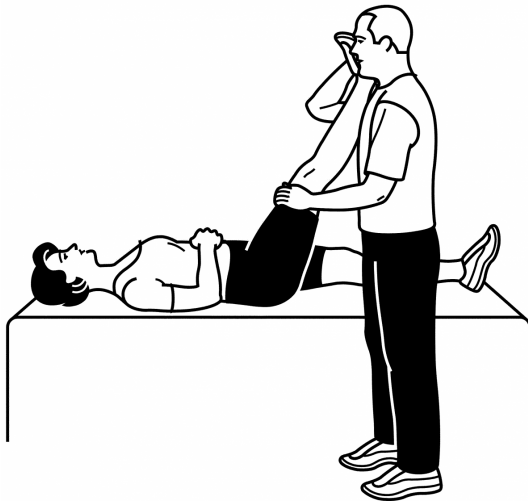


Picture 3. Using passive single leg raise test, as a hamstring stretch (Simmons, 2015, Presentation).

This technique is great for clients who have perhaps tight muscles or nerve pain, because the therapist has a greater amount of control on how much stretch is being created at each angle. (Willhuber & PiuZZi, 2019)

## 6.2 Ergonomics of the Shoulders & Arm During Assisted Stretching

When performing stretches, the physiotherapist has to deal with the weight of the leg, the myotatic reflex, and resistance caused by contraction of the muscle during a pre-contraction stretch. Fatigue and discomfort can occur overtime and to optimize the efficiency, other techniques can and should be used. (Chezar, Berkovitch, Haddad, Keren, Soudry and Rosenburg, 2013, 214-219)



Picture 4. Assisted passive hamstring stretch. (Berkley University of California website, Berkley Wellness, 2019)

When performing the pre-contraction stretch, the client needs resistance to push against. Picture 4. shows a common way of performing the hamstring stretch with the foot located on the shoulder to rest and the legs are used to increase the angle of the stretch. By positioning oneself under the leg of the client, using the shoulder as a resting place for the foot, the leg can be supported easily. The increase of stretch can be performed by starting from a squat and standing up to increase the angle. Once fully erect, the next step is to take a step forward to further increase the stretch. (Ylinen, 2018, 215-270) As math shows, having the point of contact far away from the axel joint of movement (the hinge), the leverage created allows for greater movement at a lower effort level. (Heckman, 20)

### 6.3 Ergonomics of Body Positioning

As stated previously, the two common places for performing a hamstring stretch are on a plinth or on the floor. Having the client on a plinth and elevated from the ground allows the therapist to utilize the techniques presented earlier. However, when this is not an option and the stretch have to be performed on the ground, body positioning should be considered. If considered as lifting a weight from the ground, an article by a Healthwise Staff (MyHealth website, 2018) indicates that one should start from a wide base, squat, keep good posture when standing and keeping the load close to the body.

The previous guideline is indicative of ergonomics when lifting but is not corresponding to the technique of a hamstring stretch where control over the knee flexion is required. Therefore, instead of bending over, a more optimal way is to go down onto one knee to lower oneself to the same level as the client. Lowering the center of mass creates a secure and stable platform, where it is easier to make micro adjustments if necessary. (Gibbs, 2016)

## 7 MUSCULOSKELETAL LOAD WHEN PERFORMING MOBILIZATION AND TRACTION

### 7.1 Ergonomics in Lumbar Mobilization

As mentioned previously, low back pain is one of the most common work-related injuries. As a result, physiotherapist may encounter patients related with back pain. Depending on the analysis of the patients, the correct treatment is applied. An example of a specific treatment that is used is mobilization. Mobilization is a technique that is performed by physiotherapists and professionals. It is used on patients as a way to increase movement and/or reduce any pain associated with the movement of the treated region. When performing mobilization, there are different techniques and grades that are applied to obtain different results. Regarding lumbar mobilization, Mulligan performs lumbar flexion in both standing and seated position. The technique used are

inclusive of having a belt to help aid with the fixation of other joints while applying the pressure in the opposite direction. (Mulligan, 2004, 44-46)

When performing this technique, there should be various concepts that should be thought out in regard to ergonomics. One of the movements required by the therapist is a pushing force onto a joint. If the patient is located at a lower level than the patient, possible hip flexion is used causing load on the lower back. The easy fix to this would be to raise the height of the plinth similar as stated in the previous section. However, if there is no adjustability of the plinth, other means are required. When lifting a heavy object from the ground, you are advised to activate the core and use the legs as the primary transfer of power instead of the back. To reduce the load on the back, having the legs in a flexed position allows the therapist to lower themselves slightly. (Straker, 2003, 83-96)

If the level of the patient is a lot lower than the therapist, a study by Dieen (1997, 355-363) states that kneeling has “a sub-optimal solution from an ergonomic point of view, but at present it could be recommended to allow for variation with the conventional working method.” However, there was no negative effect onto the low back. Kneeling is a consideration that a therapist should take into thought when performing the mentioned manual therapy. The study continues by saying that the groups of participants preferred sitting than kneeling.

## 7.2 Ergonomics of Lumbar traction

Another technique that a therapist can use is traction. It is used to decompress the joints of the treated area. Lumbar traction is performed in a supine position on a plinth with the therapist at the end. When the therapist performs the traction, a pulling force is done to create distraction of the lumbar joints. The traction is held for several seconds at a time and is maintained through the arms. (Mulligan, 2004, 36-38)

Performing the traction for a specified amount of time at a constant rate of force can be difficult. There is a possibility of variance between the left and right arm. Therefore, a strap is suggested to provide a constant force where the therapist can have an easier time to spread the force evenly. In addition, pulling the strap with the arms is one way of performing the traction. The correct way of creating the force is with fixated arms

and the use of body weight shifting. Thus, this approach can utilize body leverage and the use of weight without relying on muscle strength. (Cassar, 2005, 28-30)

## 8 ONLINE READING GUIDE

This thesis goes through published books and papers to help define manual therapy and discusses the most common injuries obtained while performing manual therapy. Furthermore, published studies are examined to determine the most common musculoskeletal related problems obtained from each subsection of manual therapy in regard to physiotherapy. By doing so, this thesis provides an alternative or optimal ergonomics for injury prevention and increased efficiency in regard to manual therapy within physiotherapy. The discussed manual therapy includes massage, stretching, and traction/mobilization. Each section covers only a small fraction of the techniques with more emphasis on most common injuries, movements or positions. Based on this thesis a power point template will be created and it can be shared and read amongst physiotherapy students. The product of this thesis is an online material that can be read and studied by students. It is a power point template that uses examples of improper physical ergonomics and integrates the use of body positioning and surrounding tools through pictures.

## 9 THESIS METHOD

### 9.1 Thesis Method

This thesis is a practice-based thesis. The research problem is identified where instructions and recommendations for physiotherapist students are provided to improve the efficiency of their work and to reduce the chance of work-related injuries when performing manual therapy. This thesis implements ways in which students can alter their ergonomics to further aid them in performing manual therapy by evaluating the current

use of manual therapy and looking at ways in which load on the musculoskeletal system can be reduced through ergonomics. The research problem of ergonomics has been reviewed and appropriate research method has been used. Finally, the development of an online power point guide is introduced for students to read. (HAMK, 2018, 7)

## 9.2 Thesis Process

The thesis process started by choosing a topic to dive into. Once a topic was chosen a specific area of focus was obtained in January of 2018. The study plan was created in January of 2018. After this, the subject of the thesis was discussed and agreed on with the client, Satakunta University of Applied Sciences, Degree programme in Physiotherapy. Once the topic was approved, searching for material regarding the theoretical background began in the summer of 2018. Most of the written work was mainly done between the Spring and summer of 2019. The final layout of the thesis and discussion part was completed in early November of 2019 and the thesis and product are presented in late-November of 2019.

# 10DISCUSSION

## 10.1 Personal Experience

With the limited experience through clinical practices, the author believes that these advices are good to have in the back of the mind before starting any treatment session. However, it is easy to forget when being caught up in the moment and only thinking about the client instead of oneself, especially as a student. In some situations, improper ergonomics is present and not avoidable, but proper ergonomics should still be considered accordingly. It is important and in the long run it will be beneficial. Of course, not everything is in black and white and some of the situations presented in this thesis might not apply directly to everyone; for example, an optimal body position while massaging presented in this thesis might be uncomfortable for someone, which is why it cannot be claimed to be the only correct way.

When the author adopted to first think about ergonomics before massaging a client, there was a realization of how much compensation is present. Nowadays, after adjusting the height of the plinth, there is less load and tension on the author's back after each massage session. By doing so, there is measurably less load that has been felt after the working hours.

From the research that the author has gathered, the most common work-related musculoskeletal problems occur from improper technique or lack of muscle strength. To prevent any future problems and to increase the efficiency, consideration of ergonomics is beneficial for everyone. Most common back related problems are due to the lack of use from larger muscles like the legs; using gravity, leverage and other external tools can help in multiple ways to assist and ease the load of performing manual therapy.

## 10.2 Further Development

Besides the correct technique on performing specific traction and mobilization, there is little research of ergonomics in regard to performing them. The author believes that it is due to the level of variance between therapists and clients, which makes it hard to define optimal ergonomic that fit every case. However, the author thinks that each section of manual therapy can go deeper and having a more in-depth approach to ergonomics would be beneficial. Continuing the work of this thesis and elaborating it in other theses by diving into each subsection and specified movements that can be optimized into another ergonomic standpoint.

## REFERENCES

- Abaraogu, U. O. Ezema, C. I. & Nwosu, C. K. 2017. Job stress dimension and work-related musculoskeletal disorders among southeast Nigerian physiotherapists. *International Journal of Occupational Safety and Ergonomics*. Volume 23. Referred 15.01.19. DOI: 10.1080/10803548.2016.1219476
- Albert, Wayne & Currie-Jackson, Nadine & Duncan, Carolyn. 2008. A survey of musculoskeletal injuries amongst Canadian massage therapists. *Journal of bodywork and movement therapies*. Referred 17.10.17. DOI: 10.1016/j.jbmt.2007.03.003
- Ankrum, D. R., & Nemeth, K. J. 2000. Head and Neck Posture at Computer Workstations - What's Neutral? Proceedings of the Human Factors and Ergonomics Society Annual Meeting. SageJournals. Referred 12.10.18. <https://doi.org/10.1177/154193120004403046>
- Anyfantis, I.D. Biska, A. 2018. Musculoskeletal Disorders Among Greek Physiotherapists: Traditional and Emerging Risk Factors. *Safety and Health at Work*. Volume 9. Issue 3. Science Direct.
- Ariëns, G. M. Bongers, P. M. Douwes M. et al. 2001. Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study. *Occupational and Environmental Medicine*. Referred. 12. 04. 18. doi: 10.1136/oem.58.3.200
- Beighton, P. Grahame, R. Bird, H. 2012. *Hypermobility of Joints*. 4<sup>th</sup> Edition. Springer.
- Boron, W.F. Boulpaep, E.L. 2003. *Medical Physiology*. Saunders. 2nd edition. Elsevier.
- Cassar, M. P. 2004. *Handbook of Clinical Massage*. A complete guide for students and practitioners. Elsevier Limited.
- Chang, M. , Wang, S. and Chen, C. 2002. Effects of massage on pain and anxiety during labour: a randomized controlled trial in Taiwan. *Journal of Advanced Nursing*. Referred 03.04.19. DOI: 10.1046/j.1365-2648.2002.02147.x
- Chezar A, Berkovitch Y, Haddad M, Keren Y, Soudry M, Rosenberg N. 2013. Normal isometric strength of rotatorcuff muscles in adults. *Bone Joint Res*. Referred 12.11.17. doi: 10.1302/2046-3758.210.2000202
- Clarke, J. Tulder, M. Blomberg, S. Heijden, G. Bronfort, G. 2006. Traction for Low Back Pain With or Without Sciatica: An Updated Systematic Review Within the Framework of the Cochrane Collaboration. Volume 31. Issue 14.
- Danion, F. Latash, M. L. Li, Z. M. Zatsiorsky, V. M. 2001. The effect of a fatiguing exercise by the index finger on single- and multi-finger force production tasks. *Experimental brain research*. Referred 08.08. 19. doi: 10.1007/s002210100698
- Dieën, J. 1997. *Applied Ergonomics*. Difference in low back load between kneeling and seated working at ground level. Volume 28. Elsevier.



Englund, L. Svärdsudd, K. 2000. Sick-listing habits among general practitioners in a Swedish county. *Scandinavian Journal of Primary Health Care*. Referred 11.12.18. DOI: 10.1080/028134300750018954

French, H. P. Brennan, A. White, B. Cusack, T. 2010. Manual therapy for osteoarthritis of the hip or knee – a systematic review. *Manual Therapy*. Referred 03.03.18. DOI: 10.1016/j.math.2010.10.011

Fritz, S. 2017. *MOSBY'S Fundamental of Therapeutic Massage*. 6<sup>th</sup> Edition. Elsevier Inc.

Gibbs, K. 2016. Stability. Referred 12.12. 18. [http://www.schoolphysics.co.uk/age11-14/Mechanics/Statics/text/Stability\\_/index.html](http://www.schoolphysics.co.uk/age11-14/Mechanics/Statics/text/Stability_/index.html)

Greene, L. Goggins, R. 2008. *Save Your Hands!: The Complete Guide to Injury Prevention and Ergonomics for Manual Therapists*. Body of Workbooks. 2nd Edition.

HAMK. 2018. *THESIS GUIDE*. Bachelor's thesis and Master's thesis guideline for thesis processes. Häme University of Applied Science.

Heckman, K. 2019. Mechanical Leverage Calculator. vCalc. Referred 09.10.19. <https://www.vcalc.com/wiki/KurtHeckman/Mechanical+Leverage+Calculator>

Hilbert, J. E. Sforzo, G. A. Swensen T. 2003. The effects of massage on delayed on-set muscle soreness. *British Journal of Sports Medicine*. Volume 37

Huijbregts, P. A. 2011. Manual therapy. In *Pain Procedures in Clinical Practice*. 3<sup>rd</sup> edition. Elsevier.

Johnson, J. 2010. *Deep Tissue Massage*. Human Kinetic Publishers.

Konin, J. G. Jessee, B. 2012. *Range of Motion and Flexibility*. Physical Rehabilitation of the Injured Athlete. 4th Edition. W.B. Saunders.

Milhem, M. Kalichman, L. Ezra, D. Alperovitch, D. 2016. Work-related musculoskeletal disorders among physical therapists: A comprehensive narrative review. Referred 22.11.19. doi: 10.13075/ijomeh.1896.00620.

Mulligan, B. R. 2005. *Manual Therapy, "NAGS", "SNAGS", "MWMS", ETC*. 5<sup>th</sup> Edition. OPTP.

Mulligan, E. 2001. Principles of Joint Mobilization. Continuing Ed. Presentation. Referred 18.11.18. [https://www.physio-pedia.com/images/c/c0/Principles\\_of\\_Joint\\_Mobilization.pdf](https://www.physio-pedia.com/images/c/c0/Principles_of_Joint_Mobilization.pdf)

Neumann, D. 2003. The Carpometacarpal Joint of the Thumb: Stability, Deformity, and Therapeutic Intervention. *Journal of Orthopaedics & Sports Physical Therapy*. Referred 10.10.19. DOI: 10.2519/jospt.2003.33.7.386

Norkin, C. White, D. 2009. *Measurement of Joint Motion. A Guide to Goniometry*.

Page P. 2012. Current concepts in muscle stretching for exercise and rehabilitation. International journal of sports physical therapy.

Passer, M. W., & Smith, R. E. 2004. Psychology: The science of mind and behaviour. 2nd edition. New York, NY, US: McGraw-Hill.

Porter, S. 2013. Tidy's Physiotherapy. 15th edition. Edinburg. Elsevier.  
Voight, M. L. Hoogenboom, B. J. Prentice, W. E. 2007. Musculoskeletal interventions: Techniques for therapeutic exercise. New York: McGraw-Hill, Medical Pub. Division.

Simmons, B. 2015. Presentation. Referred 12.03.18.  
<https://slideplayer.com/slide/7674941/>

Straker, L. M. 2003. A review of research on techniques for lifting low-lying objects: 2. Evidence for correct technique. Vol. 20. IOS Press.

Tamayo, J. 2017. Distributed loading. Referred 25. 05.18. <https://www.doc-city.com/en/distributed-loading-by-copying-god/2241763/>

Waters, T. R. Dick, R. B. 2015. Evidence of health risks associated with prolonged standing at work and intervention effectiveness. Referred 22.12.19.  
DOI:10.1002/rnj.166

Website of Berkley University. Referred 12.10.18. <https://www.berkeleywellness.com/fitness/exercise/article/stretching-better-buddy>

Website of CIEHF. Referred 20.08.18. <https://www.ergonomics.org.uk/Default.aspx>.

Website of Ergonomics. Referred 20.10.17. <http://www.ergonomics.com.au/what-is-ergonomics/>

Website of International Ergonomics Assosiacion. Referred. 27.10.17.  
<https://www.iea.cc/whats/index.html>

Website of Massage Therapy. Referred 13.08.18. ROM End Feel. <https://www.massagetherapyreference.com/rom-end-feel/>

Website of Merrium-Webster Dictionary. Referred 29.12.15. <https://www.merriam-webster.com/dictionary/ergonomics>

Website of MyhealthAlberta. Referred 10.10.18. <https://myhealth.alberta.ca/Health/pages/conditions.aspx?hwid=hw206944>

Website of Oregon Occupational Safety and Health. Referred 20.10.18.  
<https://osha.oregon.gov/OSHAPubs/ergo/ergoadvantages.pdf>

Website of United States Department of Labor. Referred 20.10.18  
<https://www.osha.gov/SLTC/ergonomics/>

Website of WebMD. Referred 20.11.19. <https://www.webmd.com/a-to-z-guides/myositis-symptoms-treatments-prognosis#1>

Weerapong, P. Hume, P.A. & Kolt, G. S. 2005. The Mechanism of massage. Sports Med.

Willhuber, C. Piuze, N. S. Straight Leg Raise Test. 2019 In: StatPearls. Treasure Island (FL): StatPearls Publishing.

Yates, John. 2004. A Physician's Guide to Therapeutic Massage, Third Edition. Ontario, Canada: Curties-Overzet Publications Inc.

Yang TH, Lu SC, Lin WJ, Zhao K, Zhao C, et al.. 2016. Assessing Finger Joint Biomechanics by Applying Equal Force to Flexor Tendons In Vitro Using a Novel Simultaneous Approach. PLOS ONE 11.

Ylinen, J. 2008. Stretching Therapy for Sport and Manual Therapies. Medirehabook Inc.