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The Ability of Physiotherapists and Physiotherapy Students to Evaluate and Classify Lumbar Movement Control by using Lumbo-Pelvic Movement Control Tests

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A dissertation submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in fulfilment of the requirements for the degree of Master of Science in Physiotherapy.

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Declaration

I, Cornelia Jacoba Huysamen, declare that this dissertation is my own work with the exception of the literature indicated in the reference citations and acknowledgements. This dissertation is being submitted for the degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It was not submitted before for any other degree or examination at this or any other University.

Signed 

At Johannesburg on the 15 th day of November 2016

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Contents

Declaration ii

Acknowledgements iii

List of figures viii

List of tables ix

Abstract x

List of abbreviations xiii

Chapter 1: Introduction: Background and Need 1

1. Introduction 1

2. Problem statement 2

3. Aim of study 3

4. Objectives 3

5. Research Questions 4

6. Hypothesis 4

7. Significance 5

Chapter 2: Literature review 6

1. Introduction 6

2. Burden and prevalence of low back pain 6

3. Risk factors 8

4. Prognosis and management 9

5. Classification 11

6. Movement impairment classification 12

7. Movement control impairment classification 13

8. Direction based patterns 14

9. Characteristics and identification of a flexion and extension pattern 16
10. Reliability and validity 18
11. Summary 20
Chapter 3: Methodology 21
1. Study Design 21
2. Study setting 21
3. Participants 21
3.1. Sample size 21
3.2. Source of participants 22
3.3. Sample Selection 23
4. Self-administered questionnaire 25
5. Information leaflet 25
6. Procedure 26
6.1. Pilot Study 26
6.2. Main Study 26
7. Ethical considerations 30
8. Data analysis 30
Chapter 4: Results 32
1. Participants 32
2. Part A: Tests used in the assessment of lumbo-pelvic movement control 33
3. Part B: Assessment of lumbo-pelvic movement control and general tests, and classification of movement control dysfunction 34
4. Conclusion to the results 39

Chapter 5: Discussion 41
1. Which tests do physiotherapists use in the assessment of lumbo-pelvic movement control? 41
2. The ability to evaluate movement dysfunction using lumbo-pelvic movement control and general tests. 43
3. The ability to classify movement abnormalities as flexion pattern or extension pattern. 44
4. To compare the ability of evaluation and classification in relation to level of experience of qualified physiotherapists and physiotherapy students 45
Chapter 6: Conclusion 47
6.1. Limitations 48
6.2. Recommendations for future research 48
6.3 Recommendations for clinical practice 49
References 50
Appendixes 56
Appendix A 56
Self-administered questionnaire (Part A): For qualified physiotherapists only 56
Appendix B 58
Self-administered questionnaire and rating sheet (Part B): For qualified physiotherapists. 58
Appendix C 60
Self-administered questionnaire and rating sheet for physiotherapy students 60
Appendix D 62

Lumbo-pelvic movement control tests (correct and incorrect movements) 62
Appendix E 65
Overall classification of extension or flexion pattern 65
Appendix F 66
Information sheet and informed consent form to volunteers that will be video-recorded while performing lumbo-pelvic movement control tests. 66
Appendix G 68
Informed consent for video recording 68
Appendix H 69
Information sheet and consent to qualified physiotherapist participants (raters) 69
Appendix I 71
Informed consent form for qualified physiotherapists (raters) 71
Appendix J 72
Information sheet and consent to physiotherapy student participants (raters) 72
Appendix K 74
Informed consent form for physiotherapy students (raters). 74
Appendix L 75
Ethics Clearance Certificate 75

List of figures

Figure 1: Classification of LBP (O'Sullivan 2005, Luomajoki 2010) 12
Figure 2: Summary of the method 29
Figure 3: Level of education of raters 32
Figure 4: Tests physiotherapists used in the assessment of NSLBP (n=93) 33

List of tables

Table 1. Classification of lumbo-pelvic movement control tests by qualified physiotherapists and physiotherapy students..... 35
Table 2. Classification of general tests by qualified physiotherapists and physiotherapy students 36
Table 3. Overall classification of movement dysfunction by qualified physiotherapists and physiotherapy students 38
Table 4. Years of experience and level of education of the qualified physiotherapists (n=93)..... 39

Abstract

Introduction

Eighty five per cent of lower back pain (LBP) cases are without patho-anatomical or radiological abnormalities and are therefore diagnosed as non-specific LBP (NSLBP). Lumbo-pelvic movement control tests aid in the subgroup classification of NSLBP. This study will focus on the two most common subgroups namely the flexion and extension pattern. The aim of this study was to establish the ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement dysfunction by using six lumbo-pelvic movement control tests and three general tests. This study also intended to establish which tests physiotherapists use in the assessment of lumbo-pelvic movement control; to establish the ability of qualified physiotherapists and physiotherapy students to evaluate videos of patients with NSLBP performing six lumbo-pelvic movement control tests and three general tests and rank them as correct or incorrect; to establish the ability of qualified physiotherapists and physiotherapy students to make an overall classification as flexion pattern or extension pattern; and to compare the ability of evaluation and classification in relation to level of experience of qualified physiotherapists and physiotherapy students.

Methodology

This study was conducted as a quantitative, observational study. An expert panel gave input, helped to develop a questionnaire and chose the videos used. Individuals with NSLBP were recruited from two private out-patient physiotherapy practices in Johannesburg for the video recording. Qualified physiotherapists attending courses, meetings, staff training and other physiotherapy gatherings around Gauteng were invited to participate, and the physiotherapy students were approached through the physiotherapy departments at three universities in Gauteng. The qualified physiotherapists completed the first part of the self-administered questionnaire prior to a short information session. Thereafter the rest of the questionnaire was completed by the participants (qualified physiotherapists and

physiotherapy students) while they observed videos of individuals with NSLBP with flexion or extension patterns. Data was entered into a Microsoft-Excel spread sheet for data cleaning and coding purposes. Therafter the STATA Data Analysis and Statistical Software (release 12; Texas, USA) program was used for data analysis. Means, standard deviations, percentages and the Fisher‟s exact test was used.

Results

A sample of 93 qualified physiotherapists and 96 fourth year physiotherapy students participated in the study. Eighty six percent (n=92) of the qualified physiotherapist participants were familiar with lumbo-pelvic movement control tests but many are not using them clinically to assess patients with NSLBP (13% use waiters bow, 17% use rocking forwards, 18% use rocking backwards, 34% use sitting knee extension, 37% use prone knee flexion and 75% use posterior pelvic tilt). There were very few statistically significant differences between the observations made for the individual tests by the qualified physiotherapists and the physiotherapy students (p-value≤0.05). A statistically significant difference was found in only three out of 24 videos for both the qualified physiotherapists and physiotherapy students (p=0.001, p= 0.007 and p=0.033) respectively. For the overall classification of flexion or extension patterns the physiotherapy students' odds of getting the assessment wrong were only 0.57 in relation to the qualified physiotherapists (p=0.078, 95% confidence interval). Physiotherapists with further qualifications and more experience did not perform better than the inexperienced physiotherapists with regard to the overall classification of a flexion or extension pattern.

Conclusion

Even though the majority of qualified physiotherapists are familiar with lumbo-pelvic movement control tests only a few are using the lumbo-pelvic movement control tests clinically. There was not a big difference between the classification results given by the qualified physiotherapists and those offered by the physiotherapy students. Physiotherapists (novice and experienced) and physiotherapy students are

able to classify patients with NSLBP into a flexion or extension pattern after receiving minimal training.

List of abbreviations

Active straight leg raise -	ASLR
Advanced Professional Development Level two-	APDL 2
Cumulative Index to Nursing and Allied Health Literature -	CINAHL
Human Research Ethics Committee -	HREC
International Federation of Orthopaedic Manipulative Physical Therapy -	IFOMPT
Lower back pain -	LBP
Marginally significant -	MS
Non-specific LBP -	NSLBP
Non-steroidal anti-inflammatory drugs -	NSAID
Not significant -	NS
Odds ratio -	OR
Passive accessory intervertebral mobilisations -	PAIVMS
Physiotherapy Evidence Database -	PEDro
Significant -	S

Chapter 1: Introduction: Background and Need

1. Introduction

Lower back pain (LBP) affects 60–85% of adults during some stage of their lives (Middleton and Fish 2009). Even though the prevalence is high the diagnosis and treatment options for LBP are diverse and inconsistent. This results in high costs and variability in management (Middleton and Fish 2009). The lumbar spine is the area of the spine that receives the most attention from manipulative physiotherapists because disorders of the lumbar spine are more difficult and complicated to diagnose than other spinal levels (Maitland et al. 2005). It is also the area of the spine that causes the most time off work (Maitland et al. 2005).

There are various pathological conditions that can cause LBP to develop but 85% of LBP cases are without patho-anatomical or radiological abnormalities. These cases are then diagnosed as non-specific LBP (NSLBP) (Dankaerts et al. 2006b). In agreement Luomajoki et al. (2007) state that up to 90% of LBP is classified as NSLBP. Non-specific lower back pain can be described as “simple back pain” with a mechanical nature and the pain is situated in the lumbosacral region, buttocks and thighs (Luomajoki et al. 2007).

Treatment of the lumbar spine is a challenge and the effectiveness of treatment is not always guaranteed. This might be because of a lack of defining subgroups for patients with LBP (Dankaerts et al. 2006c). Patients with NSLBP can be classified into the following subgroups: flexion pattern; flexion or lateral shifting pattern; active extension pattern; passive extension pattern and multidirectional pattern (Dankaerts et al. 2006b). Classification is done according to motor control impairment (Luomajoki 2010). This study will only focus on the flexion and extension patterns for they are the most common.

Forward bending, sitting and slump sitting can also show motor control abnormalities (O’Sullivan et al. 2006). Slump sitting is relaxation of the thorax in relation to the pelvis or rounding of the lumbar spine (O’Sullivan et al. 2006). Sitting commonly

aggravates LBP and this will specifically be the case for patients with NSLBP with a flexion pattern (Dankaerts et al. 2006b). During clinical observation it can be seen that these patients position themselves in end-range flexion during sitting. When asked to slump these individuals lack further flexion because they are already sitting in end-range flexion (Dankaerts et al. 2006a). Individuals with an extension pattern hold themselves in a hyperextension pattern during sitting. When asked to slump they show a lack of flexion relaxation (Dankaerts et al. 2006a).

Lumbo-pelvic movement control tests are widely used to evaluate patients with LBP but no gold standard is available (Luomajoki et al. 2008). Various different movement control tests and active lumbar movements are available to help therapists in the diagnosis and classification of patients with LBP. The lumbo-pelvic movement control tests chosen for this study are based on the previous studies of Luomajoki et al. (2007) and O'Sullivan et al. (2005); they found that flexion and extension patterns were the most common patterns in patients with NSLBP. A flexion pattern can be identified by using the waiters bow, rocking backwards and sitting knee extension lumbo-pelvic movement control tests. Pelvic tilt, rocking forwards and prone knee bend can be used to identify an extension pattern (Luomajoki et al. 2007).

2. Problem statement

Non-specific lower back pain is a common and disabling condition. Accurate assessment techniques can aid the accurate classification and subsequent effective rehabilitation of NSLBP. There have been studies done to determine the reliability of the movement control tests previously. Good results were found for inter- and intra-rater reliability but only four physiotherapists rated the tests and they had intense training. Increased familiarity improved the reliability but it was not tested with physiotherapy students or physiotherapists with minimal training (Luomajoki et al. 2007). Van Dillen et al. (1998) conducted a study to test the reliability of the classification of LBP. The results showed that experienced physiotherapists, who have been trained, can obtain good reliability but it was suggested that the reliability should also be tested when more physiotherapists use the tests or by using physiotherapists who have not had previous training (Van Dillen et al. 1998). Movement tests need to be consistent and reliable in a clinical setting especially

where more than one physiotherapist records data and treats the same patients (Luomajoki et al. 2008). Therefore, the ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control need to be determined where intensive training is not being done.

Not being aware of which tests are being used in the clinical setting limits our ability to create awareness of the current evidence regarding more reliable tests. Obtaining information on what tests are currently being used will assist educators to impart current evidence. A test and its interpretation that is poorly understood is unlikely to be used even if it is very reliable.

3. Aim of study

The aim of this study was to establish the ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control by using six lumbo-pelvic movement control tests and three general tests.

4. Objectives

Part A

1. To establish which tests physiotherapists use in the assessment of lumbo-pelvic movement control.

Part B

2. To establish the ability of qualified physiotherapists and physiotherapy students to evaluate videos of patients with NSLBP performing six lumbo-pelvic movement control tests and three general tests and rank them as correct or incorrect.
3. To establish the ability of qualified physiotherapists and physiotherapy students to classify movement abnormalities as flexion pattern or extension

pattern by interpreting six lumbo-pelvic movement control tests and three general tests.

4. To compare the ability of evaluation and classification in relation to level of experience of qualified physiotherapists and physiotherapy students.

5. Research Questions

1. Which tests are used by physiotherapists in the evaluation of patients with NSLBP?
2. What is the ability of physiotherapists and physiotherapy students to evaluate and classify lumbo-pelvic movement control by using six lumbo-pelvic movement control tests and three general tests?

6. Hypothesis

Part A

Null- Hypothesis: Physiotherapists are not using lumbo-pelvic movement control tests in the assessment of patients with NSLBP.

Alternative hypothesis: Physiotherapists are using lumbo-pelvic movement control tests in the assessment of patients with NSLBP.

Part B

Null- Hypothesis: Physiotherapists and physiotherapy students are unable to classify lumbar movement control by using six lumbo-pelvic movement control tests and three general tests.

Alternative hypothesis: Physiotherapists and physiotherapy students are able to accurately classify lumbar movement control by using six lumbo- pelvic movement control tests and three general tests.

7. Significance

Lumbo-pelvic movement control tests can help physiotherapists to classify patients with NSLBP. If the classification of NSLBP is reliable the treatment programme which is based on the classification will be more effective. A standardised set of lumbo-pelvic movement control tests will help physiotherapists to identify specific motor control abnormalities without wasting time with several unnecessary tests. The tests that were chosen for this study were previously found to have good inter- and intra- rater reliability when the physiotherapists were intensively trained. If these tests can be proven to be used accurately with minimal training and if students can identify movement dysfunction with these tests all physiotherapists should be able to use the tests even if they are inexperienced. Clinically physiotherapists choose which tests are most useful for them and that give them the most information needed. In this study it would be beneficial to also find out which tests are commonly used clinically by physiotherapists. This will provide valuable information to educators and create awareness of the existence of potentially more reliable tests in current usage.

Chapter 2: Literature review

1. Introduction

This chapter will give an overview of the literature available on the topic of NSLBP and lumbo-pelvic movement control. The prevalence, risk factors and causes, prognosis and management, classification methods including movement impairment and movement control impairment and direction based patterns with more focus on the flexion and extension pattern will be discussed. Various databases were used in the search for good literature including Medline, Pubmed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Controlled Trials Register in the Cochrane Library, Physiotherapy Evidence Database (PEDro), EBSCO, Science Direct and SCOPUS. The key words that were used included back pain, NSLBP, motor control, lumbo-pelvic movement control, classification and subgroups. Literature used was critically analysed to ensure that high quality articles were included.

2. Burden and prevalence of low back pain

Lower back pain is one of the major current concerns in health care (Luomajoki 2010). It is also the most prevalent musculoskeletal condition and the most common cause of disability (George et al. 2012). There is an 85% incidence of at least one episode of LBP in one's lifetime (Walker 2000). According to Louw et al. (2007) LBP results in significant levels of disability, producing substantial restrictions on usual activity and participation, such as an inability to work. Lower back pain is a global burden and the prevalence among Africans is rising (Louw et al. 2007). Lower back pain has a tremendous social and economic impact on society, and it is a major public health care problem worldwide (Balagué et al. 2012). The lifetime prevalence of LBP is reported to be as high as 84%, and best estimates suggest that the incidence of the pain becoming chronic is about 23%, with 11–12% of the population being disabled by it (Balagué et al. 2012). Lower back pain is the second most common pain condition to result in a loss of productive time at work. Together with headaches it is the dominant cause of missed days of work (Stewart et al. 2003).

The cause of work abscence, during a six month period, shows eight per cent of patients requiring sick leave due to LBP and 45% having pain lasting at least a day (Balagué et al. 2012). The costs for physician visits due to back pain has increased substantially in the United States of America in the past decade (Balagué et al. 2012). Eleven point six per cent of patients with LBP consults with a family doctor, and six point four per cent consult with a specialist (Balagué et al. 2012). The loss of 600 million working days annually, lower production rates, the financial compensation of the injured workers, and the cost of hiring and training new personnel are only a few of the consequences of LBP in Greece (Spyropoulos et al. 2007). Lower back pain incurs billions of dollars in medical expenditures each year and this economic burden is of particular concern in poorer nations such as Africa, where there are already restricted health care funds (Louw et al. 2007).

Symptoms arising from disorders of the lumbar spine are more difficult and complicated to diagnose than those of the cervical or thoracic spine (Maitland et al. 2005). When a definite diagnosis cannot be achieved by radiological methods the LBP is then classified as NSLBP (O'Sullivan 2005). The majority of lumbo-pelvic pain disorders have no diagnosis leaving a management vacuum. From this perspective classification of NSLBP disorders into sub-groups, based on the mechanism(s) underlying the disorder, is considered critical to ensuring appropriate management (Dankaerts and O'Sullivan 2011). Identification of subgroups of NSLBP pain patients is needed and may improve clinical outcomes and research efficiency (Petersen et al. 2004).

Ninety per cent of LBP is classified as NSLBP (Luomajoki et al. 2007). The most important symptoms of NSLBP are pain and disability (Koes et al. 2006). Less than 10% of LBP individuals can be assigned to a specific LBP category, such as nerve root compression, vertebral fracture, tumour, infection, inflammatory diseases, spondylolisthesis, spinal stenosis or definite instability. Non-specific lower back pain can be divided into three stages: acute (zero to six weeks), sub-acute (six to 12 weeks), and chronic (12 weeks and longer) (Luomajoki 2010). Lower back pain often develops into a chronic fluctuating problem with intermittent flare-ups (Dankaerts et al. 2009).

According to Balagué et al. (2012) elderly people are often affected by LBP. It was suggested for decades that children and adolescents did not suffer from LBP unless they had serious or life-threatening disorders. Epidemiological studies showed that all age groups are affected by LBP. They further mention that the prevalence of LBP in teenagers is similar to that in adults, but LBP seems to have little effect on their quality of life unless the pain is highly recurrent, present in other locations as well, or both (Balagué et al. 2012).

3. Risk factors

According to Balagué et al. (2012) NSLBP is by definition “a symptom of unknown cause”. Currently the underlying pathology for the condition cannot be reliably identified. However, many factors have been identified as possible causes of the pain. Studies have reported a significant association between LBP and degeneration of the lumbar discs. Balagué et al. (2012) also state that there is a weak association between smoking and LBP while Van Tulder et al. (1997) state that there is an association between NSLBP and disc degeneration, osteophytes, and sclerosis. Mechanical factors, such as lifting and carrying, standing and walking, manual handling or assisting patients, pushing or pulling, bending and twisting, occupational sitting or awkward positions probably do not have a major pathogenic role on NSLBP according to eight systematic reviews (Balagué et al. 2012).

Delitto et al. (2012) state that there are two major categories of suspected risk factors for LBP. These include individual and activity-related (work and leisure) factors. Individual factors are demographic, anthropometric, physical, and psychosocial factors. The individual factors for which there is the most research include genetics, gender, age, body build, strength, and flexibility. Genetic factors have been linked to specific disorders of the spine such as disc degeneration. However, the link of heredity to the development of NSLBP remains questionable. Females have three times higher chance of developing back pain than males. They further state that back pain can be associated with operating heavy equipment (Delitto et al. 2012).

According to Balagué et al. (2012) genetic constitution can play an important role as a risk factor for NSLBP. People who are overweight or obese have an increased risk of LBP with the strongest association for care-seeking for LBP. Disuse and physical deconditioning are directly associated with chronic LBP in either a causal or consequential manner (Balagué et al. 2012).

Even with these factors that were listed as possible causes and risk factors for LBP there may not be a specific definite cause for initial episodes of LBP. The risk factors for LBP are multifactorial and population specific (Delitto et al. 2012).

4. Prognosis and management

According to Wand and O'Connell (2008) the prognosis for acute NSLBP is relatively favourable. They also state that a significant percentage of sufferers, probably over 50%, do not consult a health care professional for the problem. Among those who do seek care most will experience rapid improvement in pain and disability within the first three months. Beyond this time the majority no longer consult and will continue to experience only low levels of pain and disability and most have returned to work and their usual daily activities. In a small group of acute patients, the problem fails to resolve and 10% will go on to develop chronic, disabling LBP (Wand and O'Connell 2008).

Middleton and Fish (2009) state that pharmacotherapy can be used for symptomatic treatment of patients with LBP. Common choices include non-steroidal anti-inflammatory drugs (NSAIDS); opioid medications; muscle relaxants; anti-depressants; or steroid injections. They further state that the main aim of pharmacotherapy is to control pain and swelling, minimise disability, and improve the quality of life. Pharmacotherapy use is commonly limited due to gastrointestinal complaints and increased cardiovascular risk with prolonged use (Middleton and Fish 2009). Non-steroidal anti-inflammatory drugs are effective in acute and chronic

pain (Roelofs et al. 2008). Muscle relaxants and NSAIDS are more effective for pain relief than placebo treatments (Koes et al. 2006).

Conservative treatment is one of the mainstays of treatment for LBP (Middleton and Fish 2009). Exercises like muscle strengthening and stretching are one of the pillars of the treatment of LBP (Middleton and Fish 2009). Exercises that strengthen the muscles of the lumbar spine can decrease LBP (Lee et al. 2011). Exercise helps to decrease pain and improve function in adults with chronic NSLBP pain (Hayden et al. 2005). In sub-acute NSLBP a graded activity program improved absenteeism outcomes (Hayden et al. 2005). Massage combined with exercise might be beneficial for LBP, especially in subacute and chronic NSLBP (Furlan et al. 2008).

Some guidelines recommend manipulative therapy for the treatment of LBP (Chou et al. 2009). Evidence is insufficient or limited for the usage of acupuncture (Furlan et al. 2005), radiofrequency (Niemisto et al. 2003), injection therapy (Staal et al. 2008) or low-level laser therapy (Luomajoki 2010, Yousefi-Nooraie et al. 2008). Bed rest is less effective than advice to stay active, and can even be harmful (Hagen et al. 2004). Koes et al. (2006) agree that bed rest is not effective in reducing pain and advise that to stay active speeds up recovery and reduces chronic disability. Spinal orthotic prescriptions for uncomplicated LBP should be discouraged (Wolff et al. 2003). No evidence supports the use of lumbar supports for the treatment of NSLBP (Koes et al. 2006). The traditional approach to treat LBP is non-surgical treatment combining physiotherapy and analgesia. Surgical treatment for chronic NSLBP is not recommended (Ibrahim et al. 2008, Koes et al. 2006).

Most treatments provide limited, short-term benefits when compared to no treatment or sham treatment. No treatment seems to be superior to general practitioner care. Furthermore, none of the cited interventions can be truly said to offer a solution to the problem of chronic NSLBP. Although the magnitude of an individual’s problem may be reduced the reduction is typically small and the problem still persists (Wand and O'Connell 2008).

One explanation offered for the failure to identify effective treatments is the lack of methods for subgrouping, or classifying, patients with NSLBP in a manner that would help direct treatment decision-making (Brennan et al. 2006). Chronic NSLBP is made up of several distinct sub-groups each reflecting different mechanisms of symptom production. These subgroups are discussed in section 5 below. The effects of treatment are diluted by the application of a single intervention to a complex, heterogeneous group with diverse treatment needs. The consequence of this assertion is that sub-groups within the chronic NSLBP population need to be identified to enable matching of the intervention with each specific mechanism. This approach has within it the assumption that current interventions, as mentioned earlier in this section (paragraph 4 on page 9 and paragraph 1 and 2 on page 10), are appropriate and will ultimately be shown to be successful if only they can be applied to the correct patient (Wand and O'Connell 2008). Further research into the most effective strategies to prevent and manage LBP in Africa is warranted (Louw et al. 2007).

5. Classification

Classification methods are needed to direct treatment more effectively and improve research efficiency. Physiotherapists evaluate patients with LBP to identify a subgroup or classification based on the data gathered during the evaluation process. This helps them to decide which interventions are most likely to benefit the patient (Fritz et al. 2006). The primary goal of the diagnostic process is to classify patients based on their signs and symptoms. However subgrouping can be more valuable than classification based on the patho-anatomical cause (Fritz et al. 2007). Effective subgrouping methods direct decision making towards the most effective management strategies and produce better outcomes when compared with treatments not based on classification methods (Brennan et al. 2006).

Patients with chronic LBP can be divided into broad subgroups (O'Sullivan 2005). In a small LBP subgroup that includes patients with specific patho-anatomical disorders there is an underlying pathological process and high levels of pain and disability. A second small subgroup exists where psychosocial issues including anxiety, fear,

anger, depression, negative beliefs, unresolved emotional issues, poor coping strategies and fear-avoidance perpetuate the pain disorder. The third sub-group, that is important for this study, is a large group where maladaptive movement or control impairments result in abnormal tissue loading, spinal instability, pain, disability and distress (O'Sullivan 2005). These subgroups are illustrated in Figure 1.

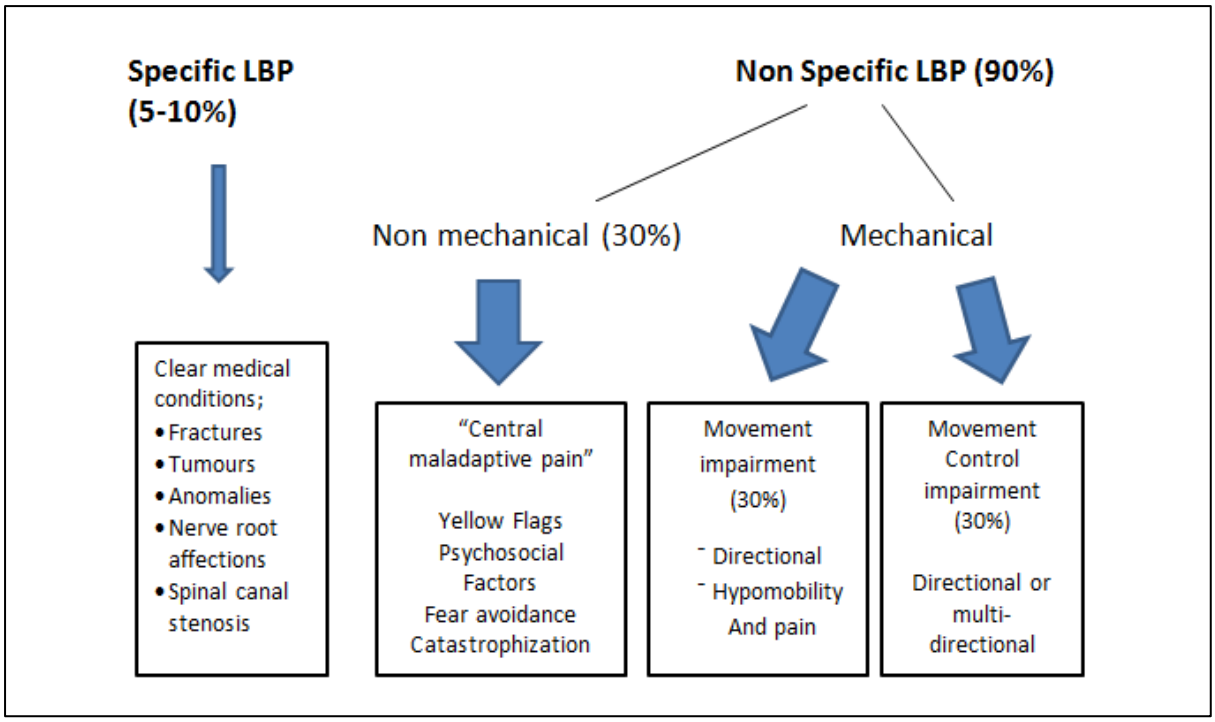

Figure 1: Classification of LBP (O'Sullivan 2005, Luomajoki 2010)

6. Movement impairment classification

Pain disorders associated with a 'movement impairment' classification are usually characterised by fear-avoidant pain behaviour and are associated with a loss of normal physiological lumbo-pelvic mobility in the direction of pain provocation (Dankaerts and O'Sullivan 2011).

O'Sullivan (2005) states that individuals classified with movement impairment usually present with loss or impairment of physiological movement in one or more direction. Muscle guarding is present and there is a co-contraction of lumbo-pelvic muscles when moving into the painful or impaired range. These individuals are also driven by

an exaggerated withdrawal motor response to pain. There is increased compressive loading across articulations, rigidity and movement restrictions which results in tissue strain and continued peripheral nociceptors sensitisation (O'Sullivan 2005).

7. Movement control impairment classification

Movement control impairment is defined as “impaired active movement control of the lumbar spine during functional activities” (Luomajoki 2010). Clinically the patients experience back pain with sustained postures, but the movement is not restricted (O'Sullivan 2005). The motor control impairment is directly related to the continuous provocation of the pain disorder, and the patients adopt provocative spinal postures and movement patterns (Dankaerts and O’Sullivan 2011). Movement control impairment is characterised by pain provocation behaviour and results in loss of functional control around the neutral zone of the spinal motion segment. This is due to under-performance of the spinal stabilisation muscles or increased spinal loading (O'Sullivan 2005).

Synonyms used for motor control impairment are movement control dysfunctions and movement impairment syndrome. Other synonyms include movement system impairment, movement control impairment, clinical instability, segmental instability and postural syndrome (Luomajoki 2010, Comerford and Mottram 2001, Harris-Hayes and Van Dillen 2009, O'Sullivan 2005).

Movement control impairment presents more often in clinical practice. Individuals with classification of movement control impairment present with pain throughout the range, at end range, or loading pain. They adopt postures and movement patterns that stress the pain sensitive structures and usually the onset of pain is gradual. Therefore, they lack a withdrawal reflex motor response. There is also a loss of lumbar-pelvic proprioceptive awareness and a painful loss or impairment of normal physiological movement in a directional manner (O'Sullivan 2005). Altered motor control can present in both static (sitting) and dynamic (forward bending) conditions (Dankaerts et al. 2009).

8. Direction based patterns

There are five direction based patterns of movement control impairment (Dankaerts and O'Sullivan 2011). Classification is done according to motor control impairment. The patterns include the following: flexion pattern; flexion or lateral shifting pattern; active extension pattern; passive extension pattern; and multidirectional pattern (Dankaerts et al. 2006b, Luomajoki et al. 2008). The patterns will be discussed according to the findings of Luomajoki et al. (2008). They conducted a case control study and it was found to be of high quality. A large sample size of 210 participants gave rise to reliable results. The purpose of the study was clear and none of the ideas has been overemphasised or underemphasised. The article was written professionally and objectively. Ethical clearance was obtained, but the physiotherapists who examined the patients were not blinded. The methods of the study were good.

8.1. Flexion pattern

The lumbar spine will tend to lose segmental lordosis and present with an abnormal excessive flexion strain. Flexion-related postures and activities can elicit symptoms while extension postures and activities can ease symptoms (Dankaerts et al. 2006c). Lumbo-pelvic movement control tests can reveal this lack of lordosis control during waiters bow, sitting knee extension and rocking on all fours backwards. The test is positive when flexion of the lumbar spine occurs instead of pure hip flexion with neutral lumbar spine (Luomajoki et al. 2008).

8.2. Flexion/Lateral shifting pattern

Motor control impairment is present and the lumbar spine tends to flex and laterally shift at the symptomatic segment. Reaching or rotating into one direction can elicit symptoms. Extension (lordosis) or reaching to the opposite direction can ease symptoms (Dankaerts et al. 2006c). One leg stance is the appropriate lumbo-pelvic movement control test to identify this impairment (Luomajoki et al. 2008).

8.3. Active extension pattern

The lumbar spine is actively held into extension during activities. Extension related postures and activities can elicit symptoms. Flexion postures and activities can ease symptoms. In some cases flexion postures and forward bending can elicit symptoms due to the tendency of keeping the lumbar spine in segmental hyperextension (Dankaerts et al. 2006c). During forward bending activities it is commonly seen that flexion of the hips occur and there is only a loss of lumbar lordosis after mid-range of flexion. When the patient returns to neutral after forward bending early hyper-lordosis of the symptomatic segment can be seen (Dankaerts et al. 2006c). Pelvic tilt, rocking on all fours forward and prone knee bending can be used to assess extension control. Extension of the hip should occur while the lumbar spine is stabilised However, if the lumbar spine goes into extension the test is positive (Luomajoki et al. 2008).

8.4. Passive extension pattern

With this motor control impairment there is a tendency to passively over-extend at the symptomatic lumbar segment. Extension-related postures and activities elicit symptoms while flexion postures and activities can ease symptoms (Dankaerts et al. 2006c). These patients tend to stand in a sway-back posture and there can be hinging at the symptomatic segment. Usually forward bending is pain free but they can tend to hyper-extend at the symptomatic segment when returning to neutral and then the pelvis moves anteriorly (Dankaerts et al. 2006c). Once again the extension control lumbo-pelvic movement control tests including pelvic tilt, rocking on all fours forward and prone knee bending can be used for assessment (Luomajoki et al. 2008).

8.5. Multi-directional pattern

There is motor control impairment with multi-directional nature. Weight-bearing postures and activities can elicit symptoms. Easing positions or activities are difficult to find during weight bearing. Patients with multi-directional motor control impairment have difficulty with neutral lordosis of the lumbar spine (Dankaerts et al. 2006c). For

the purpose of the study only flexion and extension motor control impairment patterns will be looked at because they are the most common.

9. Characteristics and identification of a flexion and extension pattern

Patients with a flexion or extension pattern present with an underlying maladaptive movement behaviour that results in continuous nociceptor stimulation as opposed to a strategy to avoid pain (Dankaerts and O'Sullivan 2011). Specific characteristics are seen when patients present with a flexion pattern or an extension pattern. These characteristics can be picked up during the assessment and examination of the patient and they help clinicians to classify the patient (characteristics are outlined in paragraphs below, paragraph 2 and 3 on page 16, paragraph 1, 2 and 3 on page 17). The aim of the physical examination is to determine what structure or factors are responsible for the production of the symptoms. Clinical reasoning needs to be carried out to interpret the complete picture (Petty 2011). Assessment is the analysis or interpretation of the findings of the physical examination (Petty 2011). The characteristics will be briefly discussed below, this will aid in the assessment and examination process.

The flexion pattern is the most common pattern. Flexion or rotation movements or activities aggravate the LBP symptoms. There is a loss of segmental lordosis and this can be seen during posture assessment, standing, sitting or when the patient flexes forward. The mechanism of injury is usually a single flexion or rotation injury, or a repetitive flexion or rotation injury (O'Sullivan 2000). Cyclists and industrial workers are often affected (Dankaerts et al. 2009). When the patient flexes forward movement is initiated at the symptomatic level and more flexion might be seen at the symptomatic level compared to the levels above and below (O'Sullivan 2000).

Sitting postures are commonly associated with flexion motor dysfunction. Sitting exacerbates and perpetuates LBP (Dankaerts et al. 2006b). Different postures during sitting may lead to altered muscle activation. This will lead to different forces acting on the skeletal system. Adopted relaxed postures such as flexed postures and

slump sitting rely on the passive lumbo-pelvic structures to maintain the upright position against gravity. These passive postures frequently exacerbate LBP because they increase the load on the lumbar discs and ligaments. Thus the lumbo-pelvic region is vulnerable to strain, instability and injury. An optimally aligned skeletal system reduces stress on the structures involved (O'Sullivan et al. 2002). With LBP, in which the passive structures of the lumbo-pelvic region already are sensitised, adopting passive postures may result in exacerbation of pain. Adopting erect postures, that facilitate key lumbo-pelvic stabilising muscles, may result in more effective load sharing within the active system reducing focal end range stress on the sensitised passive structures (O'Sullivan et al. 2002).

There are differences noted in sitting posture when a patient is classified as either having a flexion or extension pattern. Patients with flexion control impairment sit more flexed in their usual sitting position than healthy control participants. In contrast patients with extension impairment sit in more extension than the healthy control subjects (Dankaerts et al. 2006b). Patients with the flexion pattern have less muscle activity and the extension group presents with more muscle activity in their back muscles (Dankaerts et al. 2006a). However, if the aforementioned classification is not done when sitting postures are compared between pain free individuals and patients with LBP no significant differences will be picked up by physiotherapists even though they exist (Dankaerts et al. 2006b, Dankaerts et al. 2006a).

Patients who present with the extension pattern usually have a history of a single extension or rotation injury or a repetitive extension or rotation strain. Activities that can cause this type of injury include swimming, running, fast walking and overhead activities like throwing. Aggravating factors for their symptoms would be extension or rotation (O'Sullivan 2000) while relief of pain would occur with flexion of the lumbar spine (Dankaerts et al. 2009). They present with an increased segmental lumbar lordosis or they may hinge at a specific level during standing and sitting. When asked to flex forward the patient holds the spine in the lordosis. During posture observation an anterior pelvic tilt can often be seen and they may have a sway back posture (O'Sullivan 2000). These patients also have difficulty assuming and/or maintaining neutral lordotic postures with a tendency to position themselves into

hyperextension (Dankaerts et al. 2009). Hyperextension has the potential to induce muscle fatigue and increased compressive loading of the posterior structures via forces generated by the activity of the extensor muscles thus perpetuating pain. If a pain disorder is related to increased extensor muscle activity (which is the case for the extensor pattern), adopting more passive postures may relieve pain (O'Sullivan et al. 2002).

10. Reliability and validity

The validity and reliability (inter- and intra-rater reliability) of the six lumbo-pelvic movement control tests and three general tests that were chosen for this study was previously investigated by various authors. The reliability and validity was found to be good as described below.

Van Dillen et al. (1998) used 28 different movement and postural tests in order to categorise patients in an impairment dysfunction sub-group. They found a very high agreement for the assessment of symptoms among the five examiners (k>0.89 and percentage agreement>98%). They also examined the reliability of observation of spinal alignment and movement. In general the interpretation of the spinal alignment was slightly lower (k=0.27-0.58) than for the observation of active movements (k=0.26–1.00) (Van Dillen et al. 1998). This article from Van Dillen et al (1998) was good quality research even though it was published in 1998. A big sample size was included (95 participants with LBP and 43 without LBP) and the methodology was well documented and clear. Harris-Hayes & Van Dillen (2009) examined the inter-tester reliability on 30 chronic patients with LBP. They categorised patients in five different groups; extension, flexion, rotation, extension-rotation and flexion-rotation. They found an overall agreement of 83% and k=0.75 (Harris-Hayes and Van Dillen 2009).

The inter-tester reliability of O'Sullivan's classification system has been tested. In the first phase, two experts who were blinded to each other examined 35 patients through interview and different physical tests. Their agreement was very good in

their classification of patients (k=0.96 and percentage agreement 97%). However, when less experienced clinicians classified the same patients, after viewing them on videos, they had a lower inter-tester reliability but it was still k>0.6, which means substantial reliability. Thus, experience may increase the reliability. However, in this study the tests used were not explained (Dankaerts et al. 2006c). Dankaerts et al. (2009) also state that the research is clear that trained clinicians (physiotherapists and medical physicians) can reliably identify subgroups for patients with NSLBP.

Dankaerts et al. (2009) demonstrated that a series of tests, involving analysis of static postures (including sitting and slump sitting) and dynamic movements (including forward flexion) reportedly causing an aggravation of LBP symptoms in the patients, discriminated between the flexion and extension subgroups and pain-free controls. These results were also identified clinically by two independent clinicians in previous tests (Dankaerts et al. 2009). This finding supports the validity of the clinical process of diagnostics where a diagnosis is determined as a result of a complete physical evaluation, involving a series of tests, while closely correlating these findings to the individual's complaints (Dankaerts et al. 2009). This article from Dankaerts et al (2009) was found to be high quality research. It was a statistical classification model. The sample size of 67 was sufficient and the clinicians who did the classification were blinded.The methodology was also good.

A study done by Luomajoki et al. (2007) demonstrated that movement control dysfunction tests of the lumbo-pelvic region have a good inter- and intra-rater reliability. The best reliability [k>0.6] was shown in the waiter's bow and sitting knee extension test for flexion dysfunction, pelvic tilt for extension dysfunction as well as one leg stance difference for rotational dysfunction. However in clinical settings it seems advisable that patients are rated by the same therapist as intra-observer reliability is better than inter-observer reliability (Luomajoki et al. 2007). This article was found to be high quality research. Their study was an inter- and intra-observer reliability study. The methodology of the study was sound and the physiotherapists who rated the tests were blinded to the patients; a sample size of 40 patients was included. Forty patients were sufficient, but larger sample sizes are always better to make sure the results are not due to chance.

The prone knee bend test with and without rotation of the hip shows that there is a significant difference in timing and amplitude of hip and lumbo-pelvic movements between patients with LBP and healthy controls. Scholtes et al. (2009) compared these items (timing and amplitude) in 41 people without and 50 people with LBP who played rotation-related sports. During knee flexion and hip lateral rotation, people with LBP demonstrated a greater maximal lumbo-pelvic rotation angle and earlier lumbo-pelvic rotation compared to people without LBP ($p<0.05$). The interpretation of this is that patients with LBP have poorer control of their lumbo-pelvic movements and, because of this, there might be more movement (for example rotation) in their lumbar spine during their everyday activities and sports which may result in pain (Scholtes et al. 2009).

11. Summary

Dankaerts et al. (2009) state that the development of a series of tests that identifies patients with motor control impairment provides the basis for further investigations into treatment outcomes and the role of motor control impairment in the generation and maintenance of LBP. Such investigations have the potential to provide greater insight into the cause and effect dilemma of altered motor control and its relationship to LBP.

The literature review looked at the background and prevalence, risk factors, prognosis and management of NSLBP. It also discussed the classification of NSLBP with regards to movement impairment and movement control impairment including the flexion and extension direction based patterns. The literature available on reliability and validity was also discussed but there seems to be a lack of literature on lumbo-pelvic movement control tests performed by inexperienced physiotherapists and students. There is also a lack of information regarding which tests qualified physiotherapists currently use in the clinical setting when they evaluate patients with NSLBP. The results of this study might give some answers on how inexperienced physiotherapists and students perform when using lumbo-pelvic movement control tests, and it would be interesting to see what tests they are using currently. This will help identify appropriate recommendations and highlight education implications.

Chapter 3: Methodology

1. Study Design

A quantitative, observational study design was employed.

2. Study setting

This study took place at universities, course venues, meetings, staff training and other physiotherapy gatherings in Gauteng, South Africa.

3. Participants

3.1. Sample size

Sample size was calculated with a sample size calculator (STATA Data Analysis and Statistical Software, release 12; Texas, USA). According to the study done by Dankaerts et al. (2006) the reliability was found to be 82% for the flexion pattern and 62% for the extension pattern (sample size 60). The assumption was made that participants in our study should be between 62% and 82% accurate during their classification. According to Aasa et al. (2014) more experienced physiotherapists perform 20% better than inexperienced physiotherapists. The sample size was estimated for a two sample comparison of proportions. Proportion one (p1) is the physiotherapy students (62% accurate). Proportion two (p2) is the qualified physiotherapists (82% accurate).

p1=p2, where p1 is the proportion in population one and p2 is the proportion in population two

Assumptions: alpha=0.05 (two-sided)
power=0.80
p1=0.62
p2=0.82
n2/n1=1.00

Estimated required sample sizes were: n1=88 and n2=88. A sample of 93 qualified physiotherapists and 96 fourth year physiotherapy students were included in the study, which met the estimated sample size requirement, and accounted for the potential of missing data.

3.2. Source of participants

Volunteers for video recording (patients)

The researcher examined patients with LBP and determined if they had NSLBP. A total of 28 individuals with NSLBP were video recorded while performing the nine chosen movements (six lumbo-pelvic movement control tests and three general tests). They were recruited from two private out-patient physiotherapy practices in Johannesburg. An expert panel gave input with regards to choosing the most appropriate videos and selected four individuals out of the 28 for the study. The videos were chosen based on the pattern the patient presented with, quality of the video itself and the quality of movement seen while the participant performed each test. It was decided to choose four out of the 28 because if only two videos were used and the first one was a flexion pattern for example, the participants would guess that the second video would be an extensor pattern and that would give inaccurate results.

Expert panel

Appropriate candidates to form part of the expert panel were recommended by lecturers at Wits, colleagues and presenters at courses. The expert panel of five qualified physiotherapists were selected according to their qualifications and experience (see inclusion criteria 3.3.2. on page 23).

Qualified physiotherapists (raters)

Qualified physiotherapists attending courses, meetings, staff training and other physiotherapy gatherings around Gauteng were invited to participate. They were approached just before lunch break, tea break or at the end of the course or meeting by telling them briefly what the study was about and how long it takes to participate. The interested physiotherapists could then stay behind to participate. A total of 93 qualified physiotherapists were included in the study.

Physiotherapy students (raters)

Physiotherapy students were approached through the physiotherapy departments at three universities in Gauteng. There were 96 fourth year students that were included in this study.

3.3. Sample Selection

3.3.1. Volunteers for video recording (patients)

Inclusion criteria

- Male or female
- Between 20 and 60 years of age
- NSLBP with a flexion or extension pattern

Exclusion criteria

- Surgery to the spine or pelvis
- Hemiplegia and other neurological conditions
- NSLBP with a multidirectional or lateral shifting pattern

3.3.2. Expert panel

Inclusion criteria

- Physiotherapists with a postgraduate qualification in musculoskeletal physiotherapy (MSc or PhD)
- Physiotherapists with Advanced Professional Development Level two (APDL 2)[1] qualification in sport or orthopaedic manipulative therapy

[1] APDL 2 is obtained after completion of a one year post graduate course in manual/manipulative physiotherapy or sport. These courses follow the principles of the International Federation of Orthopaedic Manipulative Physical Therapy (IFOMPT) guidelines of assessment and management of neuromuscular skeletal disorders. The courses are based on high level research evidence/outcomes studies and examinations are done.

- Physiotherapists with at least five years of working experience in musculoskeletal physiotherapy

Exclusion criteria

- Physiotherapists who were not familiar with lumbo-pelvic movement control tests

3.3.3. Qualified physiotherapists (raters)

Inclusion criteria

- Qualified physiotherapists, registered with the Health Professions Council of South Africa (HPCSA)
- Qualified physiotherapists involved in the treatment of patients with NSLBP
- Male or female

Exclusion criteria

- None

3.3.4. Physiotherapy students (raters)

Inclusion criteria

- Fourth year physiotherapy students at universities in Gauteng, South Africa
- Male or female
- Between 20 and 30 years of age

Exclusion criteria

- None

4. Self-administered questionnaire

A self-administered questionnaire was developed by the researcher. The expert panel participated to establish the content validity and once the necessary changes were made to the content, they completed the questionnaire. The questionnaire consisted of mostly closed ended questions and a small number of open ended questions.

Part A asked physiotherapists if they were familiar with lumbo-pelvic movement control tests and which tests they used to assess lumbo-pelvic movement control (Appendix A). This was to determine which tests qualified physiotherapists currently use.

Part B focussed on the physiotherapy students' and physiotherapists' ability to classify six lumbo-pelvic movement control tests and three general tests, as well as to make an overall classification as flexion or extension pattern. Each lumbo-pelvic movement control tests could be classified as correct or incorrect in order to use this information for the overall classification as flexion or extension pattern (Appendix B and C).

5. Information leaflet

An information leaflet was developed to highlight when a lumbo-pelvic movement control test can be classified as correct or incorrect and what abnormalities can be seen during forward flexion, sitting and slump (Appendix D). A summary of the overall classification was also included in the information leaflet (Appendix E). The qualified physiotherapists and physiotherapy students (raters) were allowed to keep this leaflet with them while completing the questionnaires in the study.

6. Procedure

6.1. Pilot Study

Three pilot studies were done prior to the main study. Two qualified physiotherapists participated in the first pilot study to identify obstacles and pick up errors or difficulties with the questionnaire and the format of the study procedure. The amount of time needed to participate in the study was also determined. The data of the first pilot study was not used because changes were made to the questionnaire. The changes included yes/no boxes that were included to make it more user-friendly, certain sentences were shortened to make it easier to read in a short amount of time and an extra tick box was added to provide further information to the researcher. A second pilot study was conducted with seven qualified physiotherapists. A slightly bigger group, it was thought, would reveal further obstacles arising from a group scenario and give more accurate time estimation. All seven participated at the same time. This was done because the data collection was done in groups. A group of 12 physiotherapy students participated in the third pilot study. This pilot study was done to identify obstacles specifically with the physiotherapy student participants. No major problems were picked up and no major changes were made after the second and third pilot study. Therefore, those results were included in the main study. The pilot studies revealed that forty minutes would be enough time to participate in the study.

6.2. Main Study

All the volunteers for the main study were informed about the purpose of the study and informed consent was obtained prior to participation. These volunteers include the individuals who were video recorded, the qualified physiotherapists and the physiotherapy students (See Appendix F, G, H, I, J and K).

Video Recording and Expert panel

The researcher evaluated and diagnosed individuals with NSLBP with a flexion pattern or an extension pattern. Thereafter videos were taken of 28 individuals

performing six lumbo-pelvic movement control tests and three other tests (Appendix F and G). Videos were recorded at two physiotherapy practices and in the Wits Physiotherapy Movement Analysis Laboratory. This was done over a period of one year. The tests that were performed included lumbar flexion, 'normal' and 'slump' sitting, waiter's bow, pelvic tilt, sitting knee extension, rocking forward on all fours, rocking backwards on all fours and prone knee bend. The researcher explained the test to each individual and thereafter they performed the test while the examiner recorded the test with a video recorder. When the test was performed incorrectly, the recording was unclear or the angle at which the test was recorded was not satisfactory the test was performed and recorded more than once. Videos were studied again by the researcher and, through a sifting process and input from the expert panel, four of the individual's videos where used for Part B of the study. The best videos were chosen based on the overall pattern that the participant presented with (flexion or extension pattern), quality of the recording itself and the quality of the movement being performed.

An expert panel of five physiotherapists were consulted to help choose the most appropriate videos. The expert panel were invited telephonically or emailed. After they agreed to form part of the expert panel they were visited at a time convenient to them and further correspondence was conducted telephonically or via email. Most experts were contacted numerous times to get their input with regards to the most appropriate videos and their classification thereof. They evaluated and classified the videos of the four individuals that were chosen. The overall classification (flexion or extension pattern) of the expert panel supported the initial classification of the researcher. The overall classification made by the qualified physiotherapists and physiotherapy students, pertaining to flexion or extension patterns, was compared to the classification results obtained from the expert panel. The expert panel gave recommendations to the questionnaire for Part B of this study.

Part A: Which tests do physiotherapists currently use in the assessment of lumbo-pelvic movement control?

The researcher contacted organisers, lecturers, heads of physiotherapy departments at government hospitals or physiotherapy practices in order to arrange to meet with qualified physiotherapists who were potential participants. After an arrangement was

made the researcher visited physiotherapy practices, courses, meetings, staff training and other physiotherapy gatherings around Gauteng where qualified physiotherapists were invited to participate in the study. All participants gave informed consent prior to participation. A self-administered questionnaire (described in section 4 page 24) was handed out to participants to complete prior to the information session that discussed the nine movements chosen for this study. After the questionnaire was completed, part B of the study commenced.

Part B: The physiotherapy students' and physiotherapists' ability to classify six lumbo-pelvic movement control tests and three general tests, and to make an overall classification as flexion or extension pattern.

This section of the questionnaire was completed by both qualified physiotherapists and physiotherapy students. Physiotherapy students were approached through the physiotherapy departments at universities in Gauteng. After an arrangement was made with the physiotherapy department, physiotherapy students had the opportunity to participate in lunch breaks and before or after class or meetings depending on the agreed arrangement with the university.

An information session and leaflet was given to the participants (raters) on how to make a classification by looking at the nine movements. The information session consisted of a slideshow and a presentation of approximately 15 minutes on how to classify a movement as correct or incorrect (Appendix D), and how to make an overall classification with regards to a flexion and extension pattern (Appendix E). The information session highlighted a few important points that were given on the information leaflet (These points can be seen in Appendix D and E). After the information session participants watched the videos while they completed the questionnaire. The researcher did all the data collection and no input was given to the participants after the information session while they completed the questionnaire and rated the videos. Figure 2 shows a schematic representation of the summarised methods.

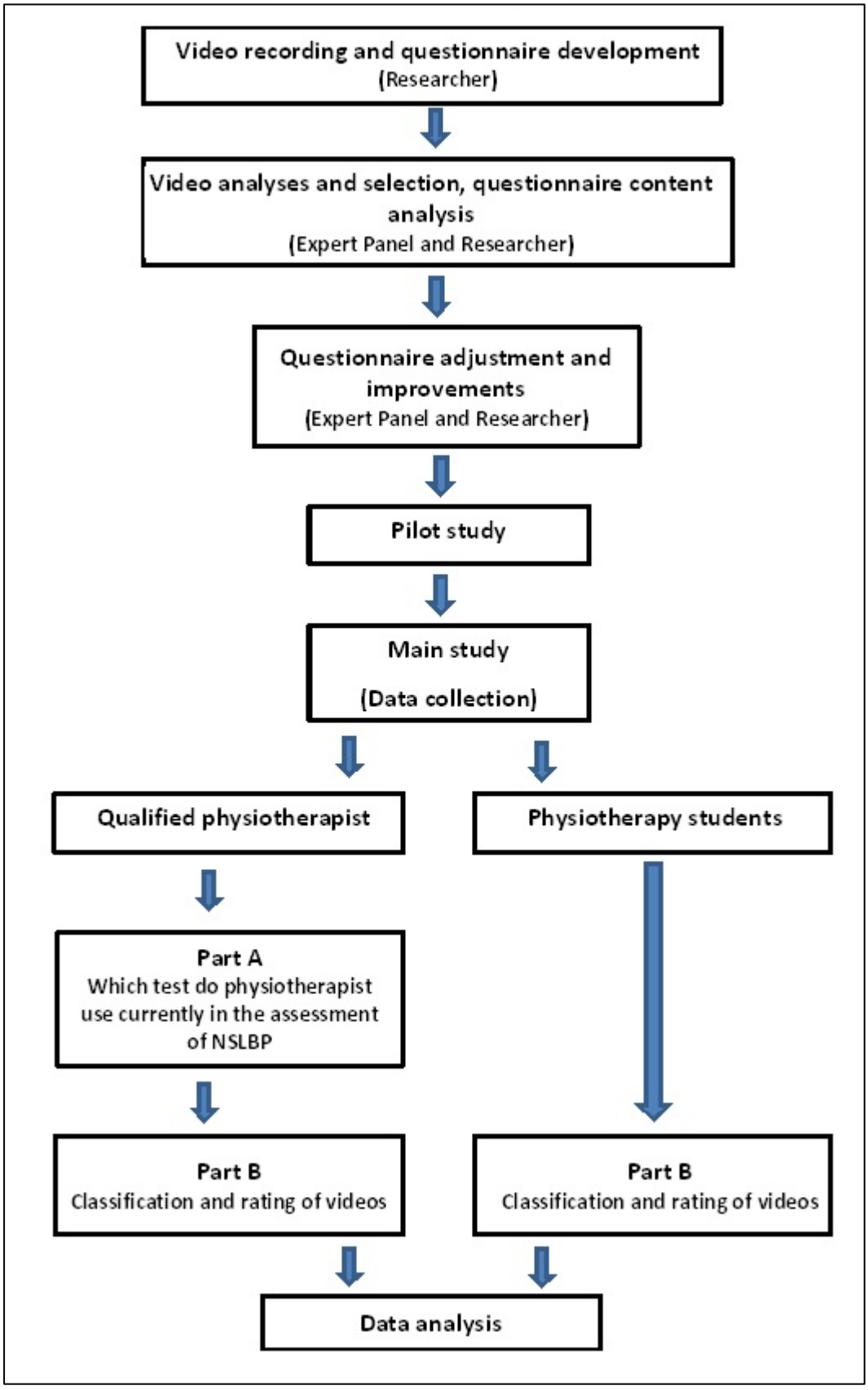

Figure 2: Summary of the method

7. Ethical considerations

Ethical clearance was obtained (ethical clearance number M130837) from the Human Research Ethics Committee (HREC) (Medical) of the University of the Witwatersrand before commencement of the study (Appendix L). Informed written consent was obtained from all the volunteers for video recording and participants before they participated in the study (Appendix G, I and K). Permission was obtained to take videos in the Wits Physiotherapy Movement Analysis Laboratory, as well as the two physiotherapy practices involved. Permission was also obtained from the Physiotherapy Head of Department at the various universities in Gauteng to approach the fourth year students. The researcher was not part of the teaching staff at the universities involved in the research which eliminated the possibility of intimidation of students and ensured that participation of the students was voluntary. Confidentiality and anonymity of all participants were maintained at all times. This was done by allocating a number to the participant as soon as data capturing started. The faces of the volunteers that were video-recorded were not shown. The participants received no monetary reward. All participants had the option to withdraw at any time without suffering any repercussions. Information obtained from the participants was only used for the purpose intended for this study. The results of this study will be made available to all participants via publication.

8. Data analysis

Data was entered into a Microsoft-Excel spread sheet for data cleaning and coding purposes. The data was then imported to a statistical software programme, STATA Data Analysis and Statistical Software (release 12; Texas, USA), for analysis. During the cleaning and coding process, missing values, extreme cases and inconsistencies were picked up and handled. Missing data was traced and then captured if available; otherwise the participant was contacted again to assist with the missing data where appropriate. Unfortunately a small amount of data was not traced and therefore the analysis was done on the available data using statistical models to allow for missing data. STATA commands to perform calculations by omitting the missing values. It calculates percentages based on the total number of non-missing cases. For other

calculations the missing values were excluded. STATA will perform list wise deletion and only display correlation for observations that have non-missing values on all variables listed.

Categorical data was presented as frequencies and percentages. The numerical variables were computed by means and standard deviations. The proportion of physiotherapists who agreed with respect to flexion pattern or extension pattern was expressed as a percentage and a 95% confidence interval was used. Individual tests agreement between qualified physiotherapists and physiotherapy students (this refers to a specific lumbo-pelvic movement control test) were also expressed as a percentage with a 95% confidence interval. Groups were compared in a two way table with respect to the proportion correct or incorrect assessments. Fisher's exact test was used to compare the two proportions used in the table.

The overall classification of the patients (individuals with NSLBP) as flexion or extension pattern (as determined by the expert panel) was known to the researcher. Therefore the overall outcome was compared to the known pattern. The collective analysis (as correct or incorrect in comparison to the known pattern) of the video assessments were analysed as panel data, i.e. each participant was now considered a panel using logistic regression, with statistic of interest the odds ratio (OR). Experienced physiotherapists (more than five years' experience) were considered the reference group, expecting them to be more correct in their assessment. A p-value equal to or less than 0.05 was considered significant (S), $0.05 < p \leq 0.1$ was considered marginally significant (MS) and $p>0.1$ was considered not significant (NS).

Chapter 4: Results

1. Participants

A total of 93 qualified physiotherapists and 96 fourth year physiotherapy students participated in this study in the Gauteng area in South Africa. The age of the qualified physiotherapists varied between 21 and 61 years. The mean age group was 28.18 years with a standard deviation of 7.97 years. There were 31.11% of physiotherapists who had five or more years of clinical experience, and 68.89% had less than five years clinical experience. The level of education for the qualified physiotherapists can be seen below in Figure 3.

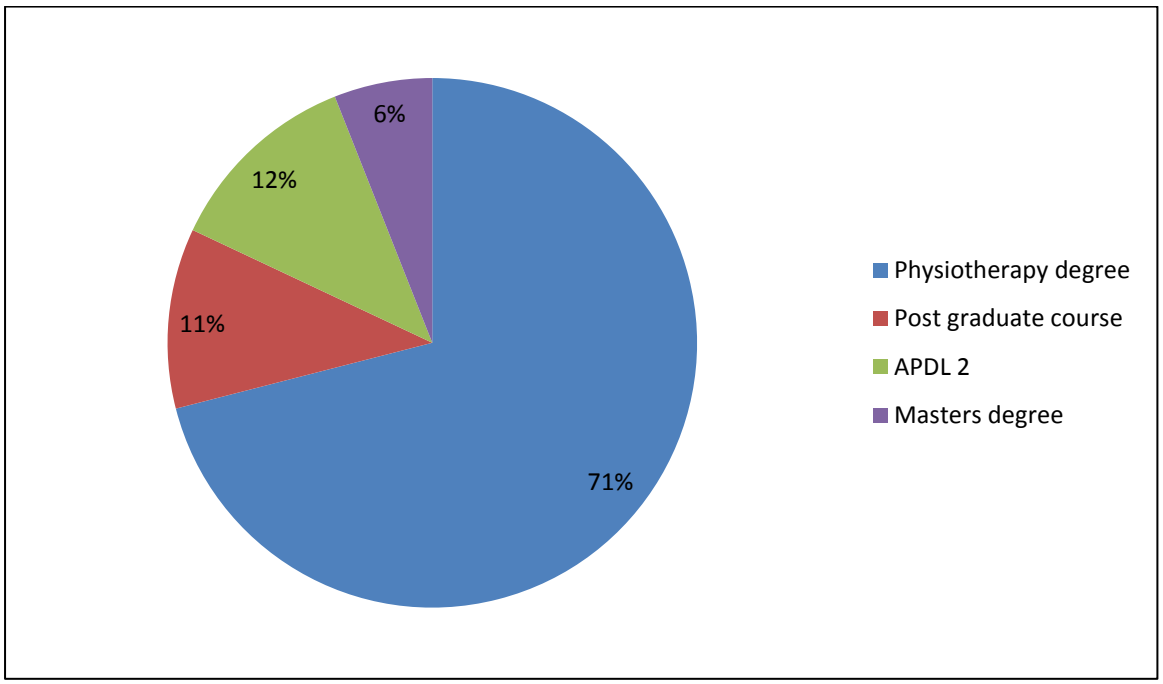

Figure 3: Level of education of raters

The age group of the fourth year physiotherapy students were between 20 and 27 years with a mean age of 22.20 years and a standard deviation of 1.48 years.

2. Part A: Tests used in the assessment of lumbo-pelvic movement control

Eighty six per cent (n=92) of the qualified physiotherapists who participated in the study were familiar with lumbo-pelvic movement control tests. Figure 4 shows which various tests the physiotherapists use in the assessment of NSLBP.

Ninety seven per cent of the physiotherapists (88 of the 91 participants) said that they use posture as part of their assessment for patients with NSLBP. It can be seen that the amount of participants varied for each assessment, this was because of missing data. Explanation of how missing data was handled can be found in chapter 3, section 8 (page 30).

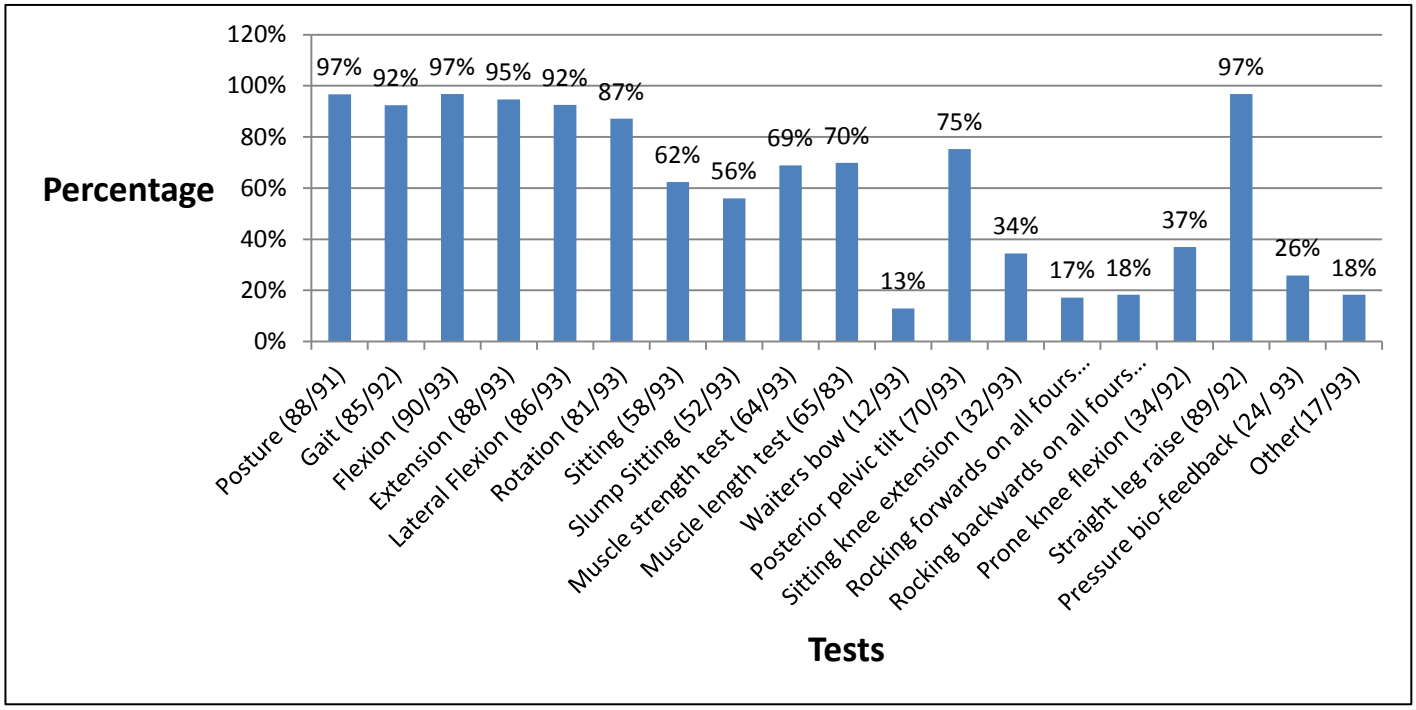

Figure 4: Tests physiotherapists used in the assessment of NSLBP (n=93)

The tests that forms part of "other" were specified by participants as McKenzie mobilisation, squats, the stork test, sport specific bike set-up and golf swing, Gillet test, Faber's test, quadrant test, Sahrmann scale for abdominal stabilisation, passive

accessory intervertebral mobilisations (PAIVMS), sit to stand analyses, side lying abduction motor control, active straight leg raise (ASLR), combined movements and transversus abdominis control.

3. Part B: Assessment of lumbo-pelvic movement control and general tests, and classification of movement control dysfunction

The classification of lumbo-pelvic movement control tests by qualified physiotherapists and physiotherapy students is shown in Table 1. In only three videos the ratings of the qualified physiotherapists and the physiotherapy students were statistically significantly different i.e. more participants in one group rated a specific video as e.g. correct than participants from the other group. Ratings were similar for most videos, except for the first waiters bow video, the second sitting knee extension video and the first rocking backwards video. Physiotherapy students and the qualified physiotherapists generally agreed on the movement being correct or incorrect.

The column “classification of movement performed as correct or incorrect” refers to whether the majority of physiotherapists and physiotherapy students classified that particular movement as correct or incorrect. The percentages in Table 1 refer to the percentage of qualified physiotherapists or physiotherapy students who all had that same classification. As an example, in Table 1 83.52% of the qualified physiotherapists and 95.83% of the physiotherapy students classified the first waiters bow as being done correct on the video. Participants’ classification of the movements was compared to whether the physiotherapy students and qualified physiotherapists agreed on the movement being correct or incorrect.

Table 1. Classification of lumbo-pelvic movement control tests by qualified physiotherapists and physiotherapy students

Lumbo-pelvic movement control test	Classification of movement performed as correct or incorrect	Video	Qualified Physiotherapists	Physiotherapy students	P-Value (Fisher's exact)
Waiters bow	Correct	1	83.52% (76/91)	95.83% (92/96)	**0.007 (S)**
	Incorrect	2	95.70% (89/93)	93.75% (90/96)	0.747 (NS)
	Correct	3	58.06% (54/93)	62.50% (60/96)	0.555 (NS)
	Incorrect	4	76.34% (71/93)	73.96% (71/96)	0.739 (NS)
Pelvic tilt	Correct	1	70.97% (66/93)	70.83% (68/96)	1.000 (NS)
	Incorrect	2	95.70% (89/93)	91.67% (88/96)	0.373 (NS)
	Incorrect	3	94.62% (88/93)	98.96% (95/96)	0.114 (NS)
	Correct	4	70.97% (66/93)	73.96% (71/96)	0.335 (NS)
Sitting knee extension	Correct	1	90.32% (84/93)	95.83% (92/96)	0.159 (NS)
	Incorrect	2	75.27% (70/93)	92.71% (89/96)	**0.001 (S)**
	Correct	3	90.32% (84/93)	95.83% (92/96)	0.159 (NS)
	Incorrect	4	92.47% (86/93)	87.50% (84/96)	0.335 (NS)
Rocking backwards	Correct	1	92.47% (86/93)	98.96% (95/96)	**0.033 (S)**
	Incorrect	2	94.57% (87/92)	95.83% (92/96)	0.743 (NS)
	Correct	3	89.25% (83/93)	90.63% (87/96)	0.812 (NS)
	Correct	4	68.82% (64/93)	72.92% (70/96)	0.631 (NS)
Rocking forward	Incorrect	1	86.96% (80/92)	90.63% (87/96)	0.491 (NS)
	Correct	2	69.89% (65/93)	79.17% (76/96)	0.181 (NS)
	Incorrect	3	97.85% (91/93)	96.88% (93/96)	1.000 (NS)
	Incorrect	4	83.87% (78/93)	81.25% (78/96)	0.703 (NS)
Prone knee bend	Incorrect	1	56.52% (52/92)	60.42% (58/96)	0.657 (NS)
	Correct	2	80.65% (75/93)	80.21% (77/96)	1.000 (NS)
	Incorrect	3	90.32% (84/93)	89.58% (86/96)	1.000 (NS)
	Incorrect	4	49.46% (46/93)	61.05% (58/95)	0.142 (NS)

Table 2 shows the classification of the general tests by qualified physiotherapists and physiotherapy students. The “classification of component as present (yes) or absent (no)” column refers to whether the majority of physiotherapists and physiotherapy students classified that particular movement as present (yes) or absent (no). There are many components that can be seen in one movement; therefore it was not possible to compare the results of the physiotherapists and physiotherapy students to only one answer. This is the reason for rather looking at the agreement between the two groups. The column in Table 2 showing the percentages refer to the percentage of qualified physiotherapists or physiotherapy

students who all had that same classification. Only a few of the movements showed statistically significant results which shows that physiotherapy students and qualified physiotherapists generally agreed on the components that was present during each movement. The following components showed significant results:

The second and third video: 'flexion occurs at the hips' and the fourth video of the 'flexion occurs in the thoracic spine', 'normal slump', 'small range of motion', and 'neither' videos. This shows that there was a bigger difference between the percentage qualified physiotherapists and physiotherapy students who agreed that that particular component of the movement was present or not for those videos. As an example, 70.83% of physiotherapy students indicated that flexion did occur at the hips (component present) where 54.84% of the qualified physiotherapists agreed that flexion occurred at the hips (flexion occurs at hips, video 2 page 37).

Table 2. Classification of general tests by qualified physiotherapists and physiotherapy students

General test	Description	Classification of component as present (yes) or not present (no)	Video	Qualified physiotherapists	Physiotherapy students	p-Value (Fisher's exact)
Forward flexion	Flexion of hips and thoracic spine	Yes	1	75.00% (69/92)	63.16% (60/95)	0.085 (MS)
		No	2	73.33% (66/90)	61.05% (58/95)	0.086 (MS)
		Yes	3	73.33% (66/90)	64.52% (60/93)	0.206 (NS)
		No	4	49.44% (44/89)	55.79% (53/95)	0.460 (NS)
	Early hyper-lordosis seen when patient returns to neutral	No	1	54.44% (49/90)	66.67% (64/96)	0.100 (MS)
		No	2	93.41% (85/91)	92.55% (87/94)	1.000 (NS)
		No	3	58.89% (53/90)	52.17% (48/92)	0.375 (NS)
		No	4	83.15% (74/89)	90.11% (82/91)	0.193 (NS)
	Loss of Lumbar lordosis	No	1	58.06% (54/93)	45.26% (43/95)	0.083 (MS)
		Yes	2	85.87% (79/92))	89.47% (85/95)	0.509 (NS)
		Yes	3	54.44% (49/90)	60.22% (56/93)	0.457 (NS)
		Yes	4	81.32% (74/91)	86.46% (83/96)	0.426 (NS)
	Flexion occurs in thoracic area	Yes	1	77.17% (71/92)	82.29% (79/96)	0.468 (NS)
		Yes	2	76.34% (71/93)	87.50% (84/96)	0.058 (MS)
		Yes	3	90.32% (84/93)	93.75% (90/96)	0.430 (NS)
		Yes	4	91.30% (84/92)	94.79% (91/96)	0.399 (NS)
	Flexion occurs in lumbar area	No	1	79.35% (73/92)	71.88% (69/96)	0.241 (NS)
		Yes	2	63.44% (59/93)	68.75% (66/96)	0.447 (NS)
		No	3	79.57% (74/93)	70.53% (67/95)	0.179 (NS)
		Yes	4	53.26% (49/92)	57.29% (55/96)	0.660 (NS)

General test	Description	Classification of component as present (yes) or not present (no)	Video	Qualified physiotherapists	Physiotherapy students	p-Value (Fisher's exact)
	Flexion occurs at hips	Yes	1	80.43% (74/92)	86.46% (83/96)	0.327 (NS)
		Yes	2	54.84% (62.96)	70.83% (68/96)	**0.025 (S)**
		Yes	3	56.99% (53/93)	72.63% (69/95)	**0.032 (S)**
		Yes	4	54.35% (50/92)	68.75% (66/96)	0.051 (MS)
Sitting	Flexion	No	1	95.65% (88/92)	98.95% (94/95)	0.206 (NS)
		No	2	68.82% (64/93)	66.32% (63/95)	0.757 (NS)
		No	3	88.17% (82/93)	93.68% (89/95)	0.212 (NS)
		Yes	4	87.10% (81/93)	82.11% (78/95)	0.421 (NS)
	Neutral	Yes	1	55.43% (51/92)	51.58% (49/95)	0.661 (NS)
		Yes	2	58.06% (54/93)	63.16% (60/95)	0.551 (NS)
		Yes	3	53.76% (50/93)	62.11% (59/95)	0.301 (NS)
		No	4	96.77% (90/93)	90.53% (86/95)	0.133 (NS)
	Extension	Yes	1	51.09% (47/92)	50.53% (48/95)	1.000 (NS)
		No	2	89.25% (83/93)	95.79% (91/95)	0.102 (NS)
		No	3	64.52% (60/93)	68.42% (65/95)	0.644 (NS)
		No	4	90.32% (84/93)	90.63% (87/96)	1.000 (NS)
Slump	Lumbar spine stays in extension	Yes	1	48.39% (45/93)	58.33% (56/96)	0.191 (NS)
		No	2	91.40% (85/93)	97.92% (94/96)	0.055 (MS)
		No	3	78.49% (73/93)	80.21% (77/96)	0.858 (NS)
		No	4	86.02% (80/93)	91.67% (88/96)	0.252 (NS)
	Flexion occurs in the thoracic spine	Yes	1	76.34% (71/93)	78.13% (75/96)	0.863 (NS)
		Yes	2	49.46% (46/93)	59.38% (57/96)	0.190 (NS)
		Yes	3	53.76% (50/93)	60.42% (58/96)	0.380 (NS)
		Yes	4	46.24% (43/93)	61.46% (59/96)	**0.042 (S)**
	Normal slump	No	1	93.55% (87/93)	85.42% (82/96)	0.097 (MS)
		No	2	69.89% (65/93)	58.33% (56/96)	0.129 (NS)
		No	3	63.44% (59/93)	66.67% (64/96)	0.651 (NS)
		No	4	73.12% (68/93)	37.50% (36/96)	**<0.001 (S)**
	Small range of movement	Yes	1	64.52% (60/93)	75.00% (72/96)	0.153 (NS)
		No	2	68.82% (64/93)	77.08% (74/96)	0.251 (NS)
		No	3	70.97% (66/93)	69.79% (67/96)	0.875 (NS)
		No	4	75.27% (70/93)	91.67% (88/96)	**0.003 (S)**
	Already sitting in a slumped position	No	1	98.92% (92/93)	95.83% (92/96)	0.369 (NS)
		No	2	81.72% (76/93)	82.29% (79/96)	1.000 (NS)
		No	3	96.77% (90/93)	97.92% (94/96)	0.679 (NS)
		No	4	88.17% (82/93)	87.50% (84/96)	1.000 (NS)
	Neither	No	1	98.92% (92/93)	98.96% (95/96)	1.000 (NS)
		No	2	97.85% (91/93)	100% (96/96)	0.241 (NS)
		No	3	100% (93/93)	96.88% (93/96)	0.246 (NS)
		No	4	92.47% (86/93)	100% (96/96)	**0.006 (S)**

Table 3 shows the agreement of the overall classification as a flexion or extension pattern. The overall classification of the patients as flexion or extension pattern was known to the researcher. Therefore the overall outcome was compared to the known

pattern (as determined by the expert panel). The percentages mentioned show the percentage of correct classifications made. E.g. 91.4% of qualified physiotherapists classified video one as extension which is similar to what the expert panel determined. Three of the four overall classifications were statistically insignificant which means that there was not a big difference between the correct overall classifications made by the physiotherapy students and qualified physiotherapists.

Table 3. Overall classification of movement dysfunction by qualified physiotherapists and physiotherapy students

Pattern	Video	Qualified Physiotherapists (n=93)	Physiotherapy Students (n=96)	p-Value (Fisher's exact)	Significance
Extension	1	91.4% (85)	92.7% (89)	0.793	NS
Flexion	2	87.1% (81)	96.9% (93)	**0.015**	S
Extension	3	90.3% (84)	88.5% (85)	0.814	NS
Flexion	4	77.4% (72)	87.5% (84)	0.085	MS

The qualified physiotherapists were expected to perform better than the physiotherapy students. However, the results proved an OR of 0.57 (95% confidence interval: 0.305-1.065) i.e. the chance of a student getting the overall classification wrong was less than that for qualified, experienced physiotherapists. The experienced physiotherapists had more than five years' experience while the inexperienced physiotherapists had less than five years' experience. This finding was however not statistically significant which means that there was not a big enough difference between the groups for the overall classification to be declared wrong in relation to the level of experience.

$$\text{OR}=\frac{Odds\ of\ getting\ it\ wrong\ when\ student}{Odds\ of\ getting\ it\ wrong\ when\ qualified\ physiotherapist}=0.57$$

Confidence interval 0.185-1.597 (p=0.078)

OR=1 indicates no chance of getting assessment wrong
OR>1 indicates a chance of getting the assessment wrong
OR<1 less likely chance of getting the assessment wrong

Table 4 shows the OR with regards to years of experience and level of education of the physiotherapists. The risk of physiotherapists with less than five years' experience making a wrong decision is only 0.54 fold that for physiotherapists with five years or more experience. The risk of post graduate course, APDL2, or masters degree physiotherapists to make a wrong decision is 1.40, 1.42 and 2.66 fold increased to that for graduate physiotherapists. This table also reflects that the chance of getting the assessment wrong gets bigger with further education. This assessment refers to the overall classification of videos as a flexion or extension pattern. Because these results were not statistically significant there was no real difference recorded between the groups and the findings could therefore be due to chance.

Table 4. Years of experience and level of education of the qualified physiotherapists (n=93)

Experience and education	Formula	OR	95% Confidence interval	P-value
Less than 5 years' experience	$\frac{Less\ than\ 5\ years\ experience}{More\ than\ 5\ years\ experience}$	0.54	0.185-1.597	0.185
Post graduate course	$\frac{Graduate\ physiotherapist}{Post\ graduate\ course}$	1.40	0.346-5.734	0.312
APDL 2	$\frac{Graduate\ physiotherapist}{APDL\ 2}$	1.42	0.374-5.373	0.374
Masters	$\frac{Graduate\ physiotherapist}{Masters\ degree}$	2.66	0.500-14.160	0.500

4. Conclusion to the results

Physiotherapists in Gauteng are familiar with lumbo-pelvic movement control tests, but only a few are using the tests clinically. Most of the results of this study were not statistically significant. This shows that generally physiotherapy students and qualified physiotherapists performed the same with the classification (meaning that they agreed on components being present or absent during the movements done and they made the correct overall classification). If the results had more statistically significant values, the aforementioned would not have been true. The statistically insignificant results also indicate that physiotherapists with further education or more experience performed the same as the inexperienced physiotherapists or

physiotherapists with a degree only because there was not a statistically significant difference in their performance. The statistically insignificant results could also indicate that the findings were due to chance and we should not assume that these results are the true representation for all qualified physiotherapists and physiotherapy students.

Chapter 5: Discussion

This study aimed to establish which tests physiotherapists currently use in the assessment of lumbo-pelvic movement control. It also aimed to establish the ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement dysfunction by using six lumbo-pelvic movement control tests and three general tests. This chapter focuses on the discussion of the results of the study outlined in Chapter 4 and how these findings relate to other research findings. The fact that most of the results were statistically insignificant shows us that there was not a big difference between the qualified physiotherapist's and physiotherapy students' ability to classify and evaluate lumbo-pelvic movement control. This will be discussed in further detail in the sections to follow.

1. Which tests do physiotherapists use in the assessment of lumbo-pelvic movement control?

Eighty six per cent (n=79) of the qualified physiotherapists who participated in the study stated that they were familiar with lumbo-pelvic movement control test. To effectively treat patients with NSLBP classification into subgroups is needed (Petersen et al. 2004). Lumbo-pelvic movement control tests can help with the classification of subgroups of patients with NSLBP (Luomajoki et al. 2007).

Only 13% (n=12) use waiters bow, 34% (n=32) use sitting knee extension, 17% (n=17) rocking backwards and 18% (n=16) rocking forward, 37% (n=36) prone knee flexion, and 75% (n=70) of the physiotherapists use pelvic tilt as part of their assessment for patients with NSLBP. The three general tests that were used in this study seemed to be more widely used by physiotherapists. Flexion is used by 97% (n=90) of the participants, sitting 62% (n=58) and slump 56% (n=52). It was surprising to see that even though qualified physiotherapists are familiar with the lumbo-pelvic movement control tests, not many physiotherapists use these tests clinically as part of their assessment for patients with NSLBP. Lumbo-pelvic movement control tests are only taught at some South African universities during

undergraduate studies (as informed by lecturers at Universities). Flexion, sitting and slump are taught more frequently at such universities. This might be a partial explanation why the general tests were used more than the lumbo-pelvic movement control tests. The most popular tests currently used by physiotherapists, in the assessment of patients with NSLBP, include the following: posture (n=88), flexion (n=90) and straight leg raise (n=91) 97%; extension (n=88) 95%; lateral flexion (n=89) and gait (n=85) 92%; and rotation (n=81) 87%. These form part of the Maitland approach to assessment (Maitland et al. 2005). While the Maitland concept emerged in 1954 (Maitland et al. 2005) lumbo-pelvic movement control was first described in 1987 (Comerford and Mottram 2012). The translation of knowledge around the concept of lumbo-pelvic movement control may have taken longer to infiltrate the clinical sphere, which explains the low level of usage.

It should be noted that even though the qualified physiotherapists who completed the questionnaire were all aware of the concept of lumbo-pelvic movement control they did not use these tests. Research shows that physiotherapists do not routinely engage in the steps of evidence based practice (Condon et al. 2015). Physiotherapists find it challenging to implement research in their daily practice and also to become involved in research (Janssen et al. 2015). A lack of confidence in translating research findings into clinical practice not only leads to the limited use of effective assessment and treatment techniques, but also the use of modalities that are not needed or care that could be potentially harmful (Schuster et al. 1998). The clinician is left on his/her own to figure out when and how to incorporate the evidence into a change in their practices and how to handle inconsistencies in evidence tools (Green and Seifert 2005, Condon et al. 2015). One way to bridge the gap between research evidence and clinical application is to go through the process of awareness, acceptance and adoption. These are necessary steps in the translation of research into clinical practice (Davis and Taylor-Vaisey 1997). Some qualified physiotherapists are only currently at the “awareness” phase, which explains the lack of application of the lumbo-pelvic movement control into their daily clinical practice. Qualified physiotherapists, who were exposed to the general tests during their undergraduate studies, are at the acceptance level because the Maitland concept forms part of their basic knowledge.

2. The ability to evaluate movement dysfunction using lumbo-pelvic movement control and general tests.

The results of this study showed that there was not a significant difference between the observations that the qualified physiotherapists made versus the physiotherapy students for the various tests. This is however different to what was found in some literature. According to Aasa et al. (2014), experienced physiotherapists had substantial overall agreement in categorising patients independently. Novice physiotherapists produced lower scoring rates when compared to those of experienced physiotherapists. The tests used in the study conducted by Aasa et al. (2014) were different to the tests used in this study in that active movement tests in the cervical spine, shoulder joint and scapulo-thoracic joints were tested by Aasa et al. (2014). In the study done by Aasa et al (2014) only four physiotherapists (two experienced and two recently educated) rated the tests, where in this research study 93 qualified physiotherapists and 96 physiotherapy students did the classifications. The results of Aasa et al. (2014) is comparable with earlier findings of Luomajoki et al. (2007) and Dankaerts et al. (2006c) who indicated that inexperienced and newly qualified physiotherapists might need more training to accurately analyse movements. Dankaerts et al. (2006c) found almost perfect agreement (Kappa-coefficient 0.96; %-of-agreement 97%) for the inter-examiner reliability when expert clinicians (12 or more years of experience and extensive training) did the classification of patients with NSLBP. Luomajoki et al. (2007) chose two clinical specialists with 25 years of working experience and a post-graduate degree in manual therapy and two raters with five years of working experience and a three day training course of movement control. Good inter- and intra-observer reliability was found when they rated the motor control dysfunctions ($k>0.6$).

The qualified physiotherapist and physiotherapy students who participated in this research study received a brief information session prior to their participation. This incorporated a summary on how to identify and classify the flexion and extension patterns. It seems that intensive training was not necessary for the physiotherapists and physiotherapy students to be able to do a correct classification because there was not a significant difference between the observations the qualified physiotherapists made versus those of the physiotherapy students. Aasa et al.

(2014) state that novice physiotherapists would benefit from guidance by more experienced physiotherapists in identifying and classifying movement faults. The chosen tests are effective for all physiotherapists and physiotherapy students to use and to still provide the correct overall classification with only minimal training.

3. The ability to classify movement abnormalities as flexion pattern or extension pattern.

The overall classification as a flexion pattern or extension pattern made by the physiotherapists and physiotherapy students were compared to the known answer as determined during the evaluation done by the researcher and the classifications made by the expert panel. The results were accurate for the qualified physiotherapists as well as for the physiotherapy students. Only the classification of the patient's NSLBP pattern in one of the videos (the second video) showed a significant difference between the result given by the qualified physiotherapists and that of the physiotherapy students. The student group performed better with the second video (flexion pattern) than the qualified physiotherapists. Ninety six point nine per cent (n=93) (Table 3 page 38) of the student group classified the second video correctly compared to 87.1% (n=81) of the qualified physiotherapists. This is still a good result for the qualified physiotherapists and shows that the overall classification was generally done correctly. The overall classification of the patient with a flexion or extension pattern is more important than the individual tests because this will determine their diagnosis which in turn will influence the treatment programme (see literature review chapter 2, section 5, paragraph 2, on page 11).

The second video had an overall classification of a flexion pattern. The students performed better than the qualified physiotherapists in this overall classification as mentioned above. The flexion pattern is the most common pattern (O'Sullivan 2000), and therefore one would assume that physiotherapists are more familiar with this pattern. The participants for this study were all recruited in the Gauteng area. A sample of convenience was chosen, by approaching physiotherapists at courses, meetings, staff training and other physiotherapy gatherings around Gauteng. This led to the recruitment of a large group of physiotherapists with less than five years

clinical experience and a physiotherapy degree only, in comparison to the recruitment of physiotherapists with five or more years' experience and further education. This might explain why there was not a big difference between the results of the qualified physiotherapists and the physiotherapy students. In a study done by Aasa et al (2014), the experienced physiotherapists had more than 20 years' experience where the novice physiotherapists had less than one years' experience.

Another reason for similar classifications made by the qualified physiotherapists and students could be because students are used to receiving new information and they were able to remember more of the information given prior to participation during the information session. The frequency of learning affects the ability to learn, the more we learn, the easier it becomes to learn new concepts (Waring and Takaki 2003).

In the study done by Aasa et al. (2014), patients and healthy participants were included. Luomajoki et al. (2007) conducted a study where patients with and without LBP were included into his study. The volunteers that were video recorded for this study were actual patients with NSLBP. Because of this reason, some of the videos were more difficult to classify than others. However, it was considered that it was better to use actual patients with LBP so that the results were a true representation of patients with NSLBP as opposed to only using a model simulating the correct or incorrect movement for a specific test and performing it perfectly. Hence, the video material was not always a textbook presentation of the movement.

4. To compare the ability of evaluation and classification in relation to level of experience of qualified physiotherapists and physiotherapy students

When the physiotherapists with more experience and further qualifications were compared to inexperienced physiotherapists with an undergraduate degree the surprising result was that the more experienced physiotherapists and physiotherapists with further education did not perform better than the inexperienced physiotherapists or physiotherapists with an undergraduate degree. The

inexperienced physiotherapists had only a 10.89% chance of getting the classification wrong. This contradicts previous finding of Dankaerts et al. (2006c) where the reliability of lumbo-pelvic movement control was tested with expert clinicians and showed that increased familiarity with the classification improved the reliability (Dankaerts et al. 2006c). Luomajoki et al. (2007) conducted a study to determine the reliability of lumbo-pelvic movement control tests but again the physiotherapists who rated the video-recordings were specialists in the field with more than five years' experience in the assessment of motor control impairment, and they received a three day course on movement control dysfunctions (Luomajoki et al. 2007). The physiotherapists and physiotherapy students who participated in this study only received a brief 15 minute information session, and four pages of information on how to evaluate and classify lumbo-pelvic movement control. It seems that these tests can be used with minimal training by most physiotherapists. The chance of getting the assessment wrong when you are an inexperienced physiotherapist with less than five years of clinical experience is only 0.54 fold that for physiotherapists with five years or more experience. (table 4, page 39). The risk of post graduate course, APDL2, or masters degree physiotherapists to make a wrong decision is 1.40, 1.42 and 2.66 fold increased to that for graduate physiotherapists. This again contradicts the literature of Aasa et al. (2014), Luomajoki et al. (2007) and Dankaerts et al. (2006c), as mentioned before.

The sample size for this study did not allow for sub-group analysis and only 6.45% of the participants had a master's degree. Therefore the results might not be true for all physiotherapists with further education. Another explanation for the aforementioned results might be the fact that the participants were not given a chance to explain the reason, or comment on their specific classification. Some videos were more difficult to classify then others and this fact might have changed some of the results if participants had been given a chance to discuss and explain the reasoning behind their classification. Furthermore, certain observations can have more than one component.

Chapter 6: Conclusion

Objective 1: To establish which tests physiotherapists currently use in the assessment of lumbo-pelvic movement control.

Qualified physiotherapists mostly use posture, flexion, straight leg raise, extension, gait, lateral flexion and rotation to assess lumbo-pelvic movement control. Even though the majority of qualified physiotherapists are familiar with lumbo-pelvic movement control tests only a few are using the lumbo-pelvic movement control tests clinically.

Objective 2: To establish the ability of physiotherapists and physiotherapy students to evaluate videos of patients with NSLBP performing six lumbo-pelvic movement control tests and three general tests and rank them as correct or incorrect.

Qualified physiotherapists and physiotherapy students were able to evaluate six lumbo-pelvic movement control tests and three general tests and rank them as correct or incorrect. There was not a big difference between the classification results given by the qualified physiotherapists and those offered by the physiotherapy students. The chosen tests can be used by any novice physiotherapist as well as physiotherapy students with minimal training.

Objective 3: To establish the ability of qualified physiotherapists and physiotherapy students to classify movement abnormalities as flexion pattern or extension pattern by interpreting six lumbo-pelvic movement control tests and three general tests.

Qualified physiotherapists and physiotherapy students are able to classify patients with NSLBP into a flexion or extension pattern after receiving minimal training. With only a short information session, and four pages of instructions to refer back to, the qualified physiotherapists and physiotherapy students both performed well during the classification task.

Objective 4: To compare the ability of evaluation and classification in relation to level of experience of qualified physiotherapists and physiotherapy students.

Experience and further qualifications did not impact on the physiotherapist's ability to correctly classify patients into a flexion pattern or an extension pattern in this specific study.

The overall hypotheses that can be accepted for this study is: physiotherapists are not using lumbo-pelvic movement control tests in the assessment of patients with NSLBP; and physiotherapists and physiotherapy students are able to accurately classify lumbar movement control by using six lumbo- pelvic movement control tests and three general tests.

6.1. Limitations

- Only flexion and extension patterns are included in this study because they are the most common patterns. The lateral shifting and multidirectional patterns need to be tested in further research studies.
- Some of the videos were more difficult to classify than others because not all patients present exactly as literature describes.
- A sample of convenience was used in Gauteng. This might not be a true representation of all qualified physiotherapists and physiotherapy students in South Africa.
- Data collection did not take place on the same day or in the same venue. This could have introduced bias or contamination.

6.2. Recommendations for future research

- In future studies it might be beneficial to further explore certain observations made by the physiotherapist during movement analysis as many of the movements can have more than one component and therefore not only one correct answer.

- Further research is needed on why and how physiotherapists choose the tests they use to evaluate NSLBP and lumbo-pelvic movement control.
- Future research can be done where different movement tests are used and then compared between inexperienced physiotherapists and experienced physiotherapists.

6.3 Recommendations for clinical practice

- Physiotherapists should receive training on how to use lumbo-pelvic movement control tests clinically as part of their assessment of NSLBP.
- Physiotherapist should be taught how to interpret lumbo-pelvic movement control tests so that patients with NSLBP can be classified into subgroups.

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Appendixes

Appendix A

Self-administered questionnaire (Part A): For qualified physiotherapists only

Name:		
Contact nr:		
Email address:		
Are you familiar with lumbo-pelvic movement control tests?	YES	NO
Which tests do you use in the assessment of Lumbo-Pelvic movement control? Please tick appropriate box.		
Posture		
Gait		
Flexion		
Extension		
Lateral Flexion		
Rotation		
Sitting		
Slump sitting		
Muscle strength test		
Muscle length test		
Waiters bow		
Posterior pelvic tilt		
Sitting knee extension		
Rocking forwards on all fours		
Rocking backwards on all fours		
Prone knee flexion		

Straight leg raise	
Pressure bio-feedback	
Other (please specify)	

Appendix B

Self-administered questionnaire and rating sheet (Part B): For qualified physiotherapists.

Do you treat patients with non- specific low back pain	
Are you a member of the HPCSA	
Age	
Years of clinical experience	
Further education or studies completed	

Please watch the following video clips and complete questions that follow.

Lumbo-pelvic movement control test	**Correct**	**Incorrect**
Waiters bow		
Pelvic tilt		
Sitting knee extension		
Rocking backwards		
Rocking forward		
Prone knee bend		

General tests	Choose most appropriate answer/s		
Lumbar flexion	• Flexion of hips or thoracic spine only	Y	N
	• Early hyper-lordosis seen when patient returns to neutral	Y	N
	• Loss of lumbar lordosis occurs	Y	N
	Where does the flexion occur:		
	Thoracic		
	Lumbar		

	Hips		
Sitting	Sitting in fl		
	Sitting in neutral		
	Sitting in ext		
Slump	Lumbar spine stays in extension		
	Flexion occurs in the thoracic spine mostly/only		
	Normal slump		
	Small range of movement		
	Patient already sitting in a slumped position		
	Neither		

Does this patient present with a:	
• Flexion pattern	
• Extension pattern	

Appendix C

Self-administered questionnaire and rating sheet for physiotherapy students

Name:	
Contact number:	
Email address:	
Are you a fourth year physiotherapy student?	
Age:	

Please watch the following video clips and complete questions that follow.

Lumbo-pelvic movement control test	**Correct**	**Incorrect**
Waiters bow		
Pelvic tilt		
Sitting knee extension		
Rocking backwards		
Rocking forward		
Prone knee bend		

General tests	Choose most appropriate answer/s		
Lumbar flexion	• Flexion of hips or thoracic spine only	Y	N
	• Early hyper-lordosis seen when patient returns to neutral	Y	N
	• Loss of lumbar lordosis occurs	Y	N
	Where does the flexion occur:		
	Thoracic		
	Lumbar		
	Hips		

Sitting	Sitting in fl	
	Sitting in neutral	
	Sitting in ext	
Slump	Lumbar spine stays in extension	
	Flexion occurs in the thoracic spine mostly/only	
	Normal slump	
	Small range of movement	
	Patient already sitting in a slumped position	
	Neither	

Does this patient present with a:	
• Flexion pattern	
• Extension pattern	

Appendix D

Lumbo-pelvic movement control tests (correct and incorrect movements)

(Luomajoki et al. 2008)

Test	Correct	Incorrect
<u>"Waiters bow"</u> Flexion of the hips in upright standing without movement (flexion) of the low back.	Forward bending of the hips without movement of the low back (50-70° Flexion hips). 	Angle hip Flexion without low back movement less than 50° or Flexion occurring in the low back. 
<u>Pelvic tilt</u> Dorsal tilt of pelvis actively in upright standing.	Actively in upright standing; keeping thoracic spine in neutral, lumbar spine moves towards Flexion. 	Pelvis does not tilt or low back moves towards Extension or compensatory Flexion in thoracic spine. 

Test	Correct	Incorrect
<u>Sitting knee extension.</u> Upright sitting with neutral lumbar lordosis; extension of the knee without movement (flexion) of low back.	Upright sitting with neutral lumbar lordosis; extension of the knee without movement of low back (30-50° Extension of the knee is normal). 	Low back is moving in flexion. Patient is not aware of the movement of the back. 
<u>Rocking backwards</u> Transfer of the pelvis backwards (“rocking”) keeping low back in neutral. Starting position 90° hip flexion.	120° of hip flexion without movement of the low back by transferring pelvis backwards. 	Hip flexion causes flexion in the lumbar spine. 
<u>Rocking forwards</u> Transfer of the pelvis forwards (“rocking”) keeping low back in neutral. Starting position 90° hip flexion.	Rocking forwards to 60° hip flexion without movement of the low back. 	Hip movement leads to extension of the low back. 

Test	Correct	Incorrect
<u>Prone knee flexion</u> Prone lying active knee Flexion.	Active knee flexion at least 90° without movement of the low back and pelvis. 	By the knee flexion low back does not stay neutral maintained but moves in extension or rotation. 
<u>Forward flexion</u>	Lumbar spine flexes forward and lordosis decreases.	Flexion occurs at thoracic spine or hips. Lumbar spine maintains lordosis.
<u>Normal sitting</u>	Lumbar spine in neutral lordosis.	Lumbar spine loses lordosis and goes into flexion.
<u>Slump sitting</u>	Lumbar spine goes into flexion, lordosis disappears.	Inability to flex lumbar spine further (might already be in slump sitting). Flexion occurs at thoracic spine and lumbar spine maintains lordosis.

Appendix E

Overall classification of extension or flexion pattern

Flexion pattern

Lumbar spine tends to loose segmental lordosis.

Incorrect: Waiters bow

Rocking backwards

Sitting knee extension

Smooth flexion might occur.

During sitting the spine might be in flexion.

Slump might be difficult due to spine being already in flexion.

Or normal loss of lordosis during slump.

Extension pattern

Lumbar spine is held into extension during activities.

Incorrect: Pelvic tilt

Rocking forwards

Prone knee bend

During forward flexion, flexion might only occur at the hips or there is only a loss of lumbar lordosis after mid-range of flexion.

Early hyper-lordosis can be seen when the patient returns to neutral after forward bending.

The spine might present with an increased lordosis during sitting, and slump might be difficult of flexion occurs only in the thoracic area.

Appendix F

Information sheet and informed consent form to volunteers that will be video-recorded while performing lumbo-pelvic movement control tests.

Study title: The ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control by using lumbo-pelvic movement control tests.

Good day

My name is Cornelia Huysamen; I am currently a registered masters student at the University of the Witwatersrand. I am a qualified physiotherapist and treat patients with various conditions, but especially patients with low back pain. I would like to invite you to participate in a research study to find out if physiotherapists and fourth year physiotherapy students are able to classify lower back (lumbar) dysfunction after assessing six lumbo- pelvic movement control tests and three general tests and if the tests are reliable.

You are invited to participate by performing these tests in order for us to video record the movements. Your identity will stay confidential and faces will not be recognised on the videos. You can withdraw from the study at any time without suffering any consequences.

It will be required of you to take off your shirt so that your back is exposed during the video-recording. The time duration to perform the nine movements will be approximately 20 minutes.

You are welcome to ask questions or contact me if anything is unclear.
Cell: 082 888 5318 Email: huysamencornelia@gmail.com

For the reporting of ethical concerns, you may contact the chair of the Human Research Ethics Committee of the University of the Witwatersrand:
Prof Cleaton Jones; Tel: 011-717-2700

If you are willing to participate in the study by being video-taped while doing certain movements, please sign the informed consent document provided to you.

Thank you.
Cornelia Huysamen

Appendix G

Informed consent for video recording

STUDY TITLE: The ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control by using lumbo-pelvic movement control tests.

RESEARCHER: Cornelia Huysamen
SUPERVISOR: Benita Olivier
CO-SUPERVISOR: Vaneshveri Naidoo
INSTITUTION: University of the Witwatersrand

I hereby give consent to participate in the video recording of the movement tests for research purposes. I confirm that I have been informed by the researcher, Cornelia Huysamen, about the nature and purpose of this research study.

I understand that participation is voluntary and anonymous and that I may withdraw at any stage.

Name _____

Signature_____

Date_____

Appendix H

Information sheet and consent to qualified physiotherapist participants (raters)

Study title: The ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control by using lumbo-pelvic movement control tests.

Good day

My name is Cornelia Huysamen, I am currently completing my masters degree at the University of the Witwatersrand. I am a qualified physiotherapist and treat patients with various conditions, but especially with non-specific low back pain. I would like to invite you to participate in a research study to find out if physiotherapists and fourth year physiotherapy students are able to evaluate and classify lumbar dysfunction after assessing six lumbo- pelvic movement control tests and three general tests.

In order to participate in this study, I would like to invite you to fill in a questionnaire regarding what tests you use in the assessment of lumbo-pelvic movement control, and then read through the short information leaflet regarding how to classify patients with non-specific low back pain using the six lumbo- pelvic movement control tests and three general tests. Thereafter I would like you to watch video recordings of four individuals performing these tests and then classify them using the attached questionnaire. Completion of the questionnaires should take approximately forty minutes.

You are welcome to contact me if anything is unclear.
Cell: 082 888 5318 Email: huysamencornelia@gmail.com

For the reporting of ethical concerns, you may contact the chair of the Human Research Ethics Committee of the University of the Witwatersrand:
Prof Cleaton Jones; Tel: 011-717-2700

You may withdraw from participating at any stage without suffering consequences. Anonymity and confidentiality will be maintained. The results of this study will be made available to the university and physiotherapists.

If you agree to participate in this study, please sign the informed consent document attached.

Thank you.
Cornelia Huysamen

Appendix I

Informed consent form for qualified physiotherapists (raters)

STUDY TITLE: The ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control by using lumbo-pelvic movement control tests.

RESEARCHER: Cornelia Huysamen
SUPERVISOR: Benita Olivier
CO-SUPERVISOR: Vaneshveri Naidoo
INSTITUTION: University of the Witwatersrand

I hereby give consent to participate in this research study. I confirm that I have been informed by the researcher, Cornelia Huysamen, about the nature and purpose of this research study.

I understand that participation is voluntary and anonymous and that I may withdraw at any stage.

Name _____

Signature_____

Date_____

Appendix J

Information sheet and consent to physiotherapy student participants (raters)

Study title: The ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control by using lumbo-pelvic movement control tests.

Good day

My name is Cornelia Huysamen, I am currently completing my masters degree at the University of the Witwatersrand. I am a qualified physiotherapist and treat patients with various conditions, but especially with non-specific low back pain. I would like to invite you to participate in a research study to find out if physiotherapists and fourth year physiotherapy students are able to evaluate and classify lumbar dysfunction after assessing six lumbo- pelvic movement control tests and three general tests.

In order to participate in this study, I would like to invite you to listen to a short information session on how to classify and evaluate patients with non-specific low back pain by using six lumbo- pelvic movement control tests and three general tests. Thereafter I would like you to watch video recordings of four individuals performing these tests and then classify them using the attached questionnaire. Completion of the questionnaires should take approximately forty minutes.

You are welcome to contact me if anything is unclear.
Cell: 082 888 5318 Email: huysamencornelia@gmail.com

For the reporting of ethical concerns, you may contact the chair of the Human Research Ethics Committee of the University of the Witwatersrand:
Prof Cleaton Jones; Tel: 011-717-2700

You may withdraw from participating at any stage without suffering consequences. Anonymity and confidentiality will be maintained. The results of this study will be made available to the university and physiotherapists.

If you agree to participate in this study, please sign the informed consent document attached.

Thank you.
Cornelia Huysamen

Appendix K

Informed consent form for physiotherapy students (raters).

STUDY TITLE: The ability of physiotherapists and physiotherapy students to evaluate and classify lumbar movement control by using lumbo-pelvic movement control tests.

RESEARCHER: Cornelia Huysamen
SUPERVISOR: Benita Olivier
CO-SUPERVISOR: Vaneshveri Naidoo
INSTITUTION: University of the Witwatersrand

I hereby give consent to participate in this research study. I confirm that I have been informed by the researcher, Cornelia Huysamen, about the nature and purpose of this research study.

I understand that participation is voluntary and anonymous and that I may withdraw at any stage.

Name _____

Signature_____

Date_____

Appendix L

Ethics Clearance Certificate

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M130837

NAME: (Principal Investigator)	Ms Cornelia Huysamen
DEPARTMENT:	Department of Physiotherapy Medical School
PROJECT TITLE:	The Inter-and Intrarater Reliability of Lumbo-Pelvic Movement Control Tests
DATE CONSIDERED:	30/08/2013
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Benita Olivier
APPROVED BY:	Professor PE Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 03/09/2013

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature M130837Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES