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Inter- and intra-rater reliability of a technique for assessing the length of the Latissimus Dorsi muscle

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Abbreviations

Table 1.1: List of abbreviations

Abbreviation	**Meaning**
ADL	Activities of daily living
GHJ	Glenohumeral joint
ICC	Intraclass correlation coefficient
LD	Latissimus Dorsi muscle
M	Muscle
ROM	Range of motion
UP	The University of Pretoria

1.1 Definition of key terms

Table 1.2: Definition of key terms

Term	Meaning/Definition
Dysfunction	Abnormal functioning of an anatomical structure. In this study applicable to the abnormal functioning of the LD or the GHJ, e.g. the dysfunction of LD is related to its length (Mosby, 2009).
Inter-rater reliability	This is the degree of agreement among raters. It gives a score of how much homogeneity, or consensus, there is in the ratings given by judges (Burns and Grove, 2005).
Intra-rater reliability	The intra-rater reliability is the degree of agreement among multiple repetitions of a diagnostic test performed by a single rater (Burns and Grove, 2005).
Latissimus Dorsi	M Latissimus Dorsi meaning 'broadest [muscle] of the back' (Latin latus meaning 'broad', Latissimus meaning 'broadest' and dorsum meaning the back), is the large, flat, dorso-lateral muscle on the trunk, posterior to the arm, and partly covered by the trapezius on its median dorsal region (Mosby, 2009).
Reliability	A term denoting the consistency of a measure obtained in the use of a particular measure/measurement technique (technique of measuring the length of LD) and is an indication of the extent of random error in the measurement method (technique of measuring the length of LD) (Burns and Grove, 2005).
Reproducibility	The ability of an entire experiment or study to be reproduced, either by the researcher or by someone else working independently. The LD length test technique should be able to be reproduced by any researcher (Burns and Grove, 2005).
Objective measurements	A measure that requires little or no judgment on the part of the researcher performing the measurement. For example, the LD length test technique will hypothetically provide the same result on a single subject with dependency on the variability of the clinician (Mosby, 2009).
Outcome measure	A quantifier of dysfunction, the standard against which the results of the LD length test is assessed (Mosby, 2009).
Technique	The systematic procedure by which a complex or scientific task is accomplished (Mosby, 2009).

Abstract

Introduction

The length of a muscle has been described as one of the factors contributing to the ideal movement at a joint. A decrease in the length of a muscle results in a decrease in the range of motion at the joint in direct relation to the function of that specific muscle. M Latissimus Dorsi is a muscle which undergoes length changes (loss of extensibility) and this muscle has a functional role in many aspects of sport and rehabilitation. The loss of extensibility may result in a decreased range of motion at the glenohumeral joint leading to dysfunction. Evidence-based practise requires the use of objective, valid and reliable tests for measuring the length of a muscle. No scientific evidence of reliability for any documented technique testing the length of m Latissimus Dorsi (LD) was found.

Aim

The aim of this study was to assess the inter-rater and intra-rater reliability of a technique adapted by Commerford and Mottram (2012) for assessing the length of LD.

Study design

The design of the study is a within-participant test-retest non-experimental quantitative study for reliability purposes

Method

Fifty-six volunteering students recruited from the Physiotherapy Department of the University of Pretoria were the participants in this study. Four qualified physiotherapists with varying numbers of years of clinical experience independently performed the test for assessing the length of LD. The test was performed twice by each physiotherapist on every participant and two measurement sessions were done. A pilot study was also done.

Data Analysis and conclusion

A sample of 56 participants provided an intraclass correlation coefficient (ICC) of less than 0.9 and this is regarded as poor reliability. The agreement between each rater and the differences in the two levels of experience of raters were also assessed. The ICC was used to determine the inter-rater and intra-rater reliability of the LD length test. A 0.05 level of significance was employed.

The ICC between the experienced raters was found to be 0.48 with a novice rater ICC of 0.48 as well. The ICC between all the raters was 0.33. This constitutes poor reliability. The poor reliability of the technique testing the length of LD was identified and addressed in order for adequate usage thereof, in research and in practice. Recommendations of a new technique to test the length of LD was provided by the researcher.
A suggestion was made regarding a manner of testing its reliability.

Key words

M Latissimus Dorsi, muscle length test, dysfunction; reliability; reproducibility; glenohumeral joint; range of motion

Chapter 1: Background and literature

1.1 Introduction

The Latissimus Dorsi (LD) is a large muscle with a role in the production of movement. Some of the functions of LD are: a major role in throwing, crutch walking, climbing and swimming. LD hypertrophies and loses extensibility in the presence of pain, overuse and dysfunction (Commerford and Mottram, 2001) (Figures 1.1 to 1.3). LD undergoes changes in length due to pathology or pain in the shoulder region (Borstad and Briggs, 2010).

It is important to evaluate dysfunction objectively. In general, a clinical measurement of dysfunction, such as muscle length, could be valuable to determine the presence of the specific impairment of a patient or to assess the change in the impairment objectively (De Vet, Terwee, Knol, and Bouter, 2006).

Outcome measure is the collective used to describe an evaluation technique to quantify dysfunction (Swinkels, van Peppen, Wittink, Custers and Beurskens2011). The technique testing the length of LD would quantify the dysfunction relating to LD muscle length discrepancy.

Muscle length measurement tests are frequently used as outcomes measures that are valuable to physiotherapists (Kendall, McCreary, and Provance, 1993).
The use of scales and measurable objectives are essential to the clinical reasoning and objectivity regarding the evaluation of a patient. These factors are essential to good clinical practice (Swinkels et al. 2011).

1.2 Background

During the assistance of a colleague's PhD data collection involving shoulder injuries in swimmers, the observation was made that the length of LD may contribute to poor shoulder joint alignment and dysfunction. To determine the contribution of LD length on shoulder dysfunction, the length of LD should be evaluated and compared to an ideal standard of length. To measure the length of LD a reliable test assessing the length of LD is needed.

LD is a large, superficial, bulky muscle that originates from the lower six thoracic vertebrae, thoraco-lumbar facia, iliac crest and inferior three to four ribs. This muscle inserts on the inter-tubercular groove of the humerus (Moore 1992).

LD has different functions. Agonistically, LD does extension; medial rotation and adduction of the shoulder joint (Moore 1992). Functionally, LD raises the trunk towards the humerus during climbing where the arms are used (Moore 1992). LD is a muscle that contributes to a variety of glenohumeral joint (GHJ) movements needed by a range of people in everyday situations. Swimmers use LD to generate enough force to propel them through the water (Herrington and Horsely 2012). Dohle and colleagues (2013) argued that LD was also one of the muscles to be treated as part of the rehabilitation of stroke patients. LD is one of the key muscles affected by stroke and rehabilitated in patients suffering from stroke. In baseball pitchers, LD is a muscle that was found to be extremely active from the late cocking phase into the acceleration phase of throwing (Nagda et al 2011). In patients with spinal cord injury, LD is often used to compensate for the loss of function of other muscles that are more proximal to LD.

The background information stated above, as well as the anatomy and functioning of LD, is described in detail in the literature review in Chapter 2.

1.3 Problem statement

LD is a bulky, superficial muscle that has a role in the production of movement and that, anatomically, runs over more than one joint; therefore LD is a global mobiliser (Commerford and Mottram, 2001). Global mobilisers may lose extensibility in the habitual use or consistent positioning of a joint, for example poor posture.

Loss of extensibility of LD may limit physiological movement. A shortened LD limits flexion and lateral rotation of the GHJ. Therefore, LD plays a role in the cause of dysfunction. Dysfunction needs to be measured in order to maintain treatment efficacy and objectivity.

A reliable test measuring dysfunction is needed in order to maintain consistency between a therapist's measurements and between therapists. This reliability is dependent on the technique of the test. This is important in the interest of objectivity. These techniques of measuring muscle lengths are frequently used, despite their lack of reliability and clinical accuracy. Most measurements of muscle length have not been tested for reliability and validity and, despite this limitation, these tests continue to be applied in theory and in practice (Borstad and Briggs, 2010).

According to the literature, there is no scientific evidence proving the existence of a reliable test technique for measuring the length of LD.

1.4 Research question

Does the technique that was described by Commerford and Mottram (2012) for measuring the length of the LD muscle render scientific inter-rater reliability as well as intra-rater reliability?

1.5 Aim and objectives

1.5.1 Aim

The aim of the study is to assess the reliability of the technique of the test to measure the length of LD.

1.5.2 Objectives

- To assess the reliability of the technique of a test measuring the length of LD by means of intra-rater agreement in both novice and experienced clinicians; and

- To assess the reliability of the technique of a test for measuring the length of LD by means of inter-rater agreement in both novice and experienced clinicians.

1.6 The Importance and benefits of the study

Physiotherapists and other clinicians use outcome measures prior to the treatment of a patient in order to obtain a baseline of informative measurements from which treatment techniques may be selected by the therapist/clinician (Borstad and Briggs 2010). The objectivity of the measurements of the length of LD between therapists in clinical settings will thereby improve the tracking of effectiveness and progress of the patient more adequately. A reliable LD length test could be valuable to determine the presence of the specific impairment of a patient or to assess the change in the impairment objectively (De Vet, Terwee, Knol, and Bouter, 2006).

Consistency between each therapist's own measurements (intra-rater reliability) of the length of LD of a single patient will also improve, thereby tracking effectiveness and progress of the patient more adequately as well.

If this technique of testing the length of LD is proven reliable, clinicians would benefit via the application of a reliable technique of a test evaluating LD length in the various clinical settings. Factors such as objectivity and consistency of outcomes measures are essential to good clinical practice (Swinkels et al. 2011).

Whether the technique for testing the length of LD is proven reliable or not, researchers will benefit via the availability of a reliable test for evaluating LD length or by being given access to an adapted test to assess the reliability as well as logistical and methodological recommendations for future muscle length test and reliability studies.

Researchers and clinicians alike, may then use this test as an outcomes measure in future studies as well as in practice, for example where LD length can be tested for correlation with pain and dysfunction by means of a technique that is proven scientifically reliable. This will add scientific rigour, accuracy and objectivity to possible future studies relating to the length of LD.

Figures 1.1 to 1.3 display functional everyday positions where a LD contraction is a major contributing factor to the functional movement displayed. Figure 1.1 displays an individual dressing herself in a jacket where extension adduction and medial rotation is needed. Figure 1.2 displays an individual attempting to pick up a box and place it beside her where the function of LD will be necessary as well. Figure 1.3 shows an everyday movement where a hospital patient would shift forward in his/her hospital bed; the same would apply to any individual shifting forward in a chair to stand up in any setting.

Figure 1.1: An individual putting on a piece of clothing from behind

Figure 1.2: An individual displaying a situation where the strength of Latissimus Dorsi is needed

Figure 1.3: An everyday movement where Latissimus Dorsi is acting functionally.

1.7Research design

The range of motion is measured in units of degrees. This is a quantifiable variable. Reliability is also quantified using the intra-class correlation co-efficient (ICC); this variable is then analysed and an interpretation thereof results in either a conclusion of good reliability or poor reliability. This reliability study is quantitative and analytical (Burns and Grove, 2005). The within-participant, non-experimental nature of the study indicates that this is a within-participant test-retest non-experimental quantitative study for reliability purposes (Lachin, 2004).

1.8 Ethical and legal considerations

Ethical and legal considerations have been accounted for, since approval by the Physiotherapy Department, School of Healthcare Sciences Postgraduate Committee and Ethics Committee of the Healthcare Sciences Faculty was obtained. The University of Pretoria Research Ethics Committee may be contacted at: The Research Ethics Office: Tel: 012 354 1330 or 012 354 1677 Fax: 012 354 136, manda@med.up.ac.za or deepeka.behari@up.ac.za. The ethics referral number for the protocol of this study is 464/2013. (Appendix B)

Firstly, the consent form and procedure were explained to all the participants in this study. At the same information session, the course of the study was explained to each of the interested parties. Each participant was informed that all questions would be answered by the primary researcher. Each participant then signed aform of informed consent, prior to the commencement of the study, at which point all the important facts regarding the procedure and what would be expected from the participants regarding the evaluation of their biomechanical dysfunction was discussed. In Appendix C, an example of the written informed consent clearly stating the expectations of the participant and the process of the study in non-technical language is attached; in this way the right of informed consent was exercised.

Appendix D contains a declaration from the statistician that he/she is objective and has no connection to the study. The data has been cleaned and checked; the corresponding declaration is attached (Appendix H).

The confidentiality of the participants was protected throughout the study. The participants were given study numbers and their identities were protected by personal information not being displayed in the data. This data will be stored for a period of no less than fifteen years (Appendix H).

The participants bore no costs in the participation of this study, since the trials have proceeded at their respective practice venues at times most convenient to them (In the event of any costs being incurred by the participant, the researcher would bear these costs, if directly related to the study).

As discussed earlier, quality control has been ensured throughout the study. All participants were given the opportunity to withdraw from the study at any time.

The participants have also been given ample opportunity for questions at the information session, thereby exercising the principle of autonomy. This is a study purely focussing on evaluation and observation and its procedures are non-invasive. This minimizes any risk of side effects and physiological change to the participant. Letters granting permission to be photographed were signed by the two individuals in the photographs (Annexure J).

1.9 Course of the Dissertation

Chapter 2presents a literature study that focuses on the description and the importance of Latissimus Dorsi (LD) with regard to classification, anatomy, function and the dysfunction of LD with specific relevance to muscle shortening. Reliability and reliability testing regarding LD muscle length tests will then be reviewed.

Chapter 3 contains a detailed account of the methodology of this study, which will ensure that this study is replicable.

In Chapter 4, the collected data and results of this study are discussed. A visual presentation of the results is also provided in the form of tables, graphs and figures.

Chapter 5 discusses the results of this study against the background of the relevant literature.

In Chapter 6 the limitations of this study, as well as the clinical significance of the findings, are discussed. A new technique to assess the length of LD is subsequently recommended for further testing in further research studies.

Chapter 2: Literature review

2.1 Introduction

Understanding the structural and functional anatomy of the Latissimus Dorsi muscle (LD) as part of the musculoskeletal system, is the key to the understanding the function of LD in the movement system. The first aim of the following literature review is to describe the importance of LD in detail regarding the anatomy of LD as it relates to its function, classification and dysfunction thereof. The second aim of this literature review is to review the literature exploring the dysfunction of LD with specific relevance to muscle shortening. The third aim of this literature review is to illustrate the importance of objectivity in the measurement of dysfunction, thereby illustrating the importance of a reliable technique to test the degree of muscle shortening with specific reference to LD. Reliability testing and the literature describing it will then be discussed with reference to the measurement of dysfunction and statistical analysis. The fourth aim of this literature review is to critically review and analyse a study in which the reliability of a technique testing the length of LD is tested. The final aim of this literature review is to summarize and apply all the literature discussed to the relevance and importance of the length of LD and the reliability of a technique to test this.

2.2 Topic development

During the assistance of a colleague's PhD data collection involving shoulder injuries in swimmers, the observation was made that the length of LD may contribute to poor shoulder joint alignment and dysfunction. To determine the contribution of LD length on shoulder dysfunction, the length of LD should be evaluated and compared to an ideal standard of length. To measure the length of LD a reliable test to assess the length of LD is needed.

A data search was performed to find proof of scientific reliability for a test that measures the length of LD. Details of the search are summarized in Table 2.1.

Table 2.1: Literature search strategy

Sources	**Keywords used**	**Applicable results**	**Limitations**
Google Scholar, Pub med, Science Direct and the Cochrane library. Physical therapy textbooks and journals have also been reviewed.	• Latissimus Dorsi • Reliability • Length test • Outcomes measures • Reproducibility • Muscle length test • Anatomy of the Latissimus Dorsi	± 50,000 results were found, of which only one was directly applicable; Borstad and Briggs, 2010, "Reproducibility of a measurement for Latissimus Dorsi muscle length", Physiotherapy Theory and Practice, vol. 26, no. 3, pp. 195-203	English Humans The study was limited to articles published in the years 2000-2013 and this limitation was subsequently removed due to the amount of literature available.

A vast majority of the articles that was reviewed related to surgical procedures where LD was resected and used in breast reconstruction surgery post mastectomy and other surgeries. The LD flap is a workhorse flap for salvage of failed expander-implant reconstructions.

The flap also provides trophic stimulation to the surrounding tissues without increased disease morbidity or interference with mammographic evaluation (Ferbeyre-Binelfa 2010).

These articles held no substantial value with regards to the concept of this study. The only applicable article relating LD length and reliability was the one by Borstad and Briggs (2010), where the reliability of the test described by Levangie and Norkin (2001) was tested. This was the only article that involved testing the reliability of a LD length test.

This article will be reviewed critically in detail later in this literature review. Another article by Herrington and Horsley (2013) will also be reviewed with regards to the method they have used to test the length of LD. Other articles selected and referred to in this study are briefly reviewed in table 2.2.

Table 2.2 Brief review of relevant articles found

Article	**Content**	**Relevance**
McGill and Norman: *Dynamically and statically determined low back moments during lifting*. Journal of Biomechanics 18:877-885, 1985	McGill and Norman concluded that the contraction of the LD and abdominal muscles created tension within the thoraco-lumbar fascia and therefore LD plays a major role in lumbar spine movements.	The thoraco-lumbar fascia provides a major support mechanism for lifting, regardless of the lumbar posture adopted. LD serves to increase the tension along the thoraco-lumbar fascia, assisting in the resistance of flexion. This article serves to show

Article	**Content**	**Relevance**
		yet another important function of LD.
Bogduk, Johnson and Spalding: *The morphology and biomechanics of Latissimus Dorsi.* Clinical Biomechanics, 13(6), 377-385, (1998).	An article using structure to reason the function of LD	A cadaver study proving the anatomical reference made to this muscle in this study.
Latissimus Dorsi and Teres Major Tears in Professional Baseball Pitchers: A Case Series American Journal of Sports Medicine, 37 2016-2020, (2013).	Anatomy listed as well as function described and prevalence of injury.	The prevalence of LD overuse injuries is used to prove relevance and importance of the muscle, and this serves to indicate the relevance of measuring dysfunction such as the length of LD.
Herrington, L. and Horsley, I. 2013: *Effects of Latissimus Dorsi length on shoulder flexion in canoeists, swimmers, rugby players, and controls*, Journal of Sport and Health Science, vol 1,	The length of LD differs between sports and controls in accordance with the specific physical demands of their sport. The inclusion and exclusion criteria were well described. The	Several studies have shown that athletes engaged in overhead sports demonstrate increased external rotation with a concomitant loss of internal rotation. The technique used in this

Article	Content	Relevance
pp.1-4.	reliability and the validity as well as the sources of the instruments used were not well described.	article is also critiqued in this literature review.
Burns, N. and Grove, S.K. 2005:*The practice of nursing research*, 5th ed., Elsevier Saunders, Philadelphia, pp. 374-376.	Textbook defining reliability and reliability testing as well as reproducibility.	This is a reliability study testing the inter and intra-rater reliability of a technique assessing the length of LD.
Aartun, E., Degerfalk, A., Kentsdotter, L., and Hestbaek, L. (2014): *Screening of the spine in adolescents: inter-and intra-rater reliability and measurement error of commonly used clinical tests*. BMC musculoskeletal disorders, vol. 15, no 1, pp. 37.	The authors tested common spinal clinical tests for inter and intra-rater reliability in adolescents.	Definitions of intra class correlation co-efficient and methods of testing reliability and data analysis applied to this study.

The main topic of this study is the Latissimus Dorsi muscle (LD). In order to understand the literature that follows this muscle will now be described with regard to its anatomical attachments and function.

2.3 The Latissimus Dorsi muscle

The words 'Latissimus Dorsi' are derived from the Latin words *latus*, meaning broad, and *dorsum*, meaning the back; therefore Latissimus Dorsi has the intended meaning of 'the broadest muscle of the back' (Mosby, 2005).

Muscle constitutes approximately forty per cent (40%) of total body weight (Petty 2004). Muscles are made up of contractile and non-contractile tissue. Skeletal muscle contracts in order to produce or prevent movement (Petty 2004). LD is a skeletal muscle producing movement; this statement will be addressed further in the literature discussed below.

LD is the widest muscle in the human body. It is relatively thin and covers almost all the muscles of the back at the posterior trunk (Mosby, 2005).

LD is a large superficial muscle that originates from the lower six thoracic vertebrae, thoraco-lumbar facia, iliac crest and inferior three to four ribs; it inserts on the inter-tubercular groove of the humerus and LD is supplied by the sixth, seventh, and eighth cervical nerves through the thoracodorsal (long scapular) nerve (Moore 1992). (Figure 2.1).

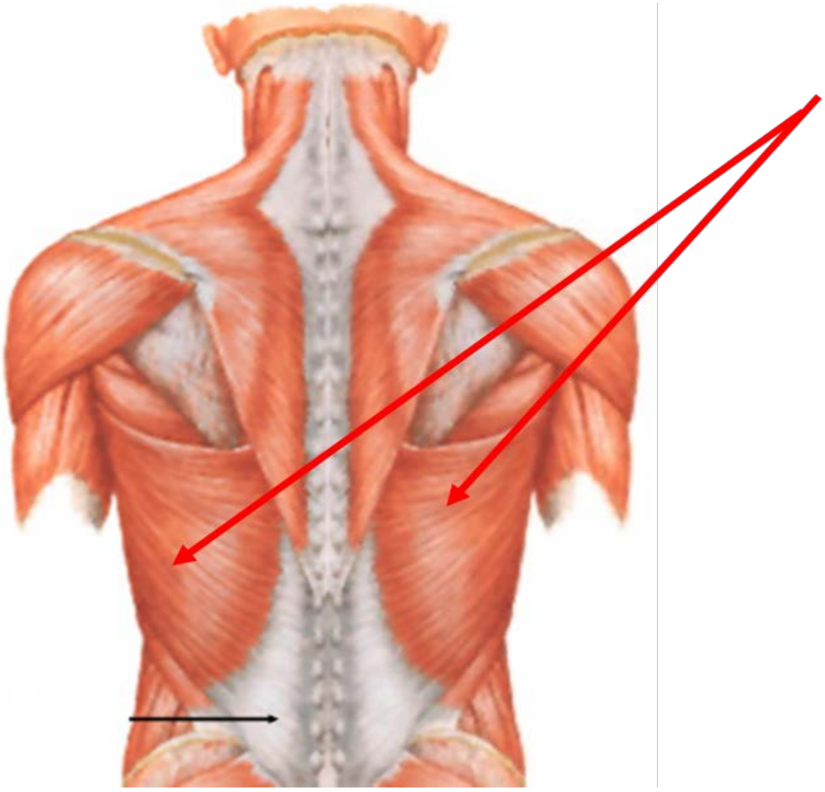

Figure 2.1: A graphic illustration of LD (Moore 1992, pp.530- 531)

The red arrows in Figure 2.1 depict the muscle belly of LD bilaterally. The black arrow indicates the fascia attachment at the thoraco-lumbar fascia.

LD has now been structurally described. The structure of a muscle is in direct correlation to its attributed function. The functional importance of this muscle will now be described.

2.4 The function and importance of LD

The LD has different functions. The main functions of LD are: extension, medial rotation and adduction of the glenohumeral joint (Moore 1992). Functionally, LD raises the trunk towards the humerus during climbing where the arms are used (Moore 1992). LD is a muscle that contributes to a variety of glenohumeral joint (GHJ) movements that are needed by a range of people in everyday situations. One example is where swimmers use LD to generate enough force to propel them through the water (Herrington and Horsely 2012).

Other examples would be a canoeist paddling through the water and a rugby player throwing a rugby ball (Herrington and Horsely 2012).

Dohle and colleagues (2013) argued that LD was also one of the muscles to be treated as part of the rehabilitation of stroke patients, since LD is one of the key muscles affected by stroke because it is the muscle of the upper limb that plays a major role in crutch/assistive device walking. In baseball pitchers, LD is a muscle that was found to be extremely active from the late cocking phase into the acceleration phase of throwing (Nagda et al 2011). In patients with spinal cord injury, LD is often used to compensate for the loss of function distal to LD. The functionality of LD is rarely explored in the available literature; the articles referred to above (Table 2.2) served the purpose of demonstrating the importance of the function of LD in sport, rehabilitation and everyday life.

Figure 2.2 provides a skeletal representation of LD function.

Two arrows originating from the LD insertion represent the directions in which the muscle can produce movement. The top arrow (A) represents extension; the horizontal arrow (B) represents adduction and medial rotation.

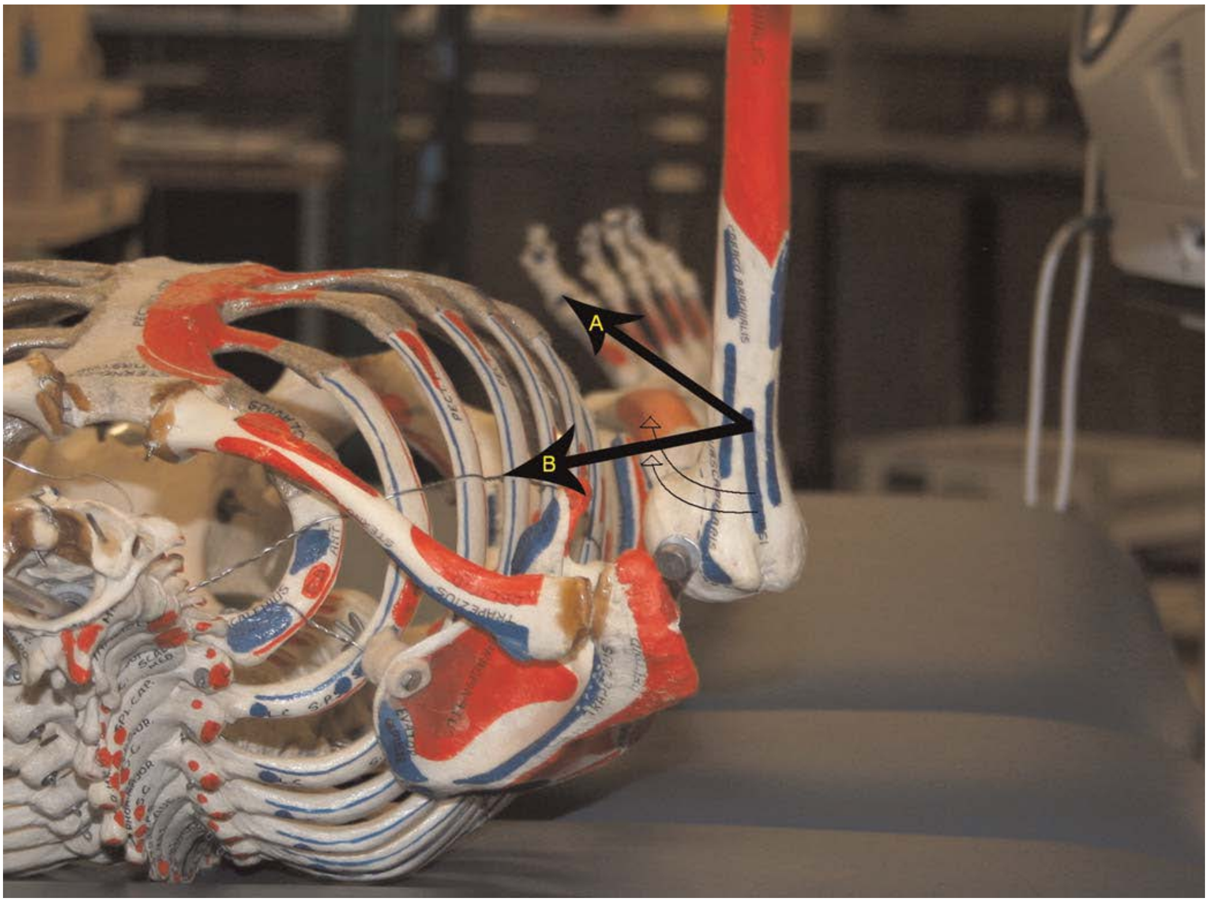

Figure 2.2: A skeletal representation of the function of Latissimus Dorsi (Borstad and Briggs 2010)

2.5 Structural and functional anatomy of Latissimus Dorsi

As mentioned above, the importance of the function and the structure of LD is integral to the understanding this muscle. The applicable literature will now be discussed in order to highlight the importance of this muscle, to classify the muscle according to its structure and function and to describe typical characteristics of this muscle.

Muscles are divided into local stabilisers or global mobilisers according to their build and function (Commerford and Mottram, 2001).

The muscular system of the body with regards to structural characteristics and anatomy is divided into two categories, namely the local and global movement systems. For categorisation, refer to Table 2.3.

Table 2.3: Structural characteristics of the two movement systems (Commerford and Mottram 2001)

Subdivisions of characteristics	Local stabilisers	Global mobilisers
Number of joints crossed by a muscle	Mono-articular	Bi-articular/multi-articular
Place of attachment	Segmental attachments	Superficial attachments
Mechanics of movement	If deep: short levers and small moment arms	Long levers, large moment arms and greatest bulk
Biomechanical differences	If superficial: broad apo-neurotic insertions to distribute load and force	Lever mechanics biased for speed or large range of movement

LD is a bi-articular muscle since it crosses more than one joint. LD is a large superficial muscle. LD has large movement arms. These structural characteristics correspond to the function of flexion adduction and medial rotation of the GHJ. If one takes the structural characteristics of LD displayed in Table 2.3 into consideration, LD would fit all the criteria regarding the subdivisions of the structural characteristics of a global mobiliser.

The muscular system of the body with regards to functional characteristics and movement is also divided into two categories, namely the local and global movement systems. Latissimus Dorsi will now be discussed with relation to its classification regarding function.

The functions of the stabilising muscles are mainly to support joints, provide stability to the joints in the ideally aligned position and these stability muscles do not activate in the presence of pain (Commerford and Mottram 2001). One example of this would be the in-activation of the Multifidus muscle in the presence of back pain.

The global mobilisers however, generate force and are involved in the acceleration of motion and hypertrophy in the presence of pain/dysfunction. The mobilisers have the possibility to loose extensibility due to over activity and hypertrophy. The loss of extensibility results in a shortened LD and a decrease in the range of GHJ motion (Commerford and Mottram 2001).

One example is a bodybuilder whose decreased range of glenohumeral joint (GHJ) horizontal abduction is accounted for by the presence of severely rounded shoulders and an increased Pectoralis major muscle bulk. This demonstrates the over activity, hypertrophy and poor extensibility of this globally mobilising muscle. The movement system classifies muscles into local stabilisers and global mobilisers. Table 2.4 provides detail regarding the different categories of muscles with specific reference to their functional characteristics.

Table 2.4: Functional characteristics of the two movement systems (Commerford and Mottram 2001)

Subdivisions of characteristics	**Local stabilisers**	**Global mobilisers**
The role of the muscle contraction	Increase muscle stiffness to control segmental motion	Generates torque to produce range of movement
The role of the type of muscle in movement	Controls the neutral joint position	Concentric acceleration of movement (especially sagittal plane: flexion/extension)
The effect of the contraction of the type of muscle on the length of the muscle	Contraction has no effect on muscle length, does not produce ROM.	Contraction concentric length change; concentric production of movement (rather than eccentric control)
Pattern of activation	Continuous activity throughout Movement	Non-continuous activity (on : off phasic pattern)

Subdivisions of characteristics	Local stabilisers	Global mobilisers
Dependency of activity on the direction of movement	Activity is independent of direction of movement	Activity is direction dependent
Stimulation needed for activation	Proprioceptive input from: joint position, range and rate of movement	Shock absorption of load
Effects of the type of muscle in the presence of dysfunction	Motor control deficit associated with delayed timing or recruitment deficiency	Loss of myo-fascial extensibility and limits physiological and/or accessory motion
Reaction of the type of muscle to pain	Reacts to pain and pathology with inhibition	Reacts to pain and pathology with spasm

LD is a skeletal muscle (Moore 1992) and is used to produce torque and force when contracting in order to execute a function (Herrington and Horsely 2012, Nagda et al 2011). According to Table 2.4 LD generates enough torque to produce: range of movement, concentric acceleration of movement (especially in the sagittal plane: flexion/extension) and a contraction of concentric length change. LD has a non-continuous activity (on/off phasic pattern). LD would react to pain and pathology with spasm. If the functional characteristics listed in Tables 2.3 and 2.4 respectively are taken into account, the functional characteristics described above are similar to the structural characteristics of LD in the sense that they fall in the category of a global mobiliser.

According to Table 2.4, activity produced by LD is direction dependent and therefore may experience a loss of myo-fascial extensibility and this may limit physiological and/or accessory motion. This is referred to as muscle shortening. This will lead to impaired functioning. Muscle shortening will now be explicitly discussed and explained, specifically relating to LD. The position of a shortened as well as a lengthened LD will be described as well.

2.6 Muscle shortening

LD is a mobilizing muscle and it hypertrophies and shortens in the presence of pain, overuse and dysfunction (Commerford and Mottram, 2001).

The habitual use of a muscle or positioning may lead to an altered muscle length (Commerford and Mottram, 2001). If one considers the functional classification of LD described above, a patient maintaining a position that places LD in a shortened position is bound to suffer with LD shortening.

When the glenohumeral joint (GHJ) is placed in flexion and lateral rotation, LD is in a maximally lengthened position and global mobilisers shorten in the habitual use or constant positioning of the globally mobilising muscle (Commerford and Mottram 2001).

This statement denotes that LD will shorten when the GHJ is placed in extension adduction and medial rotation for prolonged periods of time; consequently, the range of GHJ flexion and lateral rotation will be limited. This is because a shortened global mobiliser may cause a decrease in joint range of motion.

The literature referred to above proves that LD is a muscle that may shorten. The effects of this will now be discussed in detail.

2.7 The effects of a shortened Latissimus Dorsi

A shortened LD will limit the physiological movement of flexion and lateral rotation of the glenohumeral (GHJ) and in turn this will decrease functionality and lengthen the progress of rehabilitation with other compensatory side effects such as trick movements in the spine, which will be discussed later in the literature review.

GHJ flexion requires an optimal length of LD in order to allow full lateral rotation of the humerus and upward scapular rotation (Herrington and Horsley 2013). If shoulder flexion (in an externally rotated position) is restricted, this may predispose the individual to shoulder pain and pathology (Herrington and Horsley 2013).

An ideal position of any joint is very important, since this would lead to correct joint alignment, which prevents joint damage. The ideal position of a joint places the muscles attached to the joint in a good tension-length relationship. This in turn has a positive effect on muscle function and strength (Levangie and Norkin, 2001).
For a muscle to function properly, the tension of the muscle has to be in good relation to the length of the muscle. This statement denotes that a joint will function optimally when the tension placed on the muscle is suitable to the optimal length of the muscle in order not to exceed the limit of tension that the muscle can handle.

A shortened muscle does not function optimally (Commerford and Mottram 2001). Every muscle has a specific function; when this muscle's function is not optimal; it is referred to as dysfunction. Dysfunction is defined as the abnormal functioning of an anatomical structure (Mosby 2005). The abnormal functioning of LD will now be addressed, as well as the impact of such functioning.

2.8 Summary of the dysfunction of Latissimus Dorsi

LD is a muscle which could lose extensibility and limit the GHJ physiological movement of flexion and lateral rotation. This limitation of the movement of GHJ flexion and lateral rotation has a constraining effect on the GHJ. This means that it impairs the functioning of the GHJ. If LD is shortened, in order for a subject to compensate for the loss of range of motion at the GHJ, an increase in the lumbar lordosis will occur abnormally, which may lead to impairment of function. An impairment of function can be related to the abnormal functioning of an anatomical structure. Therefore, it can be argued that LD length can contribute to musculo-skeletal dysfunction.

It is important to recognise dysfunction objectively and in general. A clinical measurement of impairment, such as muscle length, could be valuable in determining the presence of dysfunction in a patient. This will be in the interest of assessing and measuring the change in the severity of dysfunction objectively (de Vet, Terwee, Knol, and Bouter, 2006). In order for objectivity and progress, dysfunction needs to be classified. Therefore, it is important to measure the length of LD objectively and to compare the results to an ideal outcome. An ideal outcome in this instance would be a full range of GHJ flexion range of motion.

Muscle length is often measured by means of special investigatory techniques such as sonomicrometry and ultrasonic imaging (Lichtwark 2007).

These methods and equipment are not readily and commonly available in a physiotherapy setting and therefore it is necessary to physically and functionally evaluate LD for dysfunction like muscle shortening. In order to determine the degree of muscle shortening, one would have to evaluate the length of LD via a reliable muscle length test.

Latissimus Dorsi is a mobilising muscle and has the capability to shorten. A shortened LD would limit physiological movement in the GHJ. If these facts are taken into consideration; the abnormal functioning of LD would have a consequential impact on the functioning of the GHJ and adjacent structures such as the muscles and neural structures. LD dysfunction will now be described with reference to specific studies denoting the impact of LD shortening on function.

2.9 Previous studies on the impact of Latissimus Dorsi dysfunction

Several studies have shown that LD loses extensibility in the presence of pain and or dysfunction (Cailliet, 1995, Kibler et al. 2013, Borstad and Briggs, M.S. 2010). The above-mentioned studies indicate that if LD is shortened it could lead to:

- An increase in the lumbar lordosis as LD has an attachment to the thoraco-lumbar fascia, due to the attachments of the fascia to the lumbar vertebrae. Shortening of LD places an increased load on the vertebral attachment, pulling the lumbar vertebrae into an increased lordosis. The increased lordosis will increase the amount of anterior pelvic tilting. It has been reported that an increased lordosis is possibly the major cause of postural pain, radiculopathy, and facet pain (Cailliet, 1995).When an individual performs an overhead activity with a shortened LD, for example, a tennis player serving a ball, to gain range of motion of GHJ flexion, which will be limited in an individual with a shortened LD, the tennis player will have to tilt the pelvis anteriorly, thereby increasing the lumbar spine lordosis and placing strain on the lumbar spine.

- Scapula mal-alignment by pulling the inferior angle of the scapula into abduction. This position of the scapula does not favour optimum shoulder positioning and function (Kibler et al. 2013). Scapulae mal-alignment attributes to poor scapulae humeral rhythm, which places and increased load on the structures surrounding the GHJ, leading to dysfunction and pathology (Kibler et al. 2013).

- A decrease in the range of motion (ROM) of glenohumeral joint (GHJ) flexion and lateral rotation. GHJ flexion and lateral rotation places LD in the lengthened position (Moore, 1992). As mentioned earlier, LD has the potential to loose extensibility (Commerford and Mottram 2001) that will result in a decrease in ROM. A decrease in ROM of the GHJ will cause a decrease in functionality of the individual. An example one could consider would be a housewife not being able to reach for an article above her head due to a decrease in GHJ flexion range of motion, which could be due to a shortened LD.

- The information from the articles described above denotes that, if LD is shortened, dysfunction at the GHJ, lumbar spine and pelvis will occur. Table 2.5 presents a critical review of the above-mentioned articles.

Table 2.5: Brief review and critical analysis of articles relating to the dysfunction of Latissimus Dorsi

Article	**Description**	**Critical review**	**Description of main findings**	**Contribution to study**
Borstad and Briggs (2010), *Reproducibility of a measurement for Latissimus Dorsi muscle length.*	A reliability study illustrated by means of a descriptive report, testing the reproducibility of a technique that tests the length of LD	The authors used an inclusion criterion and an exclusion criterion applicable to the study, with an adequate sample size and performed the test according to reliability testing requirements. The test was also described to have been performed according to the descriptions by Levangie and Norkin in 2001. There are, however, discrepancies between this study and the study by Borstad and Briggs, namely, the time taken between measurements as well as the quality and qualification of the raters who were taking the measurements of LD length in the study by Borstad and Briggs. The logistics of the	A reliability study done testing an orthodox technique that is used to assess the length of LD with too many inconsistencies and variables in the methodology, therefore mainly finding the test to be irreproducible.	This was used as a point of reference for the methodology used in this study as well as source of comparison for LD muscle length testing technique. The shortcomings and recommendations discussed were implemented in the execution of this study. The resulting values obtained by Borstad and Briggs, (2010) were also used as a basis of comparison between the two techniques available to assess the length of Latissimus Dorsi.

		testing method were not fully described. The study design was a quantitative analytical reliability study which was well suited to the methodology. A conclusion has been made and all the results given in the study supports the conclusion.		
Article	**Description**	**Critical review**	**Description of main findings**	**Contribution to study**
Commerford and Mottram (2001). *Movement and stability dysfunction–contemporary developments*	A narrative review exploring the literature related to global and local movement systems	The authors have specific reference to the characteristics of muscles with function in mobility and muscles with function in stability, clearly outlining the major concepts regarding the local and global movement systems, thus adding to the development of an integrated model of movement dysfunction whereby muscles may be classified according to their structural and functional	A narrative review displaying the structural and functional characteristics used to classify a muscle under the movement system sub headings.	This article provided the evidence used to classify LD and then use the characteristic shortening of LD to prove the importance of this study.

		characteristics. This article was a narrative review review. The inclusion and exclusion of articles used was vague. The background information needed to understand the content of the article was well referenced and described. A clearly focused research question was being asked and the correct studies were included in the review of literature. More than one database has been used and for this reason also improves the validity of the study. The results of the various studies have been combined in a comprehendible fashion. However, the article is, aged but still holds value as it is one of its kind.		
Article	**Description**	**Critical review**	**Description of main findings**	**Contribution to study**

Kibler, W. Ben, et al. (2013) *Clinical implications of scapular dyskinesis in shoulder injury*	An article summarizing the 2013 consensus statement from the scapular summit	An article summarizing the 2013 consensus statement from the scapular summit. This article was very recent and provided relevance, although the level of evidence was not of a high stature.	Clinical implications of scapular dyskinesis in shoulder injury.	As described in the anatomy Latissimus Dorsi has a relationship with the scapulae and this article described the importance of the alignment of the scapulae from a very recent summit.

As described above, measurements of impairment or dysfunction need to be consistent. For a measurement to be consistent the measurement tool will have to be reliable. Reliability will now be defined and discussed.

2.10Reliability

The reliability of a test can be defined as a description of the consistency of the measures obtained (Nancy Burns 2005). Reliability is most frequently described using the intraclass correlation coefficient (ICC). The ICC index ranges from zero to one. The closer the value of the ICC to one, the higher the indication of the reliability of the test will be. All the models used to calculate reliability include variability between subjects. This means that, in order to test reliability, there has to be variation between the subjects being tested (Portney and Watkins, 2000). This part of the definition of the term ‘reliability’ means that when the test is used the results are consistent irrespective of the clinician performing the test. For example, if in a hospital setting the patient is treated by more than one clinician, the result of the test used should be consistent between therapists. It is important for the test to be standardized and reliable in order to maintain complete objectivity and minimizing error in evaluation (Swinkels et al. 2011). Table 2.6 displays a brief review on articles related to reliability testing and the reporting thereof.

Table 2.6 Brief review of articles relevant to reliability testing

Article	Brief description	Contribution
Walwork, Hides and Stanton, 2010	A study testing the intra-rater and inter-rater reliability of assessment of lumbar Multifidus muscle thickness using Rehabilitative ultrasound imaging.	The study used the ICC and Bland Altman method in order to report reliability of a technique assessing the thickness of a muscle. This assisted the author in the understanding and reporting thereof.
Bjourklund et.al. 2006	A study where the reliability of a criterion-based test of athletes with knee injuries; where the physiotherapist and the patient independently and simultaneously assess the patient's performance is conducted.	The ICC was interpreted according to Altman (1983); <0.20 = Poor,0.21–0.40 = Fair, 0.41–0.60 = Moderate, 0.61–0.80 = Good, 0.81–1.00= Very good. This method of reporting has also been employed in the interpretation of the results from this study.
Mutlu, Livanelioglu and Gunel (2008)	A study assessing the reliability of Ashworth and Modified Ashworth Scales in children with spastic cerebral palsy.	In this study the ICC is also employed. It is explained that the ICC is used to interpret reliability as the ICC is the mathematical equivalent of the weighted Kappa value for ordinal data. It is stated that the ICC can also assess reliability for more than two raters at a time and for different numbers of raters for each subject. This directly applies and validates the use of the ICC in the methodology of the reliability study at hand.

Article	**Brief description**	**Contribution**
Peeler and Anderson (2007)	The reliability of the Thomas test was assessed.	The Thomas test, like the Latissimus Dorsi muscle length test, assesses the length of a muscle. The reliability reporting included the standard error of measurement as well as the ICC to classify reliability of the muscle length test. The standard error of measurement is used to compare a true value versus an observed value from a test such as the Latissimus Dorsi muscle length test (Portney and Watkins, 2001).

In a reliability study by Aartun, Degerfalk, Kentsdotter and Hestbaek (2014), two chiropractors assessed 111 adolescents aged 12–14 years old. A standardised examination protocol was used to test inter-rater reliability, including tests for scoliosis, hypermobility, general mobility, inter-segmental mobility and end range pain in the vertebral column.

Subsequently, 75 of the 111 subjects were re-examined after one to four hours to test intra-rater reliability. The continuous data was analysed by means of interclass correlation (ICC) and Bland-Altman plots with Limits of Agreement (LoA). If Latissimus Dorsi length were to be measured, the outcome would be described by a number in degrees of GHJ flexion.

This would represent a continuous variable; therefore, this method of data analysis and reliability testing applied in the study done by Aartun, Degerfalk, Kentsdotter and Hestbaek (2014), would apply to a study testing a technique for assessing the length of the LD for inter-rater and intra-rater reliability. The background information given in this study is well written and referenced and ensures adequate understanding of the topic. The study design is adequate, although it was not well described. The inclusion and exclusion criteria were vaguely described. The methodology and procedure was described well and in detail and this validated the use of this article as a reference point for reliability testing. Its data analyses and method was indicated clearly as well.

Techniques that actually measure the length of LD will now be described with regard to methodology applied, reliability status and testing.

2.11 Techniques used to measure the length of Latissimus Dorsi

In an article by Herrington and Horsley (2013) titled, "The effects of Latissimus Dorsi length on shoulder flexion in canoeists, swimmers, rugby players, and controls", 100 subjects were measured for the length of LD. The subjects consisted of 25 professional rugby union players, 20 elite canoeists, 15 elite swimmers and 40 physically active people who assumed the role of the control group. The results from the study allowed the authors to come to the conclusion that the length of LD differs between sports and controls in accordance with the specific physical demands of their sport.

The length of LD was measured using a standard goniometer, but the shoulder measurement was taken at full GHJ lateral rotation and full GHJ medial rotation. The knees were flexed to 90degrees and the hips of the participants were flexed to 45 degrees. The pelvis, however, was held in full posterior tilt and this was monitored by a biofeedback unit. The shoulder was passively flexed by the same examiner in all cases, and the end of range was defined as firm resistance to movement.

The method that was used had no reference proving scientific reliability and even though one examiner was used in all of the measurements. Intra-rater reliability would be crucial in the validity of the measurements. There was no reference proving intra-rater reliability of this technique assessing the length of LD. Scapulae abduction was not controlled.
This would decrease the objectivity of the test used by Herrington and Horsley (2013) to test the length of LD. Another issue with this method of testing the length of LD is the fact that a biofeedback unit is not commonly available in all physiotherapy settings.

Another factor that adds to the inconsistency of this test is the fact that the GHJ was not maintained in a neutral position. If maximal medial rotation and flexion of the GHJ was the point at which the measurement should be taken, there would be no consistency of medial rotation and this would influence the consistency of the test results.

A physiotherapy book (Levangie and Norkin, 2001) that is used as a text book in undergraduate physiotherapy training describes a technique of a muscle length test which assesses the length of LD. During the performance of this technique, the patient lies in a crook lying position on a plinth.

The patient is asked to keep the back flat, which means that he/she should not increase the lumbar lordosis or anterior pelvic tilt. This should be done actively by the patient. The patient is then asked to actively flex the GHJ with the GHJ in neutral (no glenohumeral rotation is allowed).

The ROM of GHJ flexion was measured using a ten-inch goniometer when either the lumbar spine lifts off the plinth or the GHJ goes into medial rotation.

Borstad and Briggs (2010) concluded that the test that was tested was unreliable and not reproducible. This conclusion is justified by the shortcomings and inadequacies described below. Borstad and Briggs (2010) suggested that a further study should be done to test the reliability of an adapted test in order to maintain a standard of objectivity and congruency between therapists when evaluating the length of LD.

There were several shortcomings with regard to the method of this test developed by Levangie and Norkin (2001) and tested for reliability by Borstad and Briggs (2010).

The first of these shortcomings is the fact that Borstad and Briggs (2010) used qualified therapists to place the participant in the position where a measurement would be taken only, while the recorders who recorded the measurements were still students in the field. This could account for error in the recording of the measurement.

The second shortcoming is that the scapulae were not taken into consideration in the test measuring the length of LD. The position of the scapulae should be taken into consideration when taking the measurement of the GHJ flexion ROM due to the fact that LD runs over the inferior angle and lateral border of the scapulae, forming a pouch over the scapulae. As stated above, LD may shorten, and if LD shortens due to the anatomical attachments, the scapulae would abduct past the midline during the end ranges of GHJ flexion (Commerford and Mottram 2001). This would happen because LD is lengthened when GHJ flexion is done. A shortened LD would pull the scapula into an abducted position past the midline. This would mean that, if the scapulae were allowed to abduct during the end ranges of GHJ flexion, the range of GHJ flexion would increase and increase inconsistently among different subjects. This would affect the reliability of a ROM measurement obtained from the test measuring LD length.

The subjects' scapulae were not stabilized to the midline in the technique used in the study by Borstad and Briggs (2010).

The third shortcoming is that the subjects' posterior pelvic tilt was not passively and objectively stabilised. The posterior pelvic tilt was maintained by asking the subject to actively keep their backs flat on the plinth. This test did not require external passive stabilization of the posterior pelvic tilt.

There was no consistency in the maintenance of an accurate and consistent amount of posterior pelvic tilting and lumbar lordosis. This would contribute to the inconsistency in ROM measurements taken by the recorders in the study.

The fourth shortcoming is that measurements in this study were taken six weeks apart. It is possible for the participants in the study done by Borstad and Briggs (2010) to have adapted their physical activity regimens during this time lapse.

According to Commerford and Mottram (2001), habitual use of a muscle or positioning may lead to an altered muscle length. This could have also affected the reliability of the test for testing the length of LD.

The technique of the LD length test described in the physiotherapy text book by Levangie and Norkin (2001) is not the only technique in which the test is performed to evaluate the length of LD. Commerford and Mottram (2012) also devised a technique to measure the length of LD which is described in their kinetic control manual.

2.12 Clinical accuracy of the test described by Commerford and Mottram (2012)

There are differences between the technique testing the extensibility of LD by Commerford and Mottram (2001) and the test used by Borstad and Briggs (2010). When the technique described by Commerford and Mottram, (2012) is performed, the scapulae of the subject is stabilised in the mid line.

As discussed above, the scapulae should be stabilised because LD forms a pouch around the scapulae and in the event of shortening of LD the scapulae will abduct in order to gain range of GHJ flexion. The elbow is to be kept straight in the mid-axillary line. Only then, with the use of a ten-inch goniometer, GHJ flexion is measured (Commerford and Mottram, 2012).

As described in the literature review above, LD is a muscle that may shorten. A shortened LD will limit the physiological movement of flexion and lateral rotation of the GHJ.

A shortened LD will also increase a subject's lumbar lordosis in the attempt to gain ROM of GHJ flexion (Moore, 1992, Cailliet, 1995, Kibler et al. 2013, Borstad and Briggs, 2010).

The technique that assesses the extensibility of LD described by Commerford and Mottram (2001), measures GHJ flexion while maintaining a neutral position of glenohumeral rotation. Scapula stabilisation and maximal posterior pelvic tilting is suggested as well.

Therefore, with clinical reasoning and taking into consideration the literature described in the review, the technique of the LD length test described by Commerford and Mottram (2012) is clinically sound and accurate in measuring the length of LD; and according to the knowledge of the researcher there is no proof of reliability of this test, nor is there any proof of reliability for any technique used to measure the length of LD.

The literature discussed will now be summarized in order to orientate the reader about the conclusion derived at, in order to apply the literature to the methodology chapter to follow.

2.13 Concluding the literature review

In the literature described above, (LD) has been described to be a mobilising muscle that shortens in the position of GHJ extension and medial rotation. This would indicate that a shortened LD would limit the physiological movements of GHJ flexion and GHJ lateral rotation. The literature has also indicated that the shortening of this muscle would lead to dysfunction such as an increased lumbar lordosis etc.

In order to maintain complete objectivity and minimizing error in evaluation, dysfunction needs to be quantified objectively (Swinkels et al. 2011). Therefore, a shortened LD has to be quantified objectively. For objectivity to be maintained, consistency in measurements are invaluable. This constitutes that the reliability of a measurement technique is vital.

The definition and description of reliability testing is therefore described above. Borstad and Briggs (2010) tested the commonly used LD length test described in a physiotherapy text book by Levangie and Norkin (2001) and found this test to be unreliable. However, there is another technique available for testing the length of LD. This technique is demonstrated by Commerford and Mottram (2012). It has not yet been tested for reliability, even though Commerford and Mottram's method of testing LD is clinically more accurate.

Therefore, there is a need for a reliable test measuring the length of LD, which could be addressed by testing the test described by Commerford and Mottram (2012) for reliability.

In the following chapter, the methodology used to carry out the reliability testing procedure for the Latissimus Dorsi muscle length and the technique described above is discussed.

Chapter 3: Methodology

3.1 Introduction

This chapter will describe the methodology of the Latissimus Dorsi muscle length testing technique as well as the logistics used during the conduction of this study. The sample size, population, inclusion criteria, exclusion criteria, instruments and methods that were used will be discussed. Ethical and legal considerations applicable to this study will also be discussed here. The method of data analyses that was used will also be described.

3.2 Research design

As discussed in 1.7 this study is a within-participant test-retest non-experimental quantitative study for reliability purposes (Lachin, 2004).

3.3 Study setting

The Physiotherapy department at the University of Pretoria (UP) was the setting where this study took place. The participants were close to this study setting for a significant time during the day. This setting was selected because of the availability of facilities (physiotherapy gymnasium and equipment) and the presence of qualified experienced clinicians. It is a controlled environment where the temperature was consistently set at twenty degrees Celsius and windows and doors were closed.

3.4 Population and sample

3.4.1 Population

The population of this study was Physiotherapy students at the University of Pretoria, ranging from first to fourth year students aged between 18 and 28 years. The examiners were four qualified physiotherapists who are employed in and around the vicinity of the University of Pretoria; they will henceforth be referred to as 'raters'.

3.4.2 Sample and sampling method

The participants were limited to young students (aged 18 to 25 years) from the University of Pretoria. The participants were all physiotherapy students ranging from first to fourth year.

The sampling method was one of convenience. Invitations to take part in the study were put up on the notice boards of the physiotherapy department (Appendix H) and students who volunteered to participate and met the eligibility criteria were included in the study. The invitation contained information regarding the study as well as information allocating a date and a venue for an information session. The information session was a session where all the prospective volunteering participants were informed about the study and were handed information leaflets (Appendix C). The interested students who did not meet the inclusion criteria were excluded from the study. These students were handed a thank you note, briefly explaining the reason for exclusion. They were also allocated an appointment with the researcher in order to discuss in detail why they have been excluded from the study.

3.4.3 Sampling size considerations

In consultation with a biostatistician, a sample size in excess of 40 participants was determined to estimate the desirable ICC of 0.9 to an accuracy of within 0.05 this was done using a one sided 95 percent confidence interval (nQuery Advisor software 7.0, Statistical Solutions). The primary statistic used was the intra-class correlation coefficient (ICC) and for this within-participant study design.

This sample size would also comply with assumption of normality as required by the Bland-Altman method to assess intra-rater and inter-rater agreement (Altman, 1983).

Fifty-six (56) participants took part in the study in order to accommodate for participants voluntarily dropping out of the study due to any reason.

3.4.4 Inclusion criteria

Male and female physiotherapy students aged between 18 and 25 years were included.

3.4.5 Exclusion criteria

It has been proven that the GHJ quadrant test can be used to determine the presence of GHJ pathology (Mullen et.al, 1989). Participants with any current shoulder joint pain or pathology were excluded from this study. A final year physiotherapy student excluded all shoulder joint pathology from the participants participating in the study by performing a technique called the shoulder flexion quadrant test. This technique was demonstrated to her by an experienced physiotherapist as well as a lecturer in the field of orthopaedic manipulative therapy. The shoulder flexion quadrant test is used to evaluate the presence of any shoulder joint pain or pathology (Maitland, 2005). The shoulder quadrant test was performed to clear the shoulder joint from any pathology. See data collection procedure for detail regarding this test.

As described in the literature review, a shortened LD will cause an increase in a subject's lumbar lordosis (Cailliet, 1995), therefore any participant who was unable to maintain a posterior pelvic tilt (keep back flat against the plinth) was also excluded from the study.

3.5 Research instruments and materials

The 10-inch-goniometer was used in this study. The goniometer measures the angle of a joint, such as the knee, GHJ or elbow. This angle is representative of the range of physiological movement at a joint. It has been reported to have an intra-tester correlation coefficient of 0.98 and is therefore a reliable measurement tool (Riddle Rothstein, and Lamb 1987).

In order to mark the centre point of the shoulder joint for the use of the 10-inch goniometer, a hypoallergenic skin marker was used. The 10-inch goniometer has been proven valid and reliable for measuring the range of GHJ flexion by Gajdosik and Bohannon (1987) as well as Mullany et al (2010) with a kappa value of Ƙ=0.94. In this study, the four goniometers used were high density transparent Precision™ goniometers. Figure 3.1 presents a photograph of the specific 10-inch goniometer.

Figure 3.1: Photograph of the Precision™ ten-inch goniometer

3.6 Pilot study

A pilot study was performed by each rater. The researcher was present and acted as timekeeper. This was in order to make sure that the Latissimus Dorsi muscle was not held in a stretched position for longer than 20 seconds, because this would affect a change in the length of the muscle, (Bandy and Irion, 1994). The participants complied with the inclusion and exclusion criteria. The pilot study was conducted in the intended study setting.

The aim of the pilot study was to test and amend the methodological procedure and provide an in depth demonstration of the methodological procedure and methods to the selected researchers.

The pilot study also allowed the researcher an indication of how much time would be needed for the measurements. This assisted in the planning of an efficient time schedule for the day of data collection.

There were various challenges met during the accomplishment of the pilot study. These challenges enforced the addition of amendments to the actual study. These will now be discussed.

3.6.1 Observed challenges during the pilot study

During the pilot study it was noted that uncontrolled rotation was occurring at the GHJ and that this was confused with forearm movements. After the pilot study, the raters were also asked to make sure that the olecranon process of the elbow joint, the styloid process of the wrist and the thumb should all be in a straight line when taking the measurement to ensure that the position of the GHJ remained consistent. This was done in order to maintain objectivity between measurements.

Another challenge noted was the fact that the raters were not aware of the exact position of the scapulae due to the surrounding soft tissue. After the pilot study, the researcher corrected logistical issues as well as asked each rater to palpate the scapula in the midline of each participant as to avoid not noticing the abduction of the scapulae passing the midline.

In the pilot study it was also noted that when the participants knew their reading values they tried to better it, therefore on the day of data collection no participants were allowed to hear the values of their readings once taken. Figure 3.5 displays this position. The raters were also asked not to allow the participants to acknowledge the values of the readings taken by viewing the recording sheet, in order to avoid manipulation by the participants.

One foreseeable challenge was the fact that a large amount of students familiar with one another would be placed in a large study setting and this posed the risk of disorder and inconsistency in the logistical methodology. Therefore, one general assistant was also allocated to the research setting to maintain the order of the participants and general consistency in the logistics of the methodological procedure due to a large number of participants being present in one venue. More assistants were recruited to maintain order and professionalism and increase efficacy. It was decided that two assistants would be present at each station as well as one assistant allocated to the student marking the GHJ center point.

3.6 Research Process

3.6.1 Research team

The study aims to assess the inter-rater and intra-rater reliability of the technique used to assess the length of Latissimus Dorsi in novice and experienced physiotherapists. The researcher selected the research team based on years of experience. Novice clinicians were classified as physiotherapists with less than 5 years of experience. Experienced clinicians were classified as physiotherapists with more than 5 years of experience in the field of musculo-skeletal physiotherapy. Four qualified physiotherapists were the raters and performed the evaluation of the LD length in this study.

Two of the raters were community service physiotherapists, with a maximum of 13 months of experience. They were selected due to the fact that they were both newly qualified and have a special interest in rehabilitation and outpatient physiotherapy as well as their willingness and availability to partake in this study.

The other two were experienced physiotherapists; one was a lecturer in the field of neurology with experience in musculo-skeletal conditions (5 years of experience) and the other was a lecturer in biomechanics and movement science (15 years of experience).

The other members of the team consisted of a fourth year (final year physiotherapy student) and eight second year student assistants.

3.6.2 The role of the researcher

During the pilot study the researcher demonstrated the technique to the four raters; key elements to the accomplishment of the technique were emphasized. The raters then demonstrated the technique to the primary researcher and their flaws were corrected. The researcher managed the logistical aspects of the procedure. Time was kept to ensure quality control in the data collection procedure.

The data collection procedure will now be described in detail. For a flow chart outline of the methodology refer to figure 3.2.

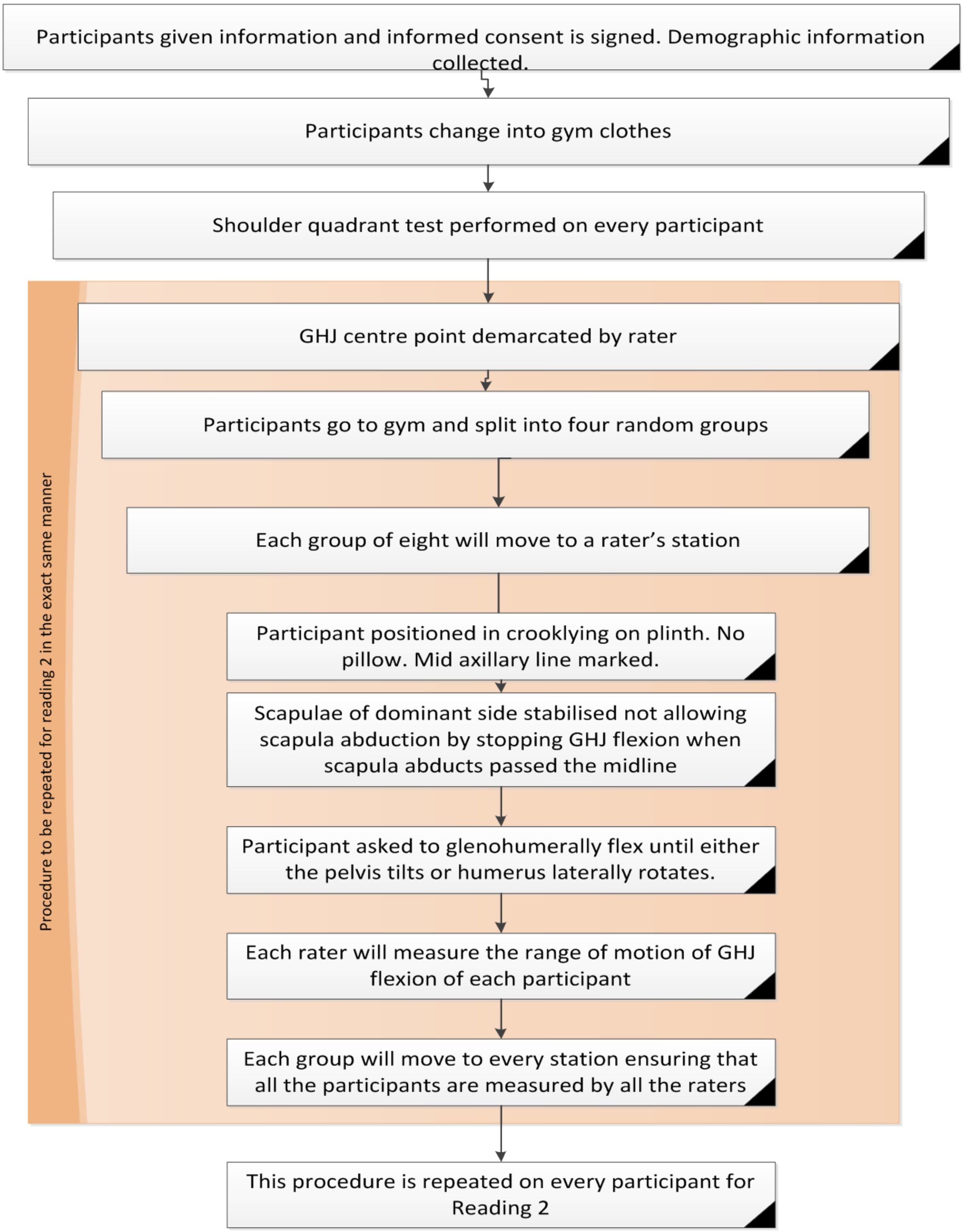

Figure 3.2: ***Flow chart representative of the reliability study***

3.6.3 Screening of the recruited participants

The participants entered the UP physiotherapy massage room where there were raters, desks, chairs, relevant paperwork and stationary. An informed consent (Appendix C) form was given to each participant and the participants were then explained the proceedings and informed that all questions that the participant had, regarding the proceedings that followed, would be answered.

The participant was handed a demographic information form by the researcher (Appendix E). The participants were then randomly allocated a number. The researcher accomplished this by taking the list of participants and, in allocating a number from 1-56 to each participant in random order, no names were reported and confidentiality was agreed upon. The master list containing the names of the participants with allocation of the numbers could be viewed by the researcher only and was kept in a safe at the physiotherapy department.

The participants were then asked to change into their gymnasium clothes. The men wore a pair of short running shorts and the females wore a pair of tights as well as a gymnasium garment which is a modified sport bra allowing palpation and viewing of the anatomical structures needed to be visible for performing the technique.

The shoulder quadrant test was performed on every participant in this study (Maitland, 2005). For the quadrant test the participant lied supine on a plinth. The therapist stood on the dominant side of the participant, facing the participant.

The dominant arm of the participant was taken into maximal GHJ abduction with a flexed elbow and medially rotated humerus, while the scapula was stabilized by the therapist through not allowing scapula elevation.

Once maximum GHJ abduction was achieved the arm was slightly laterally rotated and then flexion of the humerus was done until no more flexion could occur.

If the entire procedure could be performed pain free, the test was rendered negative and shoulder joint pathology was excluded and the participant was then allowed to proceed to participate in the study. If the GHJ quadrant test was positive, the participant would be excluded from the study, since this would indicate GHJ pathology, which could limit GHJ flexion (Maitland, 2005).

3.6.4 The allocation of participants to stations and raters

Each rater was given a recording sheet (Table 3.2). This form was kept by the assistant at each of the stations and was handed in after the last station that each participant had visited after their fourth recording. This was handed to the researcher on the day after each reading. This form ensured adequate record keeping, structure and almost equal time in between stations.

The included participants were taken into the physiotherapy gymnasium. In the gymnasium there were four testing stations. Each of the stations had a plinth, a goniometer, Velcro, a hypoallergenic skin marker, stationary, a desk, a chair and a therapist (rater). At each station there was also an assistant present. The assistant was one of the students used in the demonstration session.

The stations of the raters were labeled 1, 2, 3 and 4. Stations labeled 1 and 2 were the stations of the experienced raters and stations 3 and 4 were the stations of the novice raters. Figure 3.3 presents a photograph displaying the labeling of the stations.

Figure 3.3: *A photographic representation of the labeled station*

The participants were then divided into four random groups by simply splitting the allocated numbers into quarters in no specific order. This number corresponded directly to the station that the participant began at, e.g. if participant 10 was allocated to group one, then participant 10 started at station one. The participants of each group were instructed to stand in a single file queue in front of the gymnasium according to the station number they have drawn. One assistant was present, ensuring order outside the gymnasium.

3.6.5 Test procedure

The procedure at each station was consistently conducted as follows:

All participants entered a room where the centre point of the GHJ on the participant's dominant side was marked by the final year physiotherapy student who also had a final year student as an assistant. This marking was made by a water soluble non-permanent and hypoallergenic skin marker. This is depicted in Figure 3.4.

Figure 3.4: *A photograph of the student marking the centre points of the GHJ of the participants*

Participants were taken into the gymnasium in groups of eight per station. Each group started at a different station. The researcher was present, assuring continuity and control. The participants were instructed to go through all the stations in order, where the first measurement was taken (Reading 1) and then one more time where the second measurement was taken (Reading 2).

The participant was in the supine position with flexed knees and hips three foot lengths away from their body with both soles of their feet placed completely flat on the surface of the plinth. This is called a crook lying position, as shown in Figures 3.5.1 and 3.5.2

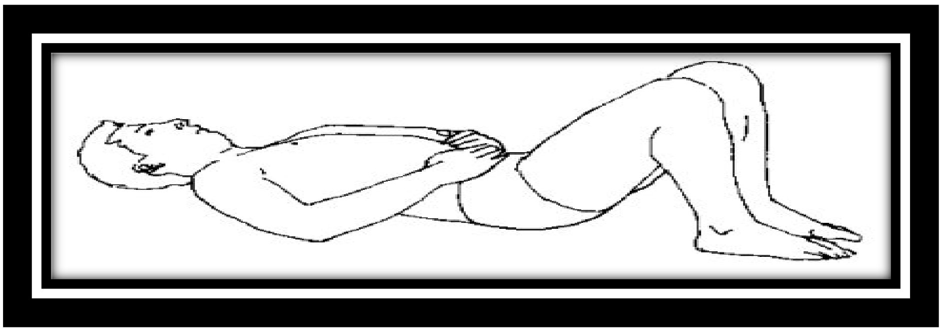

Figure 3.5.1: *Illustration of the crook lying position (Source: Levangie and Norkin, 2001)*

The therapist asked the participant to press his/her lumbar spine against the plinth. A Velcro strap was tightly wrapped around the anterior superior iliac spines of the pelvis as well as the plinth by the assistant at each station, since this level would rise in the event of anterior tilting and or in the event of the lumbar lordosis being increased in the participant (Cailliet, 1995). (Figure 3.5.2).

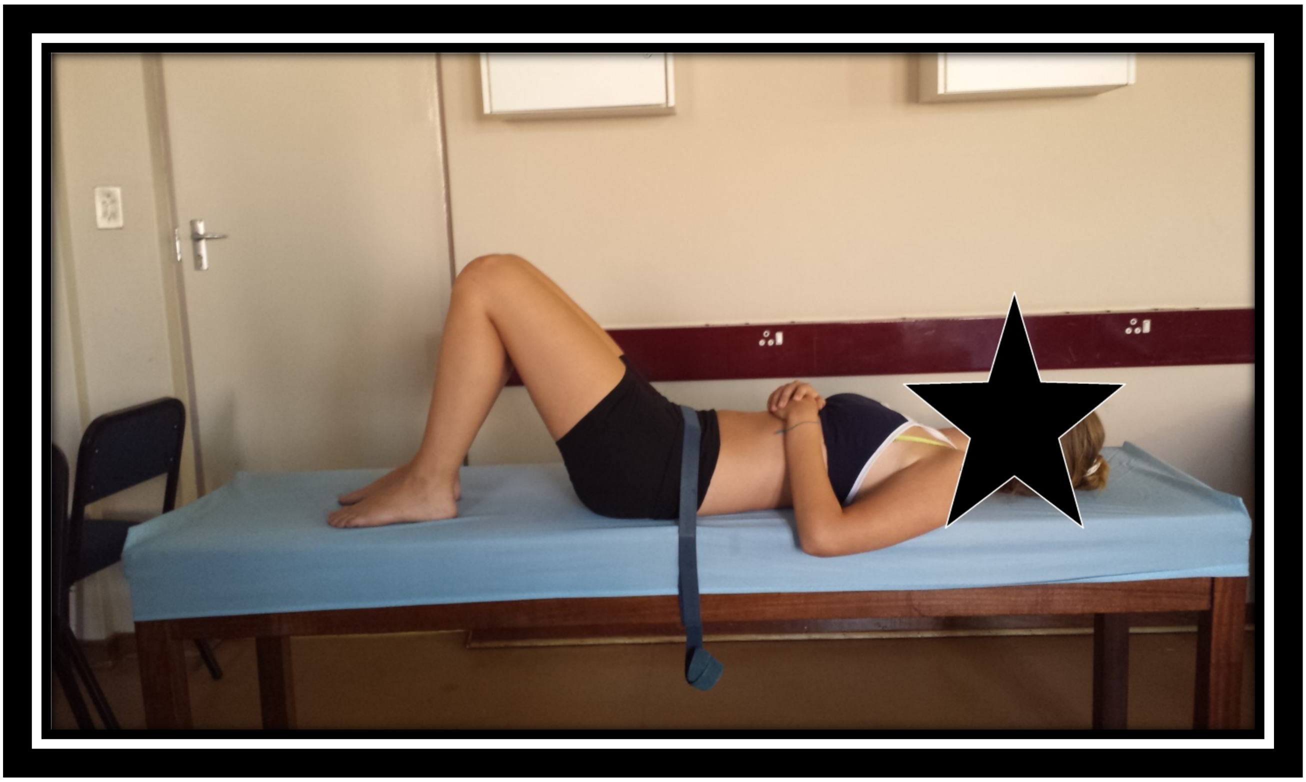

Figure 3.5.2: *Photograph of the crook lying position with Velcro strapping*

The non-dominant hand of the participant was placed on the Velcro strap on the participant on the non-dominant side of the patient. The participant was instructed to notify the therapist in the event of the Velcro strap being pulled tighter, which would have been due to the participants' lumbar spine lifting off the plinth and the anterior tilting of the participant's pelvis. This would have been felt by the non-dominant hand of the participant as well as heard by the therapist.

The participants' mid axillary line was marked in order for the therapist to acknowledge when the scapulae abducts passed the midline. This point was also palpated during the movement in order to be more objective during the test.

The participant flexed the glenohumeral joint (pure flexion next to face) of the side of dominance with his/her thumb facing the roof and keeping his/her back flat (in order to not medially rotate the GHJ or allow an increase in the lumbar lordosis as both factors would inconsistently increase the range of GHJ flexion which would in turn decrease the reliability of the test) figure 3.4.

The rater stopped GHJ flexion of the participant at the point where none of the following additional movements occurred: a decrease in the participant's posterior pelvic tilt, an increase in lumbar lordosis, medial rotation of the GHJ or scapula abduction (lumbar spine lifts off the plinth, Velcro strap is felt or heard pulling tighter, thumb of participant pointing medially or scapula passing the point marking the midline). The available range of GHJ flexion was then recorded by the assistant at each station.

Figure 3.6: *A photo of the test position illustrating scapulae and GHJ positioning*

Important note:

The measurement of GHJ flexion was then taken with the ten-inch goniometer without any of the above-mentioned additional movements occurring.

The entire test procedure was repeated by each therapist on all the participants in exactly the same manner.

Table 3.1: Example of the final recording sheet that each rater will have

STATION NUMBER: 1	**READING 1**	
Participant number	**Degrees of GHJ flexion**	**Time**
11	120	15:00

After Reading 1 was taken, the exact same form as above (Table 3.1) was given to the rater for Reading 2. The form, on which Reading 1 was recorded, was collected by the primary in order to avoid bias and/or contamination of the data.

A summary of the results from these tests were transferred to the collective data collection form by the researcher. This data was cleaned and checked (Appendix I). This collective data recording form is attached in Appendix F (See table 3.2). This data was then analysed statistically by a bio-statistician.

Table 3.2: Collective data collection form

	Reading 1				**Reading 2**			
Sub	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
11	120	119	120	121	120	119	120	121

Keys: S= Station Number Sub= participant number

A conclusion regarding reproducibility and reliability of this test was then drawn via an interpretation of the ICC deriving the reliability of the test. The intra-rater reliability was concluded from analysing the ICC from a comparison of the values of Reading 1 versus Reading 2 within each station.

The intra-rater reliability was analysed using the same method, but using Reading 1 comparing the values across stations. This data will be presented in the next chapter of this dissertation.

3.6.6 Quality control

Quality control is vital and was assured by using only valid and reliable measurement tools.

Qualified and skilled researchers performed the trials and evaluations (Appendix J).

The study took place in a setting where the temperature was controlled at 20 degrees Celsius consistently. The order of the readings taken and timing between readings were controlled as well.

3.7 Data analysis

Each physiotherapist (rater) assessed the ROM of glenohumeral flexion of the participants twice. For intra-rater reliability, the ICC was determined for raters individually, using the two observations made on a participant by the particular rater. For inter-rater reproducibility, the ICC was determined using the first observation made on each participant by each of the raters. The data was transferred to Microsoft Excel format and was cleaned and checked (Appendices E and H).

The ICC measuring inter-rater agreement was done for: (1) all the therapists together, (2) experienced therapists and (3) novice therapists only. The ICC's 95% confidence will be reported as well.

The ICC measuring intra-rater agreement was done by test-retest reliability, comparing the measurements taken at both measurement sessions by the same rater.

The ICC was determined by making use of time series regression (xtreg command in Stata) with the maximum likelihood (MLE) option.

An ICC in excess of 0.9 was regarded as excellent reproducibility. Agreement between raters or classes of raters was also assessed using the Bland Altman method. A 0.05 level of significance was employed.

Chapter 4: Results

4.1 Introduction

The aim of this study was to assess the inter-rater and intra-rater reliability of a technique adapted by Commerford and Mottram (2012) for assessing the length of LD. The study was conducted as described in Chapter 3. Out of the 74 interested participants, 56 met the inclusion criteria and took part in the study. The following chapter will merely display the results obtained from the captured data.

4.2 Descriptive statistics

Table 4.1 represents the demographic information of the 56 participants. The ages of the participants ranged between 18 and 28 years and the average age of a participant included in the study was 22 years. The sample consisted of 8 male physiotherapy students and 48 female physiotherapy students. The demographic information presented plays no role in the reliability of the test and is displayed in order to illustrate the representativeness of the sample population.

Table 4.1: Demographic information (n=56)

Subject Characteristic	Mean	Range
Age in years	22	18-28

Table 4.2: Descriptive Statistics(n=56)

Rater	Reading	n	Mean(SE)	Difference Scores (SD)
All Raters Combined	1	224	145° (0.69)	3° (8.34)
	2	224	142° (0.65)	
Experienced Group	1	112	146° (0.87)	2° (6.50)
	2	112	144° (0.83)	
Novice Group	1	112	144° (1.06)	2° (9.01)
	2	112	142° (0.98)	
Station 1	1	56	147° (1.33)	4° (9.99)
	2	56	143° (1.21)	4° (9.03)
Station 2	1	56	145° (1.09)	0° (8.17)
	2	56	145 ° (1.14)	0° (8.54)
Station 3	1	56	144° (1.42)	1° (10.62)
	2	56	143 (1.29)	1° (9.64)
Station 4	1	56	143 (1.59)	2° (11.91)
	2	56	141 (1.48)	2° (11.07)

Table 4.2 displays the descriptive statistical data. All the raters combined had an average reading (Mean) of 145 degrees with a Standard Error (SE) of 0.69, Standard deviation (SD) of 8.33 and the total number of observations (n) were 224. The difference scores (differences between the means for all the raters combined) was three degrees.

The table of raw data in Appendix E reflects a graphical representation of Readings 1 and 2 of GHJ flexion taken at all the stations measured in degrees and Figure 4.1 presents a line graph representation of the average reading of each individual across the stations.

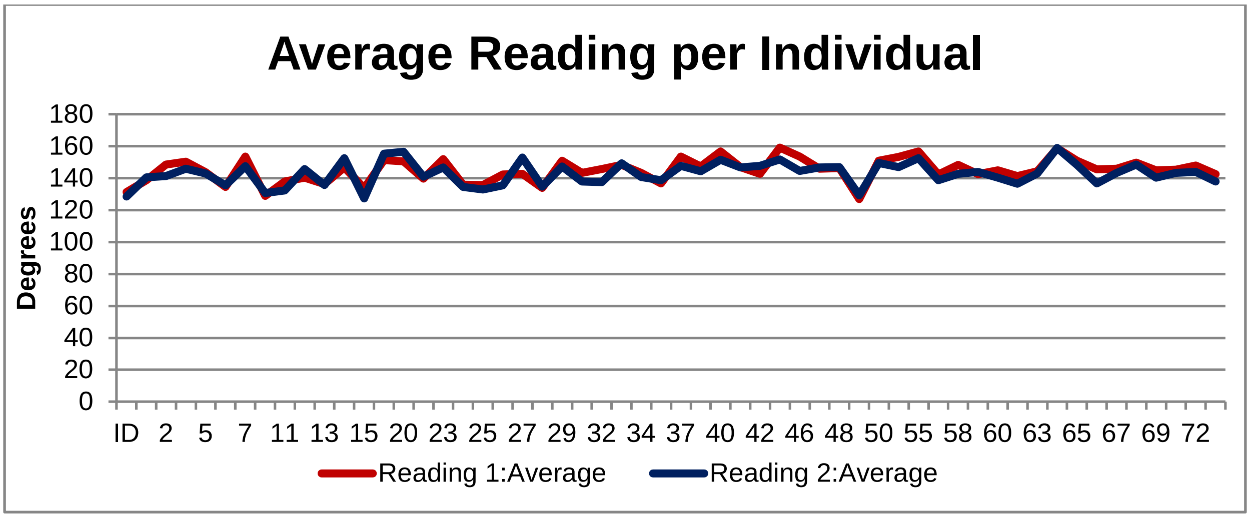

Figure 4.1: Line graph representing the average readings per individual

4.3 ICC – Intra-rater agreement

Table 4.3 represents the data displaying the intra-rater reliability by means of ICC. The ICC for station 1 (experienced rater) is 0.6.

The ICC for station 2 (experienced rater) is 0.55. The ICC for station 3 (novice rater) is 0.6. The ICC for station 4 (novice rater) is 0.76.

Table 4.3: Intra-rater reliability agreement

	Station 1	Station 2	Station 3	Station 4
ICC	0.6	0.55	0.6	0.76
Upper CI	0.77	0.74	0.77	0.87
Lower CI	0.43	0.37	0.43	0.65

ICC: intra-class correlation coefficient
CI: confidence interval

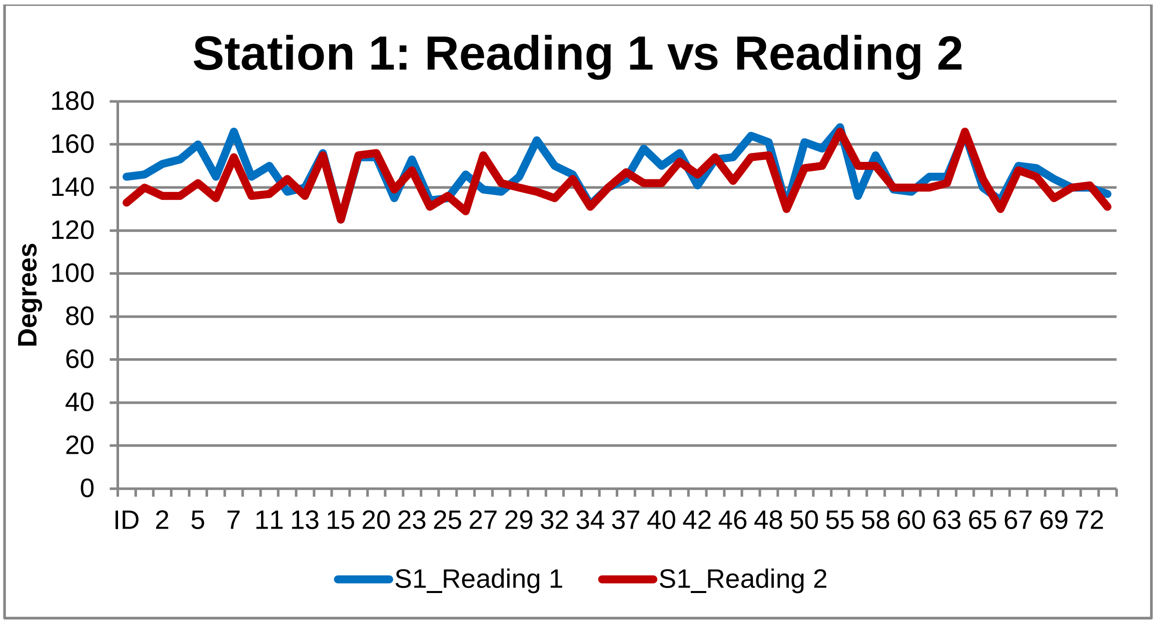

Figure 4.2: *Line graph representing Reading 1 compared to Reading 2 in station 1*

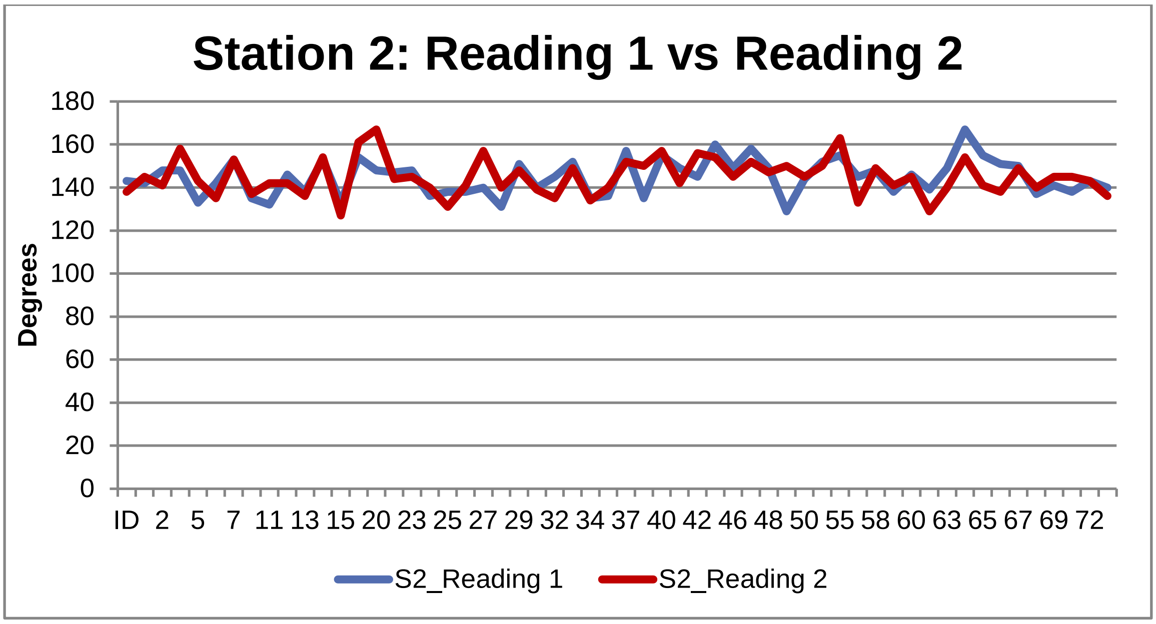

Figure 4.3: *Line graph representing Reading 1 compared to Reading 2 in station 2*

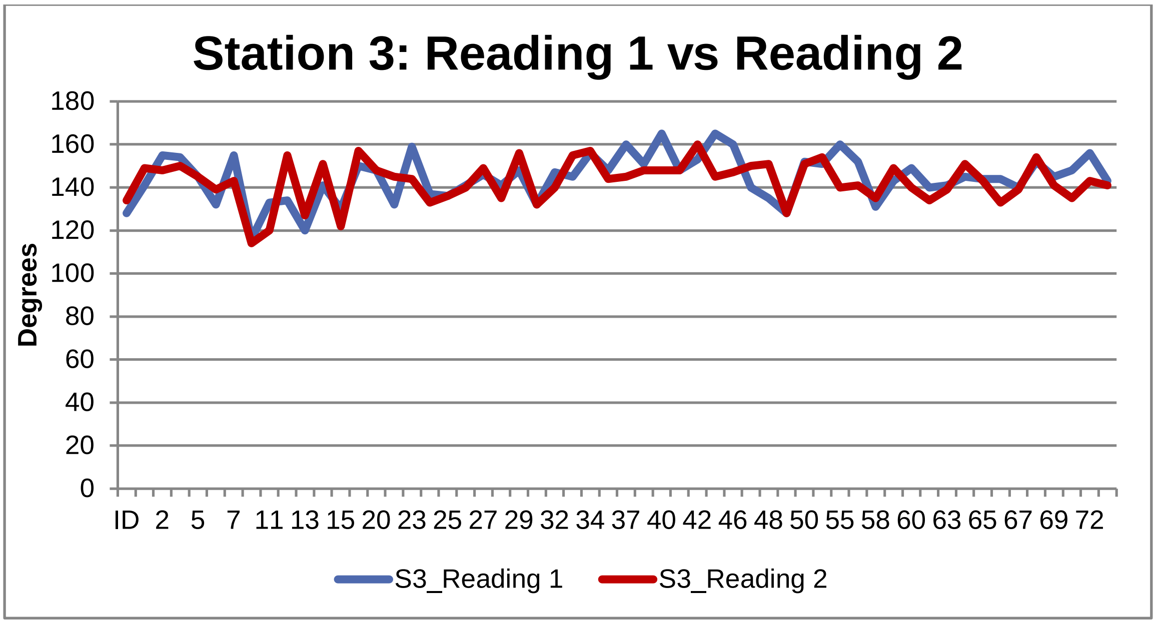

Figure 4.4: *Line graph representing Reading 1 compared to Reading 2 in station 3*

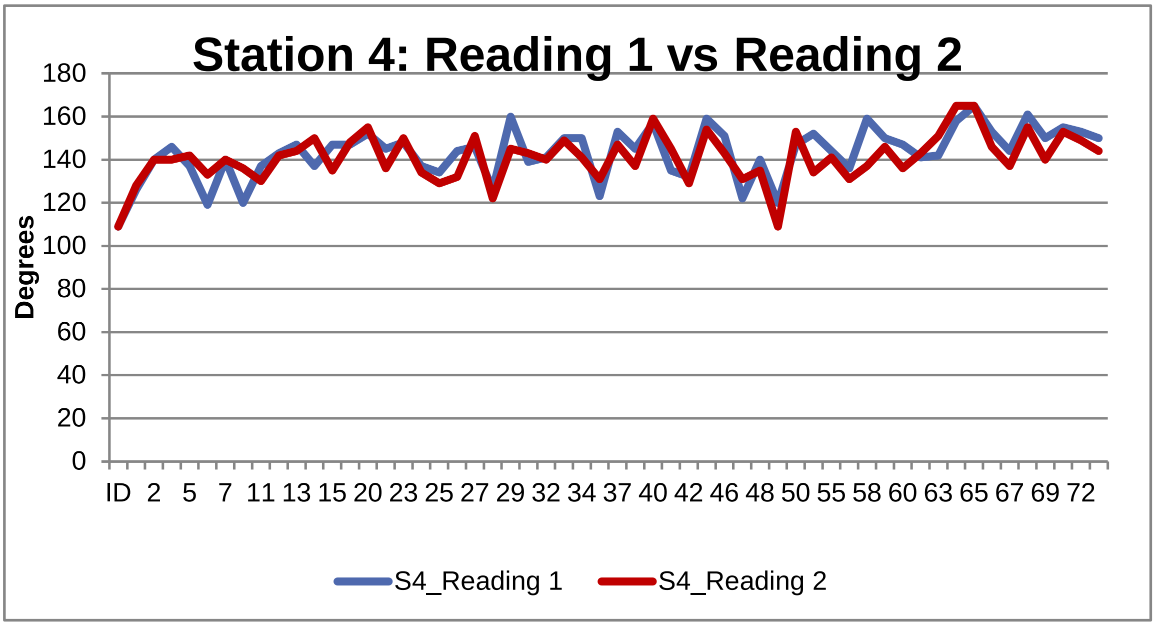

Figure 4.5: *Line graph representing Reading 1 compared to Reading 2 in station 4*

Figures 4.2, 4.3, 4.4 and 4.5 are line graphs representing the comparisons between Reading 1 and Reading 2 values of GHJ flexion in degrees, as obtained stations 1 to 4 in order (a graphic representation of table (4.4).

4.4 ICC – Inter-rater Agreement

Table 4.4 displays the Inter-rater reliability and agreement parameter results between experienced raters. This is a comparison between the values obtained at station 1 and station 2. The intra-class correlation coefficient between these two stations is 0.48, with a confidence interval between 0.68 and 0.28.

Table 4.4: Inter-rater reliability and agreement parameter results between experienced raters

Statistical characteristic	Station 1 and Station 2
ICC	0.48
Upper CI	0.68
Lower CI	0.28

ICC: intra-class correlation coefficient

CI: confidence interval

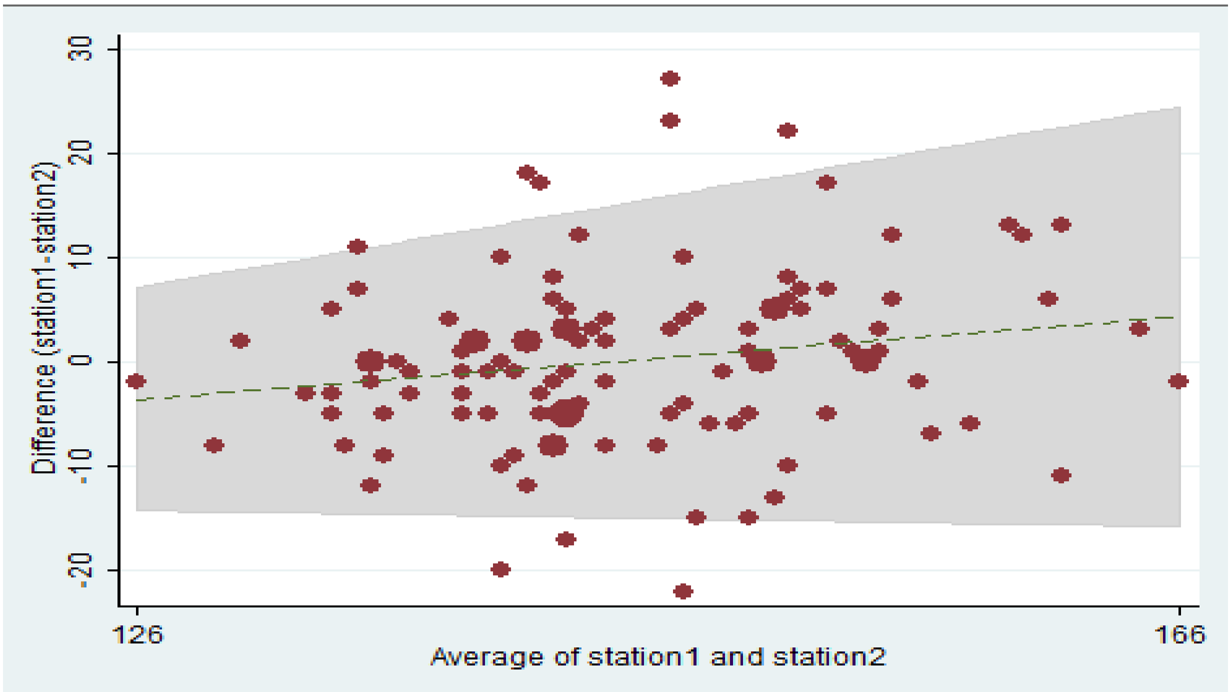

Figure 4.6: Bat plot representing the inter-rater reliability and agreement parameter results between experienced raters

Figure 4.6 is a Bat plot that is graphically representing the inter-rater reliability and agreement parameter results between experienced raters.

Table 4.5 displays the inter-rater reliability and agreement parameter results between novice raters. This is a comparison between the values obtained at station 3 and station 4. The intra-class correlation coefficient between these two stations is 0.48 with a confidence interval between 0.68 and 0.27.

Table 4.5: Inter-rater reliability and agreement parameter results between novice raters

	Station 3 and Station 4
ICC	0.48
Upper CI	0.68
Lower CI	0.27

ICC: intra-class correlation coefficient

CI: confidence interval

Figure 4.7 is a Bat plot that graphically represents the inter-rater reliability and agreement parameter results between novice raters.

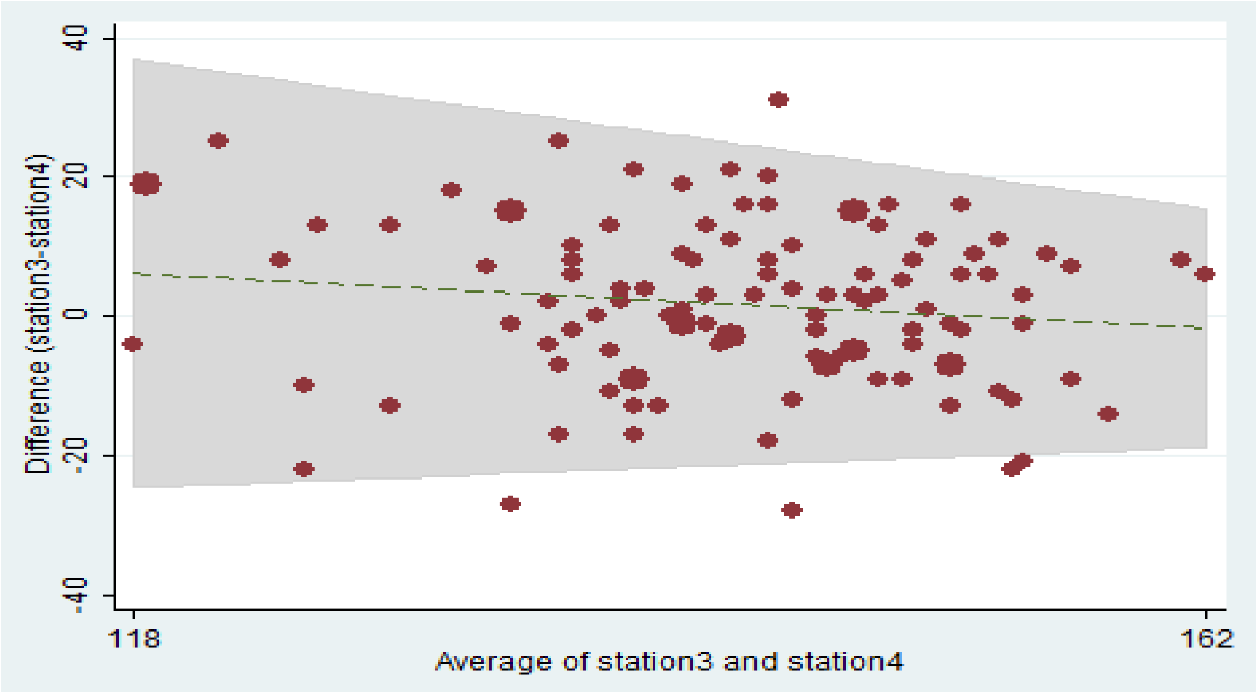

Figure 4.7: *Bat plot representing the inter-rater reliability and agreement parameter results between novice raters.*

Table 4.6 displays the Inter-rater reliability and agreement parameter results between all the raters combined. This is a comparison between the values obtained at station 1, station 2, station 3 and station 4. The intra-class correlation coefficient between these two stations is 0.33 with a confidence interval between 0.50 and 0.19.

Table 4.6: *Inter-rater reliability, all raters*

	All raters
ICC	0.33
Upper CI	0.50
Lower CI	0.19

ICC: intra-class correlation coefficient
CI: confidence interval

4.5 Summary

Table 4.7 displays a summary of the data collected. The ICC between the experienced raters was at 0.48 and between novice raters the ICC was at 0.48 as well. The ICC between all the raters, between the novice and experienced clinicians were at 0.33 with a standard error of measurement (SEM) of 6.83°.

Table 4.7: Summary of Inter-rater reliability

	Experienced	**Novice**	**All**
ICC	0.48	0.48	0.33
SEM	4.69°	6.50°	6.83°

SEM= Standard error of measurement= SD*√1-ICC

4.6 Conclusion

The values obtained from the test ranged between 129 degrees of glenohumeral joint flexion range of motion to 159 degrees of glenohumeral joint flexion. This falls under the normal functional ranges of glenohumeral joint flexion (Safaee-Rad et. al 1990).

Therefore, all the participants had a normal functional pain free range of motion. This proves that the screening of participants done to exclude glenohumeral joint range pathology was effective and successful. The average age and the small differences when comparing Reading 1 and Reading 2 across the average reading per individual indicates that the homogenous group sample size is representative of the population.

Fifty-six participants were tested for the length of Latissimus Dorsi as described in Chapter 3. As described in detail in Chapter 2, the reliability of an objective measure, such as a LD length test, displays the consistency of the measures, the LD length test results, obtained (Nancy Burns 2005). The intra-class correlation (ICC) coefficient displays the reliability of the technique; the ICC index ranges from zero to one. The closer the value of the ICC is to one, the higher the indication of the reliability of the test will be (Nancy Burns 2005).

Therefore, the intra-rater reliability of this test for experienced raters and novice raters is poor to moderate. This means that if one performs this test on one participant more than once there will be a poor consistency and reproducibility between the measurements taken by one rater using this LD length test. The novice rater at station 4 had the highest ICC of 0.76, which would constitute moderate intra-rater reliability.

The small ICC of less than 0.9 regarding intra-rater and inter-rater reliability agreement parameters shown across all raters indicates that the LD length test used in this study is scientifically unreliable and not reproducible in a clinical study or laboratory setting (Lachin, 2004). These statements will be discussed in detail in Chapter 5.

Chapter 5: Discussion

5.1 Introduction

The research question asked by the researcher was, “Is the technique described by Commerford and Mottram (2012) testing the length of LD scientifically reliable?” The question was addressed through the development of an aim and two main objectives. The main aim of the study was to determine the scientific reliability of the LD length test developed by Commerford and Mottram, (2012). This aim was accomplished by developing and addressing two main objectives. The first of the two main objectives was to assess the reliability of the technique of a test measuring the length of LD by means of intra-rater agreement in both novice and experienced clinicians. The second objective of the study was to assess the reliability of the technique of a test measuring the length of LD by means of inter-rater agreement in both novice and experienced clinicians.

5.2 The reliability of the technique

In addition to the ICC, the standard error of measurement (SEM) was calculated (Table 4.7) as an agreement parameter as recommended for measurements on a continuous scale (deVet et. al, 2006). The SEM was calculated by multiplying the standard deviation of the measurements by the square root of 1 minus the ICC (SD*√1-ICC). The SEM is equivalent to the standard deviation of the measurement error, reflecting the variability in the distribution of the measurements (Portney and Watkins, 2000). The SEM values for the experienced, novice and all the raters combined were 4.69°, 6.50° and 6.83° respectively. The SEM represents the standard deviation of the measurement, with higher values indicating a less reproducible measurement in test-retest conditions within the same individual (Borstad and Briggs, 2010). For exa

mple, the results indicate that the experienced raters had a mean measurement value of 144 for reading 1 (SD 6.50) and an SEM of 4.69°.

This range of error indicates that it would not be too difficult to use this measurement to make evaluative interpretations and provides some support for its clinical use. Due to the fact that the participants in this study were young and asymptomatic for shoulder pain, the SEM results suggest that this measurement may be even less reproducible in patients with shoulder pain.

The intra-rater agreement at the measurement stations labelled 1 to 3 were moderate, i.e. at 0.6, 0.55 and 0.6 respectively, while at the station labelled 4 the intra-rater agreement was at an ICC of 0.76 which still falls under the moderate level of reliability although the value is closer to the ICC values representative of higher levels of reliability.

Inter-rater agreement for both the experienced and novice clinicians respectively was at 0.48 which denotes low to moderate reliability which cannot be seen as indicative that the LD length test used is suitably reproducible in a scientific or laboratory setting.

An interesting fact to be noted is that although the inter-rater reliability was the same for both novice and experienced clinicians, for the absolute measurements of the first reading, reading 1, the novices measured lower than the experienced clinicians ($p=0.048$; 143.8 degrees vs. 146.0 degrees; Random-effects GLS regression).

This method of assessing reliability, using the ICC, was employed to determine the reliability of the technique that tests the length of LD. The inter-rater reliability agreement is summarized in Table 4.7. The ICC between the experienced raters was 0.48 with a novice rater ICC of 0.48 as well. The ICC between all the raters was 0.33.

This proves that this test is not scientifically reliable regarding inter-rater and intra-rater reliability between experienced raters, novice raters and all the raters combined. In the study in which Borstad and Briggs (2010) determine the reliability of the test developed by Levangie and Norkin (2001), the ICC values obtained by them in 2010 for the inter-rater reliability of the test for all the raters combined, experienced raters and novice raters were 0.19, 0.30 and 0.15 respectively. All these values displayed by Borstand and Briggs (2010) constitute poor reliability.

If one compares the ICC values obtained in this study to the values obtained in the study assessing the technique that tests the length of LD by Borstad and Briggs (2010), it indicates a much higher scientific reliability of the test developed by Commerford and Mottram (2012) when compared to the test developed by Levangie and Norkin (2001). Both of these tests are, however, scientifically unreliable due to the low ICC values obtained in both this study and the study by Borstad and Briggs (2010). The higher ICC and the small standard deviation between the readings of the LD length test developed by Commerford and Mottram, (2012) obtained in this study, suggests that the test by Commerford and Mottram (2012) has a greater clinical accuracy than the test assessed by Borstad and Briggs (2012). As described in the literature review, this is attributed to the increased consistency in the stabilisation of the lumbar lordosis and other contributing factors such as the stabilisation of the scapulae and the standardized positioning of the glenohumeral joint in the test developed by Commerford and Mottram, (2012).

This does not change the fact that the ICC values obtained in this study, indicates poor to moderate reliability of the test developed by Commerford and Mottram (2012). It was decided to do a further literature search.

5.3 A new literature search

A second literature search was done in order to rule out the possibility of any new literature applicable to the study being available. New keywords were added because the researcher suspected that the ability of the participants to cognitively learn the movement pattern of the testing technique affected the resulting poor reliability.

The keywords consisted of the following: Latissimus Dorsi, reliability, length test, outcomes measures, reproducibility, muscle length test, anatomy of Latissimus Dorsi, cognitive learning, muscle length and stretching time.

The searches that included the key words used in previous searches were limited to articles from the year 2013 onwards.

The sources searched in order to explain the poor reliability of the technique used to assess the length of LD were Google Scholar, Pub med, Science Direct and the Cochrane library. Physical therapy textbooks and journals were also reviewed.

There were 120,000 results that were found. Of these results, four articles were found to be directly applicable to an adequate explanation as to the resulting poor reliability of the test. The limitations regarding the logistics of the methodology as well as the limitations regarding the actual technique itself will now be discussed to account for the poor reliability of the LD length test in correlation to these four articles.

5.4 Limitations

The poor reliability of this LD muscle length test can be attributed to probable flaws in the test itself, the test procedure and unforeseen limiting factors the logistical methodology. These limitations in the technique will now be discussed in order to ascertain the reasons behind the poor reliability of this technique that tests the length of LD.

There were various limitations in the logistical aspects of the methodology which became clear when the articles described above were reviewed. These limitations will now be explored with specific reference to the articles applicable to each limitation.

The first article is one that discusses the neuroenhancement of the aging brain and the time taken in the restoring skill acquisition in old subjects (Zimerman et.al, 2013). The researchers discovered that cognitive learning and an acquisition of a new skill happens very fast in persons aged between 18 and 31 years.

Participants in this study assessing the reliability of a LD length test were aged between 18 and 28 years and this could have allowed them to manipulate the results of the test. It is stated that the acquisition or learning of a new skill such as a movement, in this case the testing position of the LD muscle length test, is optimally acquired between the ages 18 to 31 years.

This age category is directly applicable to the sample population of this study, since the participants were aged between 18 and 28 years. This information is important because, if the participants were able to optimally learn the position of the LD length test position, they would be able to actively gain range by manipulating the movement, thereby affecting the reliability of the test. The participants were all physiotherapy students and this would make understanding the movement and manipulating it so much easier as well.

The second article that was used was in the interest of practice-induced motor memory formation Stefan et.al (2008). Ten participants, naïve to the study aims, were examined to see if performance gains relating to a thumb movement were possible if action observation and imitation was allowed. Numerous behavioural investigations have demonstrated that performance gains can be induced by action observation and by imitation. This article by Stefan et.al (2008) is relevant to this study because the participants in this study were able to observe each other in the study setting (physiotherapy gymnasium). This could have influenced the degrees obtained from the LD length test as performance gains was proven to be induced by action observation and imitation Stefan et.al (2008).

They indicated that that the observation and mimicry of a movement pattern is enough to induce performance gains.

This knowledge indicates that the fact that participants could observe each other in the testing position as well as mimic the person being concurrently tested could contribute to performance gains of range of motion of glenohumeral flexion, which would also have contributed to the resulting poor reliability of the muscle length testing technique.

The third article is an article written about the effect of different practice schedules on motor learning by Tanaka et.al (2010). Sixty healthy subjects were divided into two groups and each group were taught motor skills, using the different practice schedules—the difference in learning was observed Tanaka et.al (2010). The results showed that motor learning does differ depending on the practice schedule and amount of repetitions of a task per practice.

This applies to this study, since, during the methodological procedure, each participant repeated the testing procedure eight times in total in less than four hours. Tanaka et.al (2010) indicated that repetition or variances in practice of a newly learned motor activity would play a role in motor learning and this could have allowed an increase in the measurements obtained from the LD length test.

The fourth article was used to determine the maximum amount of time that a muscle could be placed in a lengthened position without a change in length being implemented in the LD muscle (Bandy and Irion, 1994). Fifty-seven subjects with limited hamstring muscle flexibility were randomly assigned to one of four groups. Three groups stretched five days per week for 15, 30, and 60 seconds respectively. The fourth group, which served as a control group, did not stretch. The hamstring muscles' lengths were determined by measuring knee extension ROM. Thirty seconds of sustained stretching was found to be the optimal time for an effective stretch. During the pilot study it was made certain that no position of a lengthened LD should exceed twenty seconds.
To the knowledge of the researcher, there is no literature that investigates the effect of multiple shorter than thirty second sustained stretches to a muscle.

It is conceivable that the amount of lengthened positions applied to the participants' LD due to the amount of times each test was repeated on each individual would affect a change in the length of the muscle. Therefore, a better testing system would have been realised if eight raters were available, in order to split the sample and focus on technique and reliability as well as decrease repetitions and possible LD muscle length altering consequences.

The technique itself had various shortcomings which were observed during the process of this study. All the raters suggested that it was difficult to read the goniometer to the nearest single digit, which would affect the resulting reliability of the technique. The proprioceptive input given by the rater during the stabilisation of the scapula during the LD muscle length test (Figure 3.5), could alter muscle recruitment, which in turn could affect the range of motion at the affected joint (Commerford and Mottram, 2001).

This means that if the amount of proprioception was not able to be consistently maintained in the exact same manner at each testing station during the accomplishment of the technique and this would allow the amount of range of GHJ flexion measured to vary with the variation in the amount of proprioception given. This is because the size and placement of the raters' hands cannot be consistent across stations. Therefore, the range of motion could inadvertently be affected and therefore could be one of the contributing factors to the poor reliability that resulted.

The Velcro strapping limited the amount of pelvic tilting, but the amount of lumbar lordosis in participants with very good dissociation could be altered inconsistently without the tilting of the pelvis and this could in turn cause a decrease in consistency of the measurements obtained and thus also be a contributing factor to the poor reliability of this test.

By stabilising the scapula when performing the technique, a stretch is only isolated on the dorsal aspects of the muscle (the part between the inferior angles of the scapulae up to the insertion on the humerus) (Refer to Chapter 2 for the anatomical description of LD).

The part of the Latissimus Dorsi muscle belly between the scapulae and the thoraco-lumbar fascia is thus unaffected with regards to its position of length. This would therefore not be a true reflection of the entire length of the muscle.

Chapter 6: Conclusion

6.1 Conclusion

In the quest for a possibly reliable LD length test, a test by Commerford and Mottram (2012) was found. This test was then applied in a clinical study to test its reliability. Due to the limitations discussed above, the scientific reliability of this test was found to be poor to moderate. The small differences noted between Reading 1 and Reading 2 regarding the standard deviation (SD) of all the raters combined, suggests that the LD length test may still prove to be useful in quantifying dysfunction in the clinical setting. The small difference scores in the mean are indicative that the technique is clinically significant. The researcher subsequently proposes a new technique that tests the length of LD. This technique is to be tested for reliability and validity in a future study. Recommendations are also given for logistical and procedural issues that a fellow researcher, interested in undertaking the recommendations, might encounter.

6.2 Recommendations

The critical analyses as well as the logistical limitations discussed in the previous chapter lead the researcher to believe that the test developed by Commerford and Mottram (2012) is not scientifically reliable, due to the difficulties expressed in the form of limitations discussed in Chapter 5.

The criterion for scientific reliability is very difficult, i.e. an ICC of 0.9 or more is needed to prove scientific reliability (Nancy Burns 2005). The poor to moderate ICC scores resulting from this study's reliability testing indicate the poor to moderate reliability and reproducibility of the LD muscle length test. Functionally, in clinical practice, the amount of negligible differences in degrees of range of motion is a lot more than the statistical norm.

A mere difference in the reading or placement of the goniometer could affect a change in the resulting reliability with regard to the ICC.

It is clear that the LD muscle length test is scientifically and statistically unreliable, but if one refers to Table 4.2 in Chapter 4, the small difference noted between Reading 1 and Reading 2, regarding the standard deviation (SD) of all the raters combined, suggests that the LD length test may have better functional intra-rater reliability. This means that this test can still prove to be useful in quantifying dysfunction in the clinical setting. The LD test procedure used in this current study was not well developed and controlled for the different factors discussed.

The researcher recommends that a new test be developed for use in clinical studies as well as clinical practice. The researcher proposes a technique to test the length of LD as well as give recommendations for a manner of testing the proposed technique for reliability.

6.2.1 A proposed new test

6.2.1.1 Proposed test procedure

The proposed technique to test the length of Latissimus Dorsi should be conducted as follows:

The participant should be marked for the centre point of the glenohumeral joint. (As described in Chapter 3) This marking will have to be done by a water soluble non-permanent and hypo-allergenic skin marker (Figure 3.4)

The participant should be positioned in supine with flexed knees and hips three foot lengths away from their body with the soles of both feet completely flat on the surface of the plinth on a biofeedback unit (Figure 5.1).

The reading of the amount of pressure, when the participant presses his/her lumbar spine against the biofeedback unit, should be taken and recorded. This reading should be maintained throughout the proposed muscle length test to ensure that there is a constant maximum posterior tilting of the pelvis and an objective position every time the length of the muscle is tested. The concentration of the participant to maintain the reading on the biofeedback unit will also create a cognitive distraction, which could decrease the possibility of the participant influencing the outcome of the proposed LD length test.

The participants’ mid axillary line will not be marked nor will the scapulae be stabilised as to allow full lengthening of the LD and as to control the amount of proprioceptive input given to the participant.

The participant will then be passively taken into the maximum possible movement of glenohumeral flexion with the biofeedback reading being kept constant, his/her thumb facing the roof and keeping his/her back flat (in order to not medially rotate the GHJ or allow an increase in the lumbar lordosis as both factors would inconsistently increase the range of GHJ flexion, which would in turn decrease the reliability of the test). The available range of GHJ flexion will then be recorded (Figure 6.1). This test is an adaptation of the tests developed by Herrington and Horsley (2013), Commerford and Mottram (2012) and Levangie and Norkin (2001). This test was described as a recommendation by the researcher in order to address critical analysis of the LD length technique discussed in the previous chapter.

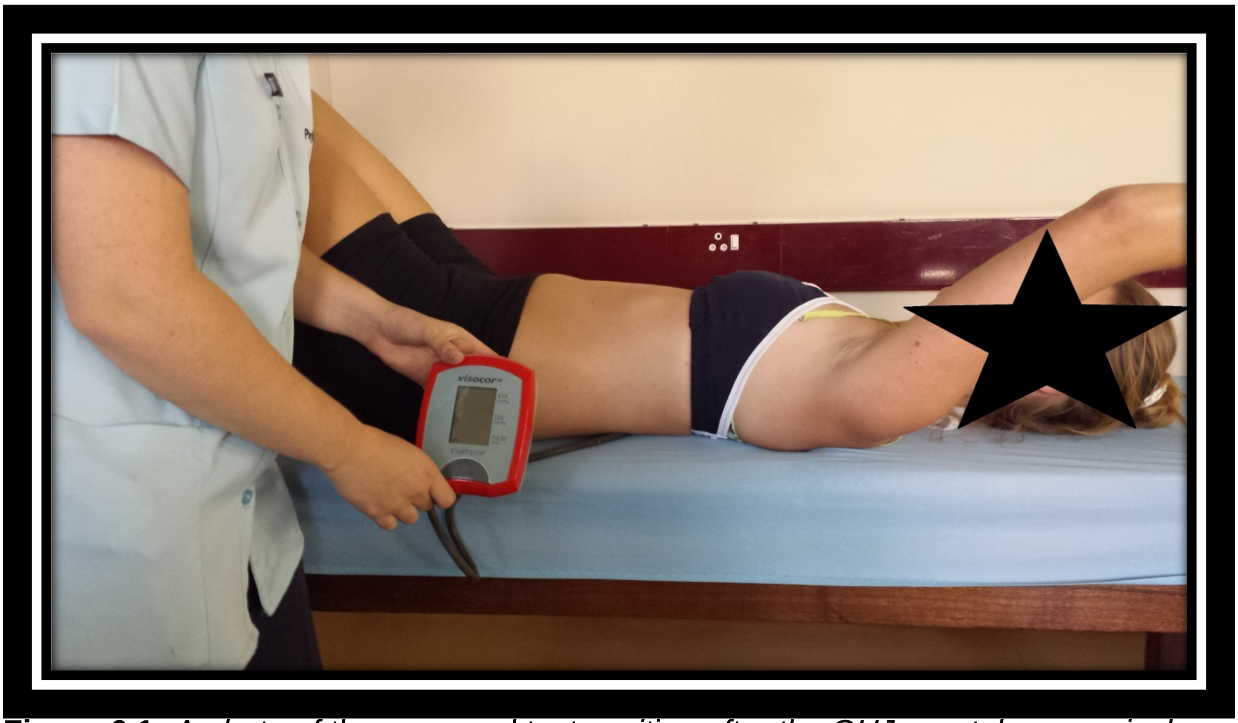

Figure 6.1: *A photo of the proposed test position after the GHJ was taken passively into full flexion*

Important note: The participant is asked to press his/her lumbar spine as much as possible into the biofeedback unit. When the reading decreases, the lumbar lordosis would decrease; this is the point where the measurement of glenohumeral flexion range of motion should be taken. This test is very similar to the test used by Herrington and Horsley (2013), with one major difference being that the GHJ in the suggested test is not allowed to go into full medial rotation and is kept in a neutral position (thumb pointing perpendicularly to the plinth). The reason for this is to maintain the consistency of the test without allowing the influence of the length or the pathology of GHJ lateral rotators. The muscles that assist and function in lateral rotation of the GHJ consist of the deltoid muscle, the Supraspinatus muscle, the Infraspinatus muscle and the Teres minor muscle (Moore 1992). It is logical that, if a muscle that acts in the functioning of lateral rotation of the GHJ is shortened, the range of GHJ medial rotation will be limited (Commerford and Mottram, 2012).

To address the issue of the poor availability of a biofeedback unit, a blood pressure cuff could be used as long as the point of the cuff that is in contact with the lumbar spine is constant amongst participants.

6.2.2 Recommendations of reliability testing of future muscle length tests

The researcher proposes that the proposed technique described above to measure the length of LD be tested for reliability. The researcher recommends that the reliability testing be done with eight raters in eight different rooms where participants are not able to cognitively learn from observation or repetition. The researcher suggests doubling the amount of raters as to be able to have enough raters to be representative of the population of novice physiotherapists and experienced physiotherapists in the interest of a valid comparison between the two groups. The researcher also recommends that the sample group be split into eight and only measured by one rater per day over a period of eight days in order to avoid altering the length of LD. The sample should preferably consist of students who are not experienced in any field of movement or health sciences in order to avoid manipulation of the testing procedure.

No GHJ flexion should be maintained for a period longer than 10 seconds. The researcher also recommends that a study be done investigating the effects of short bursts of frequent (more than three times a day) muscle stretching when compared to longer 30 seconds stretching. This is to rule out the queried lengthening effect of a repetitive movement done in one day. The researcher also proposes that this new test be assessed for validity using the Qualysis™ movement analysis system.

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Chapter 8: Appendices

The Appendices now follow, seperated by a title page each time.

APPENDIX A – PLAGIARISM DECLARATION

DECLARATION OFORIGINALITY/ DECLARATIONON PLAGIARISM

The***Department ofGeology (University of Pretoria)***placesgreatemphasisuponintegrityand ethicalconductinthepreparationofallwrittenwork submitted foracademic evaluation.While academic staff teaches you about referencing techniquesandhow toavoidplagiarism,youtoohavea responsibility in this regard. If you are at any stageuncertainastowhatisrequired,youshouldspeak toyourlecturerbeforeanywrittenworkissubmitted.

You areguilty of plagiarismif you copy somethingfromanotherauthor'swork(e.g.abook,anarticle orawebsite)withoutacknowledgingthesourceandpassit off as yourown. In effect you arestealing somethingthatbelongstosomeoneelse.Thisisnotonlythecasewhenyoucopyworkword-for-word (verbatim),but also whenyou submit someone else'sworkinaslightlyalteredform(paraphrase)or usea line of argument without acknowledging it.Youarenotallowedtouseworkpreviouslyproduced by anotherstudent. You are alsonot allowed to letanybody copy your work with the intention of passingifoff ashis/herwork.

Studentswhocommitplagiarismwillnotbegivenanycredit for plagiarised work. The mattermay also bereferredtotheDisciplinaryCommittee(Students)foraruling.Plagiarismis regardedas aserious contraventionof the University'srulesandcanleadtoexpulsionfromtheUniversity.

The declaration which follows mustaccompany all writtenworksubmittedwhileyouareastudentof the***Department ofGeology (University of Pretoria)***. No written work will be accepted unless the declarationhasbeencompletedandattached.

I,theundersigned,declarethat:

1. Iunderstandwhatplagiarismisandamawareof the University'spolicy in this regard.
2. I declare that this assignment (e.g. essay,report, project, assignment, dissertation, thesis,etc) is my ownoriginal work. Where otherpeople'sworkhasbeenused(eitherfromaprinted source, Internet or any other source), this hasbeenproperlyacknowledgedandreferencedin accordancewithDepartmentalrequirements.
3. I have not used workpreviously produced by another studentorany other person to hand inas my own.
4. I have not allowed, and will not allow, anyone tocopymy work withthe intentionof passing it off ashisorherownwork.

Full names ofstudent:

Student number:

Date submitted:

Topic ofwork:

Signature:

Supervisor:

APPENDIX B – APPROVAL AND CLEARANCE LETTERS

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Facultyof HealthSciences/FakulteitGesondheidswetenskappe Office of theDeputyDean/Kantoorvandie AdjunkDekaan

24 September 2013

Towhomitmayconcern:

<u>MuhammadDawood: PermissiontousetheUPPhysiotherapy Department gym and approach studentvolunteers.</u>

I hereby giveapproval toMuhammadDawood'srequesttousethePhysiotherapyDepartment gym,ontwo afternoons in Januaryas part ofhis Mastersdegreeresearch. Theafternoons willbechosen accordingtothe availabilityofthe studentsandthe gym.

He may alsoask forstudentvolunteers toparticipate inhis study fromthepopulationof students affiliatedto the physiotherapy department.

This permissionis dependent onthe appropriate permissionfromthe Head oftheDepartmentof Physiotherapy.

Yours sincerely

ProfDManning

Deputy Dean:Education

APPENDIX C – INFORMED CONSENT AND INFORMATION FORM

INFORMATION LEAFLET, INFORMED CONSENT FORM

TRIAL TITLE: The assessment of the inter and intra-rater reliability of a method assessing the length of the Latissimus Dorsi muscle

INTRODUCTION You are invited to volunteer for a research study. This information leaflet is to help you to decide if you would like to participate. Before you agree to take part in this study you should fully understand what it is and what is expected of you. If you have any questions, which are not fully explained in this leaflet, please do not hesitate to ask the investigator, Muhammad Dawood. You should not agree to take part unless you are completely happy about all the procedures involved.

WHAT IS THE PURPOSE OF THIS TRIAL? You are a physiotherapy student. You are currently in the process of learning valuable assessment techniques in order to evaluate your future patients objectively. The whole concept of objectivity means that something has to be quantifiable with little to no discrepancy in the measure between therapists. This is why adequate assessment techniques should be reproducible. This means that if you as a physiotherapy student perform an evaluation technique on subject A and I as a qualified physiotherapist do the same our results should be similar if not the same. If this is true this would mean that the test is reliable. There is a muscular length test for the Latissimus Dorsi muscle which I would like to test for reliability in order for us and the profession to be able to use it objectively in research and in practice.

WHAT IS THE DURATION OF THIS TRIAL? If you decide to take part you will be one of approximately 50 subjects. You will be assessed by physiotherapists, some being your lecturers, for the length of your Latissimus Dorsi. You will have to be present in the student gym of the physiotherapy department for four hours on two occasions in one week in the month of November 2013.

EXPLANATION OF PROCEDURES TO BE FOLLOWED You will be expected to dress in to your normal practical assessment garments usually worn by you in practical physiotherapy classes. This is in order for specific structures to be visible and palpable. You will lie in supine and flex both hips and knees until both soles of the feet may be completely flatly placed on the surface of the plinth. This is called a crook lying position. <u>At the first meeting a shoulder quadrant test will be performed to rule out any pre- existing shoulder pathology, if it has been found that there is pre-existing pathology you will be excluded from the study and explained why and if necessary you will be referred to the adequate healthcare professional</u>

for treatment. If you are included in the study, on the day of the procedure, the therapist will first position you in the crook lying position. You will then be asked to press your lumbar spine against the plinth a Velcro strap will be tightly wrapped around your waist. You will then be asked to flex your shoulder with your thumb facing the roof and keeping your back flat on the plinth. A therapist will measure your range of motion of shoulder flexion with a goniometer.

HAS THE TRIAL RECEIVED ETHICAL APPROVAL? This clinical trial protocol was submitted to the Faculty of Health Sciences Research Ethics Committee, University of Pretoria and written approval has been granted by that committee. The study has been structured in accordance with the Declaration of Helsinki (last update: October 2008), which deals with the recommendations guiding doctors in biomedical research involving human/subjects. A copy of the declaration may be obtained from the investigator should you wish to review it. The University of Pretoria Research Ethics Committee may also be contacted at: The Research Ethics Office: Tel: 012 354 1330 or 012 354 1677 Fax: 012 354 136, manda@med.up.ac.za or deepeka.behari@up.ac.za.

WHAT ARE YOUR RIGHTS AS A PARTICIPANT IN THIS TRIAL? Your participation in this trial is entirely your choice and you can refuse to participate or stop at any time without stating any reason.

MAY ANY OF THESE TRIAL PROCEDURES RESULT IN DISCOMFORT OR

WHAT ARE THE RISKS INVOLVED IN THIS TRIAL? There are no risks and you will feel no pain. A mild stretching sensation or discomfort of your muscle called Latissimus Dorsi may be felt for a few seconds while the measurement is being taken.

INSURANCE AND FINANCIAL ARRANGEMENTS It will cost you nothing to participate in this trail. You will not receive any compensation for your participation in this trial.

Should you experience any research related complications, side effects and/or injuries during the trial. You should notify the investigator (Muhammad Dawood 0721182565)

SOURCE OF ADDITIONAL INFORMATION For the duration of the trial, the physiotherapist conducting the trail will be Muhammad Dawood. If at any time during the trail, you feel that any symptoms are causing any problems, or you have any questions during the trial, please do not hesitate to contact him. You can contact him at: 0721182565 MDawoodphysio@gmail.com . You may also contact his supervisor at ekorkie@medic.ac.za.

CONFIDENTIALITY

All the information that is gathered in this trail will not be shared with anyone. Information that may be reported in scientific magazines will not include any information which identifies you as a patient in this trial. In connection with this trial, it might be important for people in the health profession, the Faculty of Health Sciences Research Ethics Committee, University of Pretoria, as well as your personal doctor and physiotherapist, to be able to review your records of this trial.

You will be informed of any finding that may be important to your health or continued participation in this trial but this information will not be given to any other third party except those listed in the previous paragraph, without your written permission.

INFORMED CONSENT

I hereby state that I have been informed by the physiotherapist, Muhammad Dawood about, how it will be carried out, the benefits and the risks of this study. I have also received, read and understood the above written information (Subject Information Leaflet and Informed Consent) regarding this study. I am aware that the results of the study including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a trial report. I may, at any stage, withdraw my consent and participation in the trial and it will not count against me. I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study

____________________________ ________________________ _________

Students' name (Please print) Students' signature Date

I, Muhammad Dawood, herewith confirm that the above patient has been informed fully about the nature, conduct and risks of the above trial.

_____________________________ _______________________ _________

Investigator's name (Please print) Investigator's signature Date

Witness's name* (Please print)	Witness's signature	Date

Information Form			
Name and Surname:			
Shoulder Pain?	YES	NO	
Age:			
Do you participate in any sport:	Yes	NO	
If yes, please specify:			
Are upper body activities and or gym included in your training regime? If yes please describe?			
Shoulder pain			
Do you or have you ever suffered from shoulder pain?	YES	NO	
Have you seen a doctor regarding this if yes what was the diagnosis given?			
Shoulder quadrant test	Positive	Negative	
Does your pain vary with activity?	Yes	No	
Have you ever had any shoulder pain or stiffness or surgery? If yes please describe.			
Medical information			
Do you suffer from any other medical conditions now?			
Consent given	YES	NO	

APPENDIX D – STATISTICIAN LETTER

APPENDIX E - DATA COLLECTION FORMS AND RAW DATA

Appendix E - Data Collection Forms and Raw Data

These Have been converted to and used in Microsoft Excel format see table with raw data below

Station Number :	Date:

Participant number	Degrees of GHJ Flexion	Time

Collective data recording form

	Evaluation on day 1 Date: Jan 2014				**Evaluation on day 2 Date: Jan 2014**			
Sub	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**

Keys: S= Station Number Sub= Participant number

Raw Data in Microsoft Excel format cleaned and corrected

Table: Summary of Collective Data

ID	Reading	Station1	Station2	Station3	Station4
1	1	145	143	128	109
2	1	146	142	141	126
4	1	151	148	155	140
5	1	153	148	154	146
6	1	160	133	145	137
7	1	145	142	132	119
8	1	166	153	155	140
11	1	145	135	116	120
12	1	150	132	133	137
13	1	138	146	134	143
14	1	140	138	120	147
15	1	156	153	141	137
16	1	125	133	130	147
20	1	154	154	150	147
22	1	154	148	148	152
23	1	135	147	132	145
24	1	153	148	159	148
25	1	134	136	137	137
26	1	135	138	136	134
27	1	146	138	141	144
28	1	139	140	146	146
29	1	138	131	141	126
31	1	145	151	148	160
32	1	162	140	132	139
33	1	150	145	147	141
34	1	146	152	145	150
35	1	132	135	156	150
37	1	140	136	148	123
38	1	144	157	160	153
40	1	158	135	151	145

41	1	150	155	165	157
42	1	156	149	148	135
43	1	141	145	153	132
46	1	153	160	165	159
47	1	154	149	160	151
48	1	164	158	140	122
49	1	161	149	135	140
50	1	131	129	128	120
52	1	161	144	152	147
55	1	158	152	151	152
56	1	168	155	160	144
58	1	136	145	152	136
59	1	155	148	131	159
60	1	139	138	143	150
62	1	138	146	149	147
63	1	145	139	140	141
64	1	145	149	141	142
65	1	165	167	145	158
66	1	140	155	144	165
67	1	134	151	144	153
68	1	150	150	140	144
69	1	149	137	152	161
70	1	144	141	145	150
72	1	140	138	148	155
73	1	140	143	156	153
74	1	137	140	143	150
1	2	133	138	134	109
2	2	140	145	149	128
4	2	136	141	148	140
5	2	136	158	150	140
6	2	142	143	145	142
7	2	135	135	139	133
8	2	154	153	143	140
11	2	136	137	114	136
12	2	137	142	120	130

13	2	144	142	155	142
14	2	136	136	127	144
15	2	155	154	151	150
16	2	125	127	122	135
20	2	155	161	157	148
22	2	156	167	148	155
23	2	139	144	145	136
24	2	148	145	144	150
25	2	131	140	133	134
26	2	136	131	136	129
27	2	129	141	140	132
28	2	155	157	149	151
29	2	142	140	135	122
31	2	140	148	156	145
32	2	138	139	132	143
33	2	135	135	140	140
34	2	144	149	155	149
35	2	131	134	157	141
37	2	140	140	144	131
38	2	147	152	145	147
40	2	142	150	148	137
41	2	142	157	148	159
42	2	152	142	148	145
43	2	146	156	160	129
46	2	154	154	145	154
47	2	143	145	147	143
48	2	154	152	150	131
49	2	155	147	151	135
50	2	130	150	128	109
52	2	149	145	151	153
55	2	150	150	154	134
56	2	166	163	140	141
58	2	150	133	141	131
59	2	150	149	135	137
60	2	140	141	149	146

62	2	140	145	140	136
63	2	140	129	134	143
64	2	142	140	139	151
65	2	166	154	151	165
66	2	144	141	143	165
67	2	130	138	133	146
68	2	148	149	139	137
69	2	145	140	154	155
70	2	135	145	141	140
72	2	140	145	135	153
73	2	141	143	143	149
74	2	131	136	141	144

APPENDIX F – DECLARATION OF STORAGE

Protocol No. ___________________________

Principal Investigator(s) Declaration for the storage of research data and/or documents

I, the Principal Investigator(s),____

of the following trial/study titled ____

____

____

will be storing all the research data and/or documents referring to the above mentioned trial/study at the following address: ____

____

____

I understand that the storage for the abovementioned data and/or documents must be maintained for a minimum of <u>15 years</u> from the commencement of this trial/study.

START DATE OF TRIAL/STUDY: ______________________________

END DATE OF TRIAL/STUDY: ________________________________

UNTIL WHICH YEAR WILL DATA WILL BE STORED: ___________________________

Name ____

Signature ____

Date ____

APPENDIX G – DECLARATION OF HELSINKI

COMMITMENTS AND RESPONSIBILITIES OF SUB- INVESTIGATORS
REQUIRED FOR RESEARCH THROUGH THE FACULTY OF HEALTH SCIENCES RESEARCH ETHICS COMMITTEE, UNIVERSITY OF PRETORIA

DECLARATION BY INVESTIGATOR:

I agree to personally conduct or supervise the described investigation.

I understand as sub-investigator that I am totally responsible for aspects of the study delegated to me by the Principal Investigator and am legally bound by the contract signed with the sponsor and will not inappropriately delegate my responsibilities to the rest of my study team.

I have read and understand the information in the investigator's brochure, including the potential risks and side effects of the drug.

I agree to ensure that all associates, colleagues, and employees assisting in the conduct of the study are informed about their obligations in meeting the above commitments, without relinquishing my total responsibility for the study.

I confirm that I am suitably qualified and experienced to perform and/or supervise the study proposed.
I agree to conduct the study in accordance with the relevant, current protocol and will make changes in the protocol only after approval by the sponsor and the Ethics Committee, except when urgently necessary to protect the safety, rights, or welfare of subjects.

I agree to inform any patients, or any persons used as controls, that the drugs are being used for investigational purposes and I will ensure that the ICH GCP Guidelines and Ethics Committee requirements relating to obtaining informed consent are met.

I agree to timeously reporting to the sponsor and Ethics Committee adverse experiences that occur in the course of the investigation according to the time requirements adopted by the Faculty of Health Sciences Research Ethics Committee, University of Pretoria.

I agree to maintain adequate and accurate records and to make those records available for inspection by the appropriate authorized agents, be it EC, FDA or sponsor agents.

I agree to comply with all other requirements regarding the obligations of clinical investigators and all other pertinent requirements in the Declaration of Helsinki and South African and ICH GCP Guidelines and am conversant with these guidelines.

I agree to inform the Ethics Committee in advance should I go on leave together with an agreed plan of action regarding an alternate principal investigator or sub-investigator to take responsibility in my absence.

I understand that the study may be audited at any time and that deviation from the principles in this declaration will be put before the Ethics Committee for action, which may include disqualification as an investigator and rehabilitation before being accepted as an investigator in other studies.

I confirm that there is no conflict of interest whatsoever in my participation in this study. I have no shares in the sponsoring company and my participation and interests are as defined in the financial agreement.

NAME (Printed) SIGNATURE OF PRINCIPAL INVESTIGATOR DATE

NAME (Printed) SIGNATURE OF SUB-INVESTIGATOR DATE

APPENDIX H – DATA CLEANING DECLARATION

APPENDIX I – PERMISSION TO BE PHOTOGRAPHED LETTERS

APPENDIX J – CURRICULUM VITAE OF RESEARCHERS INDICATING DIFFERENT EXPERIENCE LEVELS

In the following Appendix J are included the four curriculum vitae. The two experienced ratters' curriculum vitae are first followed up by the Novice ratters'. The assisting student who performed the screening tests on the participants is also included.

CURRICULUM VITAE

FRANCINA ELZETTE KORKIE

Experienced Rater 1

Address	Plot 29 Haakdoornlaagte Buffelsdrift Pretoria
Postal Address	PO Box 370 Derdepoortpark 0035
Work tel:	+2712 – 354 2023
Cell number:	+2782 890 1793
E mail:	ekorkie@medic.up.ac.za

<u>Personal Information</u>

Surname	Korkie
Names	FrancinaElzette
ID no.	680419 0166 081
Birth Date	19 April 1968
Sex	Female
Marital status	Married
Husband	Johann
Children	Two boys, Jaco = 18 years and Jandre = 15 years
Home language	Afrikaans
Health	Very good
Criminal records	None
Computer knowledge	Good

<u>Education</u>

School	Volksrust Highschool Volksrust Grade 12, 1985

<u>Tertiary education</u>

University
Degrees

- B Sc. (Physio) 1989, University of Orange Free state, Bloemfontein
- M Sc (Physio) 2004, University of Pretoria

<u>Work Experience</u>

Kalie de Haas Hospital
January 1990 – June 1990

PretoriaAcademicHospital
July 1990 – August 1991

Work experience (continue)

Private Practice
September 1991 – December 1999

Department Physiotherapy,
Faculty of Health science, University of Pretoria
July 1999

Responsibilities within the Physiotherapy Department
I am responsible for the following modules within the physiotherapy curriculum:

First years
Developed an integrated CD with the first year's study content (2004) with special emphasis on practical skills. In use since (2006)

Second years (120 lectures per year)
- Movement analysis and rehabilitation

Third years (50 lectures per year)
- The introduction to orthopaedic manual therapy
- Spinal mobilisation techniques
- Spinal biomechanics
- Spinal syndromes
- Evaluation of the spinal patient

Fourth year (20 theory lectures and 70 hours small group discussions)
- Integration of spinal pathology and treatment
- Special conditions, for example sacral iliac joint syndromes, temporal mandibular joint syndromes
- Industrial back and neck care
- Prevention of spinal pain recurrences
- Spinal orthrosis
- Special spinal treatment techniques
- 3 hour small group discussions weekly

Post grad program (course work Masters: sport and neurology)
- Biomechanics, movement dysfunction and rehabilitation

Research
- Supervisor undergraduate research (2000 – 2011)
- Supervisor: two Master students
- Personal: PhD – write up phase

Administrative responsibilities
- Undergraduate coordinator (2012, 2013)
- Time table coordinator (2001 – 2013)
- Evaluation of students on the clinical blocks

Other

Courses attended

- Course in Pharmacology, Department of Pharmacology, UP 995
- Orthopaedic Manual Therapy I (post graduate course) Bloemfontein 1997
- Movement Impairment Syndromes, Level 1, Vancouver, Canada, 2007
- Sacro-iliac dysfunction, Ina Diener, July 2008
- Cervical disorders: assessment and management, Ina Diener, April 2009
- Movement system impairment syndromes of the hip joint, Shirley Sahrmann, November 2009
- *Kinetic control courses:*
- Understanding movement and function – theory and concepts manual October, 2007
- Diagnosis of mechanical back pain, sub-groups and stability retraining of the lumbar spine October 2007
- Diagnosis of mechanical dysfunction and stability retraining of the neck and shoulder girdle October 2008
- Diagnosis, classification and motor control retraining for the hip August 2009
- Motor control assessment and retraining of the lower leg August 2009
- Diagnosis of uncontrolled movement and restoration of sacro-iliac joint and pelvis mobility November 2009
- Diagnosis of segmental instability and functional motor control retraining of the sacro-iliac joint and pelvis November 2009
- Diagnosis, Mobilisation and Motor control retraining of the Thoracic spine and Ribs (2010)
- Myofascial trigger point therapy in the management of movement dysfunction (2010)
- Master class (2010)
- Integration of hip rehabilitation, Mark Camerford, Chichester, 2011
- Short course in Click-up overview, August 2011

Courses presented

- Co lecturer in presenting the Orthopaedic manual therapy I course (1999 – 2006)
- Thoracic rehabilitation – specific spinal stabilising exercises and motor control (2010, 2011)
- Functional Movement - Analysis and Rehabilitation pre congress workshop (World congress for physiotherapists, Africa 2012)

- *Lunch hour CPD courses:*
- The diaphragm, SBAH Physiotherapy department, 2010
- Functional analysis of movement, SBAH Physiotherapy department, 2012
- The Thorax – the missing link, Melanie Skeen Private practitioner, 2012

Congresses attended

- Attended the International Federation of Orthopaedic Manual Therapists (IFOMT) Congress, Cape Town, 2004
- Attended the World congress for Physiotherapists, Vancouver 2007
- Attended 3rd International congress on movement dysfunction, Edinburgh, 2009

Papers / posters presented

- Presented a paper at IFOMT (2004)
- Presented a paper at the Health science's Faculty Day, 2004
- Presented a paper at the International conference for Physiotherapists, Pretoria October 2008
- Paper presentation, Neuroscience day, UP, 2010
- Presented a poster at Faculty day, 2011

Other

- External examiner for physiotherapy (2001 UOFS, 2002 Wits, 2006 UOFS, 2007 UOFS, Wits 2009, 2010)
- External examiner for anatomy (ANA 151, 152, 161, 162) 2009 - 2012
- Locum in the private sector (2007, 2008, 2009)
- Clinical service: Monday (16h00 – 17h00), Tuesday – Thursday (7h00 – 8h00) Pilates classes, Physiotherapy Department

GENERAL

Sport	• Aerobics, cycling, pilates classes
References	• Prof. T van Rooijen Department of Physiotherapy +2712 - 354 2023 Tania.VanRooijen@up.ac.za • Dr C E Eksteen Department of Physiotherapy +2712 – 3541249 Carina.Eksteen@up.ac.za • Sarah Mottram Movement Performance Solutions 33 West Street Chichester PO19 1QS +441243 786555 0845 1300808 www.kineticcontrol.com
Peer reviewers	Benita Olivier Department of Physiotherapy Wits +27823325776 Benita.Olivier@wits.ac.za Anri Human Department of Physiotherapy Medunsa Anri.human@gmail.com +27835959759 Jacqueline Swart Private practitioner Accredited Kinetic control tutor physio.jswart@gmail.com +27827877742

CURRICULUM VITAE

Marlize Cochrane

Experienced Rater 2

UNIVERSITY OF PRETORIA

FORMAT OF CURRICULUM VITAE

The University prefers the following CV format. Specific items can be added to or omitted to reflect Faculty specific and/or individual circumstances, but the given numbering should, as far as possible, be followed to facilitate the evaluation process.

Provision of information about race and gender is optional, but will assist the University to report in terms of current Employment Equity legislation.

EVALUATION DATE: *(Office use only)*

1. BIOGRAPHICAL SKETCH

1.1 GENERAL INFORMATION

Surname	Cochrane									
First names	Maria Elizabeth				**ID Number**		8502190103082			
Citizenship	South African				**Title**	Miss	**Female**	✓	**Male**	
Place of birth	Kempton Park				**Date of birth**		19/02/1985			
Population group	**African**		**Coloured**		**Indian**		**White**	✓	**Other** *(Please specify)*	
Department	Physiotherapy				**Position**		Lecturer			
Direct Telephone	079 895 0641				**Direct Telefax**					
E-mail	marlize.cochrane@up.ac.za / cochrane.m2@gmail.com									
Date of appointment	01/01/2011				**Permanent full-time**	✓	**Temporary full-time**			

1.2 ACADEMIC QUALIFICATIONS OBTAINED

Degree/ Diploma	Field of study	Higher education institution	Year	Distinctions
BPhysT	Physiotherapy	University of Pretoria	2007	2
MPhysT	Physiotherapy – Neurology and Neurosurgery	University of Pretoria	2012	2

1.3 WORK EXPERIENCE TO DATE		
Name of employer	**Capacity and/or type of work**	**Period From** (mm//yy to *mm//yy)*
University of Pretoria	Lecturer	01/1/2011 – present
Gauteng Department of Health	Senior Physiotherapist	01/09/2009 – 31/12/2010
RehabworX	Junior Physiotherapist	01/01/2009 – 30/08/2009
Gauteng Department of Health	Community Service Physiotherapist	01/01/2008 – 31/12/2008

2. TEACHING ACTIVITIES

2.1 Courses presented		
Course	**Level** *(e.g. second year, Masters)*	**Self developed** *(Yes or No)*
FTP 100 – Introduction to Child Health	First Years	Yes
FTP 203 – Burns, Amputations and Motor Control	Second Years	Yes
FTP 300 – Neurology	Third Years	Yes
FTP 400 – Neurology	Fourth Years	Yes

2.2 Other education and pedagogic courses presented		
Course	**Year**	**Institution**
Vertigo and Vestibular Rehab course	2012	Pietersburg Hospital in Limpopo
Hemiplegic Shoulder-Hand Syndrome Management course	2013	Life Rehabilitation – Eugene Marais Hospital
Vertigo and Vestibular Rehab course	2013	Rehab Matters - Johannesburg

3. TEACHING OUTPUTS

3.1 Educational publications and products

Provide full details including full titles, names of all the authors, publishers, dates, page numbers etc. Specify your exact contribution to the publications or products. Note that the publications here should be of a didactic nature e.g. articles in educational publications, papers presented at educational conferences, etc. A summary and description of educational products developed can be provided (e.g. study guides, learning materials, multimedia productions (CDs), educational videos, web materials, text books etc.) relevant to university education.

Educational Products: Study Guides for third year physiotherapy – clinical work and theory.

4. OTHER TEACHING CONTRIBUTIONS

4.1 Membership of national and international bodies

List all the teaching associations or societies to which you belong. Name your involvement, e.g. honorary member, founder member, full member, chairman, president, secretary.

Full member and past-chairperson (North Gauteng branch) of the South African Society of Physiotherapists.

Full member of the International Neurological Rehabilitation Task Team (WCPT related)

4.2 Visits to local and overseas universities as guest professor or lecturer in regard to teaching

Provide details

External examiner at the University of the Free State 2012 and 2013

5. RESEARCH OUTPUTS

5.1 Publications in peer-reviewed or refereed journals

Provide full details of each publication, including full titles, names of all the authors, journals, dates, page numbers etc.

I have submitted two articles to journals for publications, but have not been published yet. The articles and journals are:

1. Determining The Effect Of Balance Retraining Post-Stroke Using The Nintendo Wiifit™: Results From A Pilot Study; African Journal of Physiotherapy and Rehabilitation Sciences

2. Measuring Weight-Shifting Objectively with Limited Resources: A Case Report; African Journal of Disability

6. OTHER SCHOLARLY RESEARCH-BASED CONTRIBUTIONS

6.1 Participation in conferences, workshops and short courses - specify type of contribution

Provide full details of participation in national and international conferences etc

6.1.1 National

Occupational Therapy Neurology Conference – speaker (2012)

Vertigo and Vestibular Rehab Short Course – presenter (2011, 2012, 2013)

7. MANAGEMENT AND ADMINISTRATIVE DUTIES

7.1 List your involvement in departmental activities (e.g. administrative functions), faculty (e.g. Faculty Committees) or other university activities.

Third Year class coordinator (2012, 2013)
Third and Fourth Year clinical coordinator (2012, 2013)
Part of the Curriculum Development committee within the Physiotherapy Department

(2013)

8. COMMUNITY SERVICE OR PROFESSIONAL SKILLS

8.1 Outreach projects

(e.g. project titles, institutions and communities involved, etc.)

- Concert and fundraiser at Phyllis Roberts Home for people living with physical disabilities

8.2 Professional service performed

(e.g. courses presented, lectures at professional associations/clubs, radio or TV appearances, outside expert or appointment committee, etc.)

Vertigo and Vestibular Rehab course presenter

8.3 Clinical service

(e.g full detail of rank/level of joint appointment, level of clinical service rendering responsibilities, university administration and academic responsibilities, CPD involvement, clinical trials involvement, etc.)

- Working 10 clinical hours per week at Eugene Marais hospital and the Physiotherapy Department Gym

8.4 Involvement with other universities/scientific institutions

(e.g. external examiner, editor of journal, advisory council, CSIR, SA Council for Scientific Professions)

- External examiner for the fourth year prepared student examinations in Bloemfontein (2012 and 2013)

CURRICULUM VITAE

Izaan De Jager

Novice Rater 1

CURRICULUM VITAE

IZAAN DE JAGER

1. CONTACT DETAILS

HOME ADDRESS	84 Tom Jenkins Drive Pretoria South Africa
CELLULAR NUMBER	082 824 7874
E-MAIL	zdejager@hotmail.com

2. PERSONAL INFORMATION

SURNAME	De Jager	SEX	Female
FIRST NAME	Izaan	NATIONALITY	South African
IDENTITY NUMBER	890916 0016 08 9	MARITAL STATUS	Single
DATE OF BIRTH	16/09/1989	DRIVING LICENSE	Code B
AGE	24		

3. EDUCATION

3.1 Primary Education

1996-2000, 2001-2002	Wonderboom Primary School Pretoria, Gauteng, RSA
2000-2001	Ste-Foy Elementary School Quebec City, Quebec, Canada

3.2 Secondary Education

2003-2007	Overkruin High School Pretoria, Gauteng, RSA
Subjects	Afrikaans, English, Mathematics, Physical Sciences, Biology, Computer Sciences, Additional Mathematics
Final Exam Results	Matriculated with distinction
Honorary Colours	4x Culture Colours of Distinction 2x Academic Colours of Distinction

3.3 Tertiary Education

2008-2011	University of Pretoria Faculty of Health Sciences School of Health Care Sciences
Course	BPhysT (Physiotherapy), 2011
Awards	BafanaShishali Award for outstanding contribution to the physiotherapy profession, 2011 Second place, Junior researcher oral presentation, *Comparing different weekend physiotherapy treatments to improve the functional outcome of patients in the acute stage of a stroke*, Faculty Day 2011

4. LEARDERSHIP ROLES

BPhysT IV Class Representative 2011
Vice chairperson Recreational Rehabilitation Clinic, 1 Military Hospital 2012

5. SPORT

Recreational participation in Mountain Biking, Adventure Racing, Triathlon and Trail Running
Kilimanjaro Ultra Mountain Bike Marathon 2011 (262km) – 3rd Female
Southern Skies 24 hour Mountain Bike Race – 1st Female
Omni-Motion Bicycling 24 hour Mountain Bike Race 2012– 5th Single Speed Overall

A[S]G 24 hour Mountain Bike Race 2013 – 1st Female
Expedition Africa 500km Adventure Race, World Series – 24th team
Thaba Trails 6 hour Mountain Bike Race – 1st Female
Multiple podiums for mountain bike and adventure races

6. CULTURAL ACTIVITIES

Die Suid-AfrikaanseGilde van Spraak- en Dramaonderwysers
Intermediêr I MondelingeKommunikasie – with distinction
Senior I ModelingeKommunikasie– with honourable mention
Advanced I ModelingeKommunikasie– with honourable mention
Trophy – Best Overall Performance 2007

7. ACADEMIC

Short courses	Basic Emergency Care Level I and II (University of Pretoria, 2009)
	Disability Sport and the Classification system explained: Yvette Sunshine and Tarina van der Stockt
	Relaxation therapy: Lt B.S. Mhlekwa
	Pilatus: Lt C Berry
	Personality types: Ms M Pienaar

8. COMMUNITY SERVICE

8.1 Disabled Sport North Gauteng Junior Classifier

Classifying disabled athletes based on their level of ability in order to compete in appropriate categories.

8.2 UP with Science (2004-2007)

Design and build an exhibit for Sci-Enza at the University of Pretoria.

8.3 NationalZoological Garden of South Africa (2008 – present)

Presented workshops for Zoo Club members on research models and presented environmental education courses.

8.4 SOAP kidz

Comity member and event organizer. As non-profit organisation, SOAP kidz aim to create environmental awareness and promote nature conservation amongst underprivileged and abused children.

8.5 Community health presentations

Multiple presentations about posture, breast cancer, disabilities and general health to communities, SAPD and 1 MilitaryHospital staff

9. PROFESSIONLA MEMBERSHIP

Health Professional Council of South Africa: PT 0112518
South African Society of Physiotherapy

10. WORK EXPERIENCE

2010- 2011	Tuks First Rugby Team, Varsity Team Sports Masseuse Christien van den Berg - 0834580337
2010- 2011	Vertical Horison Co-founder and race organiser www.verticalhorison.co.za

	Francois Jooste – 084 584 44663
2010	Block 1- Orthopaedics, SteveBikoHospital Block 2- Pulmonology, SteveBikoHospital Block 3- Spinal, 1 Military Hospital Block 4- Out Patients Department, KalafongHospital Block 5- Paediatrics, SteveBikoHospital Block 6- Geriatrics, OnsTuis
2011	Block 1- Community, Eersterust Block 2- Out Patients Department, 1 Military Hospital Block 3 –Sport, High Performance Centre Bloc4 - Neurological Rehabilitation, Little Company of MaryHospital Block 5- Intensive Care Unit, 1 Military Hospital Block 6- Cerebral Palsy, paediatric. PretoriaSchool
June 2011	Disabled Tennis World Cup Physiotherapist Christien van den Berg - 0834580337
2012	1MilitaryHospital, South African Military Health Services, Department of Defence Community Service Physiotherapist Spinal and neurological rehabilitation, ICU and paediatric ICU, internal medicine.surgical, psychology and paediatric wards and out patients department.
2013- Present	Dawood andDe Jager Physiotherapy Physiotherapist and owner 074 699 9373 Eugene Marais Life Hospital Cardio and thoracic ICU Physiotherapist Cornette Smith – 082 774 6834

11. NEXT OF KIN

Prof. Tiaan de Jager

Tel:	+27 (0)12 354 2226
Fax:	+27 (0)86 518 9932
E-mail:	tiaan.dejager@up.ac.za
Street address:	24A 4th Street Menlo Park 0081

12. REFERENCES:

1. Lt Col T le Roux
   Head of Department of Physiotherapy
   1 Military Hospital
   SAMHS

   Cell: 082 646 3373

2. Kris Jooste
   Manager and owner
   Vertical Horison

e-mail: kris@verticalhorison.co.za

3. Dr Carina Eksteen
Senior Lecturer
Department of Physiotherapy
University of Pretoria

e-mail: carina.eksteen@up.ac.za

CURRICULUM VITAE

RookayaKadwa

Novice Rater 2

Curriculum Vitae

RookayaKadwa

Address:	292 2nd Avenue Laudium Pretoria 0037
Contact no.	
Cell:	071 864 6942
Home:	(012) 374 4786
D.O.B:	3rd January 1990
Age:	23
Gender:	Female
Nationality:	South African Indian
Marital Status:	Married
Highest Grade Passed:	Grade 12, 2008
School:	WendywoodHigh School, Wendywood

Subjects:

English home language	81%
Afrikaans First Add Language	66%
Mathematics	87%
Life Orientation	78%
Accounting	73%
Life Sciences	88%
Physical Sciences	73%

Tertiary Qualification:	Bachelor of Science in Physiotherapy (2012)
Institution:	University of Witwatersrand (2012)

Skills and Abilities:

- Computer literate - Microsoft Word, Excel, and PowerPoint
- Speak, read and write fluent English
- Fair Command of Afrikaans
- Good people skills
- Friendly, neat and responsible
- Great with children of all ages

General Achievements:

- Level 1 First Aid certificate
- Successfully completed the "LEUKO Sports/Clinical trapping Course" (27th January 2012
- Obtained Clinical Solutions "Dry Needling: The Lumbar Spine, SIJ, and Hip" CPD accredited course (16th March 2013)
- Attended the CP basic management workshop, Chris Hani Baragwanath Academic Hospital (16-17 April 2013)
- Attended "Basic counselling for Therapist in Rehabilitation" CPD course (17th July 2013)

Personal Achievements:

- Elected as prefect in school for 2007/08
- Gold Honours Award for
  Academic excellence in High School (2007 and 2008)
- Winner of the Hatzkilson Metric Award (2008) – Recognizes pupils who display wholehearted commitment and made an outstanding contribution throughout his/her high school career.
- Certificate of Excellence for "Most Outstanding 4th year Research Poster" in the department of Physiotherapy (2012)

Experience:

- **Dawood and DeJager physiotherapy** (January 2014 – Present)
  Full time Locum at Louis Pasteur Hospital. Responsible for treating In andOut Patients on a daily basis Monday – Friday.

- **Tshwane District Hospital** (January 2013 – December 2013)
  Served community service hours for a 12 month period at the hospital from Monday- Friday. Treated In patients with conditions varying in all aspects of physiotherapy except in the ICU setting as there was no High Care wards available. I also treated various Out patient conditions, as well planning and assisting in educational and

health promotional activities. I also assisted with fourth year physiotherapy student supervision and tutorials.

- **Look and Listen, Woodmead branch** (December 2010 – March 2011)
  Sales assistant during the December period as well as weekends thereafter until March 2011

- **Kelvin village pharmacy** (February 2009 – March 2009)
  Assisted with stock taking, merchandising and sales on weekends

- **ToyZone,**WoodmeadShopping Center
  Sales assistant during December, 2007
  Cashier's assistant and also aided in labeling and Merchandising of stock

- **Reebok Outlet Store**, WoodmeadCenter
  Sales personal during December 2006
and on weekends thereafter until July 2007
  Aided in packing, labeling, stock taking
and assisted to the customer's needs

<u>**Volunteer work:**</u>

- **Islamic Medical Association South Africa** (2011 – current)
  Volunteer on a regular bases at Health Screening Awareness Programmes in various locations around Gauteng in disadvantaged communities to offer free basic health care screening and treatment. I assist with calculating BMI, Blood pressure measurements, Glucose and HIV testing. I also assist with basic physiotherapy screening and treatment sessions as well providing education and relevant advice regarding client's conditions.

- **Muslim Students association** (2009 – 2012)
  I was an active member since 2009 at university. Involved in planning events centered around the promotion of Islam, educating fellow students and supporting the Freedom for Palestine. I also aiding the fundraising projects to provide basic food and hygiene hampers to the disadvantaged communities in and around Gauteng four years in a row.

- **Helping Hands Organization** (2007 – 2009)
  Volunteered and assisted with the feeding a patient scheme at Johannesburg General Hospital on Tuesdays and Thursdays since 2007

References:

Muhammad Dawood
Partner in DawoodandDeJager Physiotherapy
Cell: 072 118 2565

Susan De Waal
Chief Physiotherapist, Tshwane District Hospital
Tel: (012) 354 5660
Cell: 082 577 5077

Lee
Store manager: Look and Listen, Woodmead 2011
Cell: 0842472250

Ingrid
Pharmacist and owner: Kelvin Village Pharmacy, 2010
Tel: 011 8022601

RashidaEssop
Member of BaitunKhair- Helping Hands Organization
Tel: (011) 444-5431

Khashiefa Martin
Regional Manager – IMASA Gauteng Branch
Tel: (011) 837 6717
Mobile: 084 701 3208

IN CLOSING

I hereby acknowledge that all the information supplied in my Curriculum Vitae is accurate and truthful. Any further information and proof of documentation is available on request.

APPENDIX K – Language editor certificate

To whom it may concern

This is to verify that I, H. E. C. Tesner, did the language editing of the master's thesis of Mr Muhammad Dawood. Before I retired, I lectured for 44 years in the subject Speech Science and Linguistics in the Department of Communication Pathology at the University of Pretoria. I retired at the end of 2009 and since then I am working as a freelance language editor.

I edit post-graduate theses and publications and several articles edited by me have been published in local and international scientific journals.

Regards,

Herman E. C. Tesner

E-mail address: htesner@mweb.co.za

Acknowledgements

The author would like to express his gratitude to the following people;

Professor A.J Van Rooijen, for the supervision, immense support and assistance.

A.M Marais for the insight into the subject specific methodology.

Professor Piet Becker for the statistical analysis.

M. Maritz and fellow University of Pretoria students for the assistance and participation in the study.

E. Korkie, M. Cochrane, I De Jager and R. Kadwa for playing the role of researchers in this study.