The Association between Hip Rotation Range of Motion and Non- Specific Low Back Pain in Distance Runners from a Running Club in Central Gauteng

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DECLARATION

I, Tracy Leigh Taljaard, declare that this research report is my own work. It is being submitted for the degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

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Tracy Leigh Taljaard

__________ day of ____________________ 2011

DEDICATION

To God Almighty for strength;

To Grant for his unending patience and support;

To my friends and family for their unwavering belief in me

ABSTRACT

Introduction

Various authors have proposed that there may be altered hip rotation range of motion (ROM) in patients with low back pain (LBP). However, limited studies have been conducted to investigate the association between hip rotation ROM and LBP specifically in distance runners. The aim of this study was to determine whether there is an association between hip rotation ROM and non-specific LBP in distance runners.

Methods

A cross-sectional design was used to look at the relationship between hip rotation ROM and LBP. Thirty five runners with LBP (24 males, 11 females) and 51 runners without LBP (29 males, 22 females) participated in the study. A questionnaire was used to divide participants into LBP and no LBP groups and to evaluate certain factors specific to LBP. Passive rotation ROM was measured in prone position using a hand-held inclinometer.

Results

Results showed no statistically significant difference ($p>0.05$) in hip rotation ROM between the two groups. Furthermore, no statistically significant difference ($p>0.05$) was found for factors specific to running, between the two groups.

Conclusion

Although no association was found between hip rotation ROM and LBP in distance runners, further research is needed into other possible causative factors of LBP in distance runners.

Keywords

Low back pain, hip biomechanics, hip mobility, hip rotation, sports and running

Operational definitions

- **Low back pain (LBP):** pain and discomfort located below the costal margins and above the gluteal folds, with or without associated leg pain (Van Tulder et al 2006).
- **Non-specific LBP:** pain not attributable to a clearly recognisable pathology (Koes et al 2006).
- **Healthy distance runner:** a runner who has had no LBP symptoms within the last 6 months.
- **Time trial:** an unofficial road running race in which participants are timed individually over a set distance, in this case, 4km.

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CHAPTER 1

BACKGROUND AND NEED

1.1 Introduction

Low back pain (LBP) has long been identified as a major problem in today's society. It has far-reaching socio-economic implications for both individual sufferers and the society to which they belong (Koes et al 2006; Woolf and Glaser 2004). Numerous epidemiological studies have been conducted to determine the exact prevalence of LBP and it is estimated that between 30% and 80% of the general population will experience LBP at some point in their lifetime (Van Vuuren et al 2005; Walker et al 2004; Maniadakis and Gray 2000; Anderson 1998). Significant disability experienced as a direct result of LBP has been estimated to affect approximately 10.5% of all LBP sufferers (Walker et al 2004). Varying levels of disability, physical and emotional stress, with consequent reduced quality of life, form part of the far-reaching consequences associated with LBP (Van Vuuren et al 2005). In order to minimise the occurrence and consequences of LBP, much focus has been on the prevention of LBP. Research has found that regular exercise is an effective measure in reducing the occurrence of LBP (Burton, 2005).

Running is an integral part of human function and anthropological research into the suitability of the human body for running, has found that the human musculoskeletal make-up is ideally designed for endurance running

(Bramble and Lieberman 2004). Not only are humans well suited for distance running but it would seem that participation in running, as a convenient and cost-effective form of exercise, is steadily on the rise (Taunton et al 2002; Van Mechelen 1992). This may be due, in part, to the heightened awareness towards the preservation of health and the benefits of exercise in modern society (Taunton et al 2002). Durant (2006) reported road running to be the second most popular sport amongst South African men and the fourth most popular sport amongst South African women in 2005.

All physical activities however, are not without risk of injury, regardless of the level at which they are performed. The overall yearly incidence rate for injuries amongst runners has been estimated to be between 37% and 56% (Van Mechelen 1992), with LBP accounting for between 10% and 13% of these injuries (Woolf et al 2002; Jacobs and Berson 1986). More recently, Gonzalez (2006) found the prevalence of LBP in the running population to be 58%. This is a much higher prevalence than found in similar studies conducted in previous years. The relative increase in prevalence of LBP in runners may probably be explained by the increased participation in running in recent years.

Causes of LBP are numerous but there is mounting evidence that the presence of LBP may be associated with a decreased hip rotation range of motion (ROM) (Van Dillen et al 2008; Woolf et al 2004; Cibulka et al 1998; Chesworth et al 1994; Barbee Ellison et al 1990; Mellin 1988). Literature examining hip rotation ROM and its relationship to LBP is fairly dated. However, the proposed notion is that, due to the relative anatomic proximity of the hip and lumbar spine and their functional relationship, a reduction in hip rotation ROM will augment altered forces on the joints and structures in the lumbo-pelvic region (Barbee Ellison et al 1990; Mellin 1988). Given the repetitive nature of ambulation, even a slightly reduced hip rotation ROM may, be amplified to further increase the load on the lumbar spine (Mellin 1988).

Running demands more balance, stronger muscle contraction and greater joint ROM when compared to walking (Levangie and Norkin 2001). According to Novacheck (1998), the specific biomechanics of the hip and pelvis during running require maximal hip medial rotation during the stance phase and a large amount of hip lateral rotation during the swing phase of the gait cycle for normal movement to occur. Normal hip rotation ROM values vary in the literature but generally, hip medial rotation ROM ranges between 30 – 45 degrees and hip lateral rotation ranges between 40 – 60 degrees of motion (Chesworth et al 1994). Although the hip joint is well designed to withstand the forces acting through it, certain factors such as muscle and soft tissue length and tension may result in altered hip mobility (Levangie and Norkin 2001) which may result in altered lumbo-pelvic mobility. In this way, restricted motion at one segment (e.g. the hip) may result in compensatory hypermobility of the unrestricted segment (e.g. the lumbar spine and/or pelvis). Hypermobility of the lumbar spine may in this way be a potential cause of LBP.

A number of studies have found there to be an association between LBP and limited hip rotation ROM (Van Dillen et al 2008; Barbee Ellison et al 1990; Mellin 1988; Chesworth et al 1994). However, none of these studies have been specific to distance running. Due to the increased participation in running, both as a leisure-activity and a form of exercise, the prevalence of LBP in distance runners is expected to be greater than previously estimated. In order to successfully treat LBP, proper examination is necessary with tests that are simple, cost effective and non-invasive (Leboeuf-Yde and Kyvik 2000). The aim of this study was hence to determine whether there is an association between altered hip rotation ROM and LBP in distance runners. Should the findings of this study support its hypothesis, screening for altered hip rotation ROM in runners complaining of LBP in physiotherapy assessment, may be motivated for and appropriate treatment strategies adopted.

1.2 Problem statement

Literature describing normative hip rotation ROM values in distance runners is limited. Furthermore, investigations exclusively concerning the relationship between LBP and factors specific to distance running are limited. The hips and lumbar spine have an anatomical and functional relationship and are thus expected to be mechanically influential on each other. It is hypothesised that this would be augmented in a repetitive activity such as running. No literature was found which assessed whether there is an association between hip rotation and non-specific LBP in distance runners. Testing of hip rotation ROM is currently not included in the physiotherapy assessment and/or treatment of LBP.

1.3 Research questions

Is there an association between hip rotation ROM and non- specific LBP in distance runners? Is hip rotation ROM asymmetry associated with non-specific LBP in distance runners? Are there other factors, which may be identified from the data collected in this study, associated with non-specific LBP in distance runners?

1.4 Aim of study

The aim of this study was to determine whether there is an association between altered hip rotation ROM and non-specific LBP in distance runners.

1.4.1 Objectives of study

- To compare hip rotation ROM in healthy distance runners and distance runners with non-specific LBP; and
- To determine whether there is an association between hip rotation ROM and non-specific LBP in distance runners; and
- To determine whether there is an association between hip rotation ROM asymmetry and non-specific LBP in distance runners; and

- To determine whether other factors specific to distance running are associated with LBP

1.5 Significance of study

Establishment of normal hip rotation ROM values in distance runners will make it possible to compare hip rotation ROM values between runners with LBP and those without. One will then be able to determine whether there is an association between limited hip rotation ROM and LBP in distance runners. If an association is found, due to the anatomic proximity of the hip to the lumbar spine, it may be deemed necessary to include specific hip rotation ROM screening procedures in physiotherapy evaluation of runners with LBP. The findings of this study may benefit the physiotherapy profession by improving assessment and management procedures for distance runners with LBP. It may also open doors for future research into the causative factors of LBP in distance runners. Lastly, distance runners with LBP may benefit from the results of this study through improved assessment and management procedures.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The Search Strategy that was used for this study was an electronic database (PubMed, Science Direct, CINHAL, Ovid and Medline) search. Keywords used were “low back pain”, “hip biomechanics”, “hip mobility”, “hip rotation”, “sports” and “running”. The Cochrane library and PEDro were also searched to ensure that published systematic reviews or clinical trials related to the topic were not overlooked.

The Literature review was done using the following sub-headings:

- Introduction
- The prevalence of low back pain
- Lumbo-pelvic and hip biomechanics during running
- Measurement instruments
- The association between hip rotation and low back pain
- Other factors
- Conclusion

LBP has previously been classified as a recurrent and chronic condition (Cassidy et al 2005), commonly referred to as one of the most common musculoskeletal disorders in the world today (Louw et al 2007; Anderson 1998). Moreover, LBP is considered to be one of the most costly conditions globally (Maniadakis and Gray 2000), giving rise to far reaching negative social and economic consequences (Woolf and Glaser 2004). Adding to the complexity of this condition is the fact that it is episodic in nature, fluctuating over time and intermittently flaring up (De Vet et al 2002). As much as 90% of all reported cases of LBP cannot be accredited to a specific known pathology and are thus classified as non-specific LBP (Van Tulder et al 2006; Koes et al 2006).

2.2 The prevalence of low back pain

A large amount of literature has delved into determining the prevalence of LBP in the general population. Lifetime prevalence rates of LBP in Western countries are reported to be between 30% and 80% (Van Vuuren et al 2005; Walker et al 2004; Maniadakis and Gray 2000; Anderson 1998). In Africa, LBP is estimated to have similar lifetime prevalence of between 28% and 70% and a point prevalence of 32% (Louw et al 2007). Although some studies have been conducted to determine the prevalence of LBP specific to the running population, recent literature in this regard is limited.

Boniolo et al (2003) evaluated the epidemiology of LBP in middle and long distance runners by means of a validated questionnaire. Within the 191 elite male runners that participated in the study, a lifetime prevalence of 51.8% was found. However, despite this high incidence of LBP, 73% of the LBP sufferers did not report their LBP to be associated with running. The authors concluded that the prevalence of LBP in middle and long distance runners is similar to that of the general population and further suggested that running is not damaging to the spine.

A similar study was conducted by Gonzalez et al (2006) who used a validated questionnaire to assess 99 recreational runners. It was found that the lifetime prevalence of LBP in their participant group was 58%. It was furthermore established that running did not worsen or, conversely, improve symptoms of LBP, which is in accordance with the findings of Boniolo et al (2003).

In contrast to the above, a study by Räty et al (1997) found that the occurrence of LBP was negatively associated with leisure and sports activities. Of the participants investigated, long distance runners reported the lowest incidence of LBP (7%) in comparison to other sporting disciplines. This is despite the fact that long distance running enforces extensive repetitive loading on the body (Räty et al 1997).

Relatively few studies were found to investigate LBP prevalence in runners and based on the above studies, it can be seen that prevalence rates of LBP in distance runners vary dramatically. When compared to the general population, it would seem that runners experience a slightly lower prevalence of LBP. Running may hence, biomechanically influence factors surrounding LBP.

2.3 Lumbo-pelvic and hip biomechanics during running

The running cycle occurs in a three dimensional plane of motion with movements in the sagittal, coronal and transverse planes occurring simultaneously. For the purposes of this study, however, we will only be discussing transverse plane kinematics of the lumbo-pelvic-hip complex during running.

Lumbo-pelvic and hip movements will furthermore be portrayed with reference to the respective phases of the running cycle. Ounpuu (1990) described one running cycle for a given lower extremity to be made up of one stance phase and one swing phase. The stance phase comprises approximately 40% of the running cycle and may be subdivided into an absorption period, commencing at foot strike and ending at midstance, and a propulsion period, commencing at midstance and ending at toe off. The swing phase comprises the other 60% of the running cycle and consists of an initial swing period, commencing at toe off and ending at midswing and a terminal swing period, commencing at midswing and ending at foot strike.

The distinguishing factor between walking and running is the absence of double support periods during running i.e. the absence of contact of both feet with the ground at the same time (Novacheck 1998). This airborne period comprises approximately 10% of the running cycle occurring at the beginning and end of each swing phase (Ounpuu 1990).

The importance of hip rotation ROM during running comes into play during the stance phase of the running cycle. This is because, during weight-bearing, the hip joint is in fact, part of a closed kinetic chain. According to Levangie and Norkin (2001), a closed kinetic chain is formed between the foot, when fixed in weight-bearing, and the head, during upright activities. Although the head is relatively free to move, it is functionally fixed over the sacrum during upright activities by the labyrinthine and optical righting reflexes, resulting in a closed kinetic chain. This means that movement or lack of movement at the hip will inevitably result in movement in at least one other joint as part of the kinetic chain (Levangie and Norkin 2001). As there is very little rotary movement possible at the knee, relative restricted mobility at the hip will most likely cause compensatory movement at the lumbar spine. This hypermobility or compensatory movement at the lumbar spine may in itself be painful or may result in protective muscle spasm or nerve root irritation. All these may present as symptoms of LBP.

Novacheck (1998) describes the predicted movement of the hip, pelvis and lumbar spine during ambulation. The femur is somewhat fixed during the stance phase and hence, rotation at the hip joint will be produced by movement of the pelvis on the head of the femur. For example, whilst weight-bearing on the right limb during the stance phase of running, the pelvis on the side of reference will rotate posteriorly, resulting in medial rotation of the right hip and lumbar rotation towards the left (Novacheck 1998).

Much difficulty has been demonstrated in accurate, quantitative measurement of lumbo-pelvic-hip movement in the transverse plane during running (Schache et al 1999). Novacheck (1998) however found that running requires a minimum of approximately 8 degrees of both pelvic medial and lateral rotation. Rotation of the pelvis about the transverse axis may be defined as medial rotation when the reference side of the pelvis is anterior and lateral rotation when the reference side of the pelvis is posterior and ranges between 16 – 18 degrees amplitude during normal gait (Schache et al 1999). The required amount of hip medial rotation ROM for normal running gait has been reported to be 12 degrees and the required amount of hip lateral rotation ROM has been reported to be 0 degrees (Novacheck 1998). Normative values for hip rotation ROM reported in various physiotherapy orthopaedic textbooks are demonstrated in table 2.1 below:

Table 2.1 Normative values for hip rotation ROM reported in textbooks

Author	Medial Hip Rotation (degrees)	Lateral Hip Rotation (degrees)
Kapandji (1974)	30-40	60
Hoppenfeld (1976)	35	45
Corrigan and Maitland (1983)	45	60
Kendall and McCreary (1983)	45	45
Magee (1987)	30-40	40-60

None of the sources listed above specified whether a goniometer or an inclinometer was used. This may be an explanation as to the variations in degrees for both medial and lateral rotation between sources.

From the above literature review it is apparent that less than maximal pelvic and hip rotation ROM is required for a normal running gait to be executed. During running, the hip, pelvis and lumbar spine move in a co-ordinated way to generate a greater stride length (Novacheck 1998). Hence, if movement is limited in the hip, compensatory movements may occur in the lumbo-pelvic area to maintain a normal running stride length. Different instruments may be used to measure the degrees of hip ROM available.

2.4 Measurement instruments

Currently, in the clinical setting, there are two instruments used to assess joint ROM: a two-arm goniometer and an inclinometer. According to Lea and Gerhardt (1995), the goniometer is more frequently used. However, Barbee Ellison et al (1990) found the inclinometer to be more reliable and easier to use.

Bierma-Zienstra et al (1998) compared the reliability of the two instruments when measuring hip ROM. The position of measurement, prone versus sitting, was also studied.

It was found that the inclinometer was marginally more reliable than the goniometer when measuring passive hip rotation ROM. When comparing hip ROM found in degrees, the inclinometer and goniometer showed systematic differences. It was therefore concluded that measurements, in degrees, taken with the inclinometer cannot be compared with normal reference values measured with a two-arm goniometer. Furthermore, it was found that rotational movement of the hip increased when measured in prone resulting in poor correlation with hip rotation ROM measurements in other positions.

Consistency regarding measurement tool and measurement position is therefore paramount. Once hip rotation ROM has been accurately established, the association between this ROM and LBP may be studied.

2.5 The association between hip rotation and low back pain

The association between hip rotation ROM and LBP has been investigated over a number of years, from as early as the 1980's. Different studies have shown an association between hip rotation ROM, in general, and LBP (Mellin 1988; Barbee Ellison et al 1990). Furthermore, some studies have shown a decreased hip rotation ROM to be prevalent amongst participants who complained of LBP (Chesworth et al 1994; Van Dillen et al 2008)

Mellin (1988) conducted research to determine the relationship between hip and lumbar spine mobility and LBP. A total of 301 men (mean age 44 years) and 175 women (mean age 46 years) with chronic or recurrent LBP were evaluated. The degree of LBP was evaluated with the Oswestry Questionnaire. Active hip ROM (flexion, extension, lateral and medial rotation) and passive hamstring flexibility were measured with an inclinometer. Lumbar spinal mobility was measured with an inclinometer and a compass. Hip rotation ROM was measured in prone and the pelvis was not stabilised. In men, results indicated correlations ($p<0.05$) with LBP in all movements except lateral rotation. Comparatively in women, only flexion and extension showed a correlation with LBP. In both men and women, hip extension ROM had the strongest correlation with LBP. The author furthermore found that hip mobility had an equal or stronger correlation to the degree of LBP as opposed to spinal mobility and degree of LBP in the same participants. The study however, had a number of shortcomings: inclusion, exclusion and age criteria were not clearly defined, no pelvic stabilisation was provided during measurements and the exact methodology followed was not clearly described.

A subsequent study was conducted by Barbee Ellison et al (1990) to describe the amount of hip rotation ROM in healthy participants and in patients with LBP. A sub-aim of the study was to classify these participants according to their different patterns of hip rotation ROM and compare distribution of healthy participants and participants with LBP within the hip rotation ROM categories. A total of 100 healthy participants (25 men and 75 women), aged between 20 and 41 years of age and 50 LBP participants (21 men and 29 women), aged between 23 and 61 years of age with varying diagnoses, were assessed. Hip rotation ROM was measured passively with an inclinometer and a goniometer in both prone and sitting positions. Four patterns of passive hip rotation ROM were described, namely; total medial rotation and total lateral rotation equal and symmetrical; total medial rotation and total lateral rotation equal and asymmetrical; total medial rotation greater than total lateral rotation by more than 10 degrees; and total medial rotation less than total lateral rotation by more than 10 degrees.

Results showed no significant differences ($p>0.5$) between the participant groups and subgroups. However, a significant difference in distribution of healthy participants and LBP participants over the hip rotation ROM pattern categories was found ($x^2 = 8.38$, df = 2, $p<0.05$). Although both participant groups demonstrated all pattern categories, the largest proportion (48%) of participants with LBP showed significantly restricted hip medial rotation ROM compared to hip lateral rotation ROM. In addition, both healthy and LBP participants exhibited less overall hip rotation ROM when compared to normative reference values. Two major shortcomings were identified in the above study; firstly, the measurements were only performed once on each participant, possibly resulting in an inaccurate reflection of ROM and secondly, the LBP group was comprised of patients with histories of both acute and chronic LBP with varying diagnoses. This may have influenced the results of the study where serious lumbar pathology was known.

Chesworth et al (1994) aimed to compare hip mobility between patients with LBP and matched healthy participants who reported no LBP in last 6 months. Twenty participants with LBP (14 men and 6 women) were matched to 20 control participants with no history of LBP within the last 6 months. Participants were matched according to gender, age, height and weight. The age range of the study population was 18 to 67 years of age. Active hip rotation ROM was measured in prone with a goniometer whilst an assistant stabilised the pelvis to prevent trick movements. The hip flexion adduction test was then performed as described by Maitland. The results of this study showed a significant difference ($p<0.001$) in hip rotation ROM between the two groups with a reduction in overall lateral rotation as opposed to medial rotation in LBP participants. No direct relationship between duration of LBP and active hip rotation ROM was found in the study groups. The authors further commented that rotation ROM values for the healthy group were within normal ranges whereas LBP participants presented with values more than 4 degrees below the lower range of normal. There was however, no significant difference ($p>0.05$) between the healthy and LBP groups for Maitland's flexion adduction test. Shortcomings of this study identified were that a small sample size was used and relevant aspects of LBP history and symptoms not identified.

When comparing the study by Chesworth et al (1994) and the study by Barbee Ellison et al (1990), it is noted that there is a contrast in the findings with reference to the direction of restriction in hip rotation ROM in participants with LBP. A possible reason for this difference may be that the two studies used different measurement tools. As discussed above, Bierma-Zienstra et al (1998) found the inclinometer and goniometer to show systematic differences in measuring ROM at the hip. Another major difference in the methodology used in the two studies was that Chesworth et al (1994) measured active hip rotation ROM whereas Barbee Ellison et al (1990) measured passive hip rotation ROM. Barbee Ellison et al (1990) furthermore had a younger mean age in the study sample group when compared to the sample group used by Chesworth et al (1994).

In a more recent study by Van Dillen et al (2008), hip rotation ROM in 24 healthy participants and 24 participants with LBP, who all participated regularly in rotation related sports at the time of study, was investigated. Two components of testing were used. The first included demographics, LBP history and a numeric rating of pain as part of self-reported measures and the second comprised of inclinometric measures of passive hip rotation ROM. It was found that those with a history of chronic or recurrent LBP demonstrated less total passive hip rotation ROM when compared to healthy participants (p=0.035 with a 95% CI). It was furthermore found that participants who presented with LBP demonstrated more hip rotation ROM asymmetry when compared to healthy participants. People with LBP also demonstrated more asymmetry of hip rotation ROM with total left hip rotation ROM being significantly less than total right hip rotation ROM (p=0.004, 95%CI). No significant asymmetry of left and right hip rotation ROM was noted in the healthy participants (p=0.312, 95%CI). Although the sample size used for this study was relatively small (n=48), findings indicate a definite association between LBP and hip rotation ROM deficits in people who regularly participate in rotation-related sports. An important shortcoming of this study was that the level of LBP disability in participants was particularly low and the authors were thus not able to generalise findings to those experiencing an acute flair-up. Another shortcoming was that a cross sectional design was used and the authors could thus not be sure whether symptoms caused hip rotation ROM limitations or vice versa.

Based on the above literature review, it is evident that a relationship between deficits in hip rotation ROM and LBP may exist. Based on these studies, it appears that people with LBP may firstly have less hip rotation ROM, whether active or passive and secondly have more asymmetry in hip rotation ROM. It has been postulated that even a small limitation in hip rotation ROM may directly affect the biomechanics of the lumbar spine and hence may in this way be linked to the presence of LBP (Mellin 1988). When applied to running, altered hip rotation ROM may alter pelvic rotation over the stance limb and thus result in abnormal biomechanics of the sacrum and lumbar spine. The normal muscle length-tension relationships in the lumbo-pelvic area may not be attained with reduced hip rotation ROM. This in itself may be a potential cause of LBP.

Few studies have been conducted with the purpose of investigating relationships between LBP and features specific to running-based sports (Woolf et al 2004) and no studies have been identified that investigated the association between hip rotation ROM and LBP specifically in distance runners. Although previous studies have found the prevalence of LBP in runners to be relatively low, it is postulated that there may currently be an increased prevalence of LBP in runners. There is therefore a need for further investigation.

The studies discussed above confirm that there may be an association between hip rotation ROM limitations and LBP. There are however, contrasting opinions as to whether medial hip rotation ROM, lateral hip rotation ROM or a combination of the two is associated with LBP. No studies were found that examined the association between hip rotation ROM and LBP specific to distance running.

2.6 Other factors

Literature examining the connection between LBP and factors specific to running is scarce (Woolf et al 2004). One study surveyed 539 participants in either a 10 kilometre run or a four mile walk to determine the prevalence, natural history and contributing factors to LBP (Woolf et al 2002). It was found that, average 10-kilometre race time, weekly mileage, and frequency of training did not have any correlation to the presence of LBP in study participants. Although participation in other sports and cross training had no correlation to current or previous LBP, participation in weekly aerobics showed a 13% reduced likelihood of having a previous episode of LBP.

Another study evaluated 191 elite male middle and long distance runners using a validated questionnaire (Boniolo et al 2003). In contradiction to the above study, a weekly mileage of more than 70km per week was identified as a predisposing factor in the development of LBP in runners. It was furthermore found that participation in less than two races per month was associated with LBP in the participants studied. This study was however, limited to elite male athletes and the results may not necessarily be applicable to recreational distance runners.

Gonzalez et al (2006) assessed the prevalence of LBP and factors associated with LBP in recreational distance runners. Data, collected via a questionnaire, revealed that gender, age, speed, general mileage and orthotic use had no correlation to LBP symptoms whilst running. Mileage per week and orthotic use, however, were found to be predictors of persistent LBP. This is in agreement with the study by Boniolo et al (2003).

From the literature discussed above, it would seem that mileage per week and orthotic use may be associated with LBP in distance runners. While other factors such as participation in other sports and cross training, have been found to have no correlation to LBP. The relevant lack of research into relationships between LBP and factors specific to running indicates that further research in this regard is required as motivate above in this chapter.

2.7 Conclusion

The prevalence of LBP in distance runners is similar to the prevalence of LBP in the general population. A certain amount of hip rotation ROM is required during running to ensure that potentially harmful compensatory biomechanics in the lumbo-pelvic-hip complex do not occur. A number of studies have found there to be an association between hip rotation ROM and LBP but no studies were found that evaluated the association between hip rotation ROM and LBP in distance runners.

CHAPTER 3

METHODOLOGY

3.1 Study Design

A cross-sectional design was used to look at the relationship between hip rotation ROM and LBP.

3.2 Study population

3.2.1 Source of participants

A local running club in Central Gauteng was identified as the population for this study. The club consisted of 220 active members who ran with the club at least once per week. The distances run by the club ranged from 4km to 56km at a time and were conducted mostly on tarred roads in the surrounding area.

3.2.2 Sample size

A sample of convenience of volunteers from the running club was selected as the sample population for this study. Based on the study done by Barbee Ellison et al (1990), the values for medial hip rotation ROM showed the most significant differences between healthy and LBP populations and were thus expected to be greater in the healthy group compared to the LBP group. The statistical power calculation was therefore based on the medial rotation ROM findings by Barbee Ellison et al (1990). The total medial hip rotation ROM was expected to differ by 15-20 degrees between healthy runners and runners with LBP with the healthy population having a mean of approximately 36 degrees. Assuming a clinically relevant difference of 18 degrees, and a standard deviation of 22.5 degrees (Barbee Ellison et al 1990), then a sample with a 2:1 ratio of healthy runners to runners with LBP, with at least 78 runners (52:26), was expected to have at least 90% power to detect a difference of 18 degrees between the two groups (nQuery 6.0). The actual sample size consisted of 86 runners constituting a ratio of healthy runners to runners with LBP of 51:35. For the same assumptions as described above, the study was powered at 94%.

3.2.2.1 Inclusion criteria

The inclusion criteria for this study were:

- Aged 18 – 50 years of age;
- Run at least twice a week;
- LBP population: Current or recent (within the last 6 months) non-specific LBP;
- Healthy population: No LBP within the last 6 months.

3.2.2.2 Exclusion criteria

The exclusion criteria were as follows:

- Previous surgery to the lumbar spine or pelvis;
- Serious pathology trauma to the lumbar spine, pelvis or proximal femur (e.g. fractures);

- Previous hip surgery;
- Current hip pain as a main complaint as this may indicate hip pathology;
- Current pregnancy as pregnant women are predisposed to LBP as well as altered joint mobility due to changes in hormonal balances;
- Diagnosis at any time by a physician with any other medical conditions which may manifest in the lumbar spine or hip or may present as LBP or hip pain (e.g. tumour, infection or joint pathologies);
- Participation in the pilot study.

3.3 Data collection tools

3.3.1 Inclinometer

A Saunders Digital Inclinometer (The Saunders Group Inc, Chaska, Minnesota, USA) was used to measure hip rotation ROM. An inclinometer was chosen in preference to a goniometer as Barbee Ellison et al (1990) found the inclinometer easier to use with better reliability when compared to a standard goniometer.

3.3.2 Questionnaire

The questionnaire used was based on that recommended by Plastaras et al (2005) for the evaluation of the injured runner (Appendix A). It was modified to include specific demographic details and details on LBP in order to accurately allocate participants into the healthy or LBP groups. Certain parts of the questionnaire were emitted as they did not relate to the aims of this study. The amended questionnaire (Appendix B) was used only to apply inclusion and exclusion criteria and determine specific demographics regarding the population sample therefore questionnaire reliability was not tested.

3.4 Procedure for data collection

Permission to conduct this study was obtained from the chairperson of the running club (Appendix C) and arrangements were made to proceed with data collection after the time trial each Tuesday.

3.4.1 Pilot study

3.4.1.1 Objectives of the pilot study

A pilot study was conducted to confirm participants' understanding of the consent form, questionnaire, data collection procedure and to gauge the time needed for questionnaire completion, evaluation and measurement of each participant. Further objectives of the pilot study were to determine possible measurement errors, test questionnaire repeatability and to confirm intra-tester reliability with measurements. Participants involved in the pilot study were recruited from the same running club as the main study and were excluded from the main study.

3.4.1.2 Methodology of the pilot study

One researcher and one research assistant conducted the pilot study. The researcher was responsible for positioning the participant correctly on the plinth, performing hip rotation and taking the measurements. The research assistant was responsible for reading and recording the measurements on the data recording sheets. Five runners were recruited to participate in the pilot study. Two of which fell into the LBP group and three had no experience of LBP within the last six months. Participants were provided with information on the importance, confidentiality and methodology of the study both verbally and in the form of an information document (Appendix D). Participants were then allocated numbers to ensure confidentiality and were asked to sign an informed consent form if they agreed to participate (Appendix E). Thereafter participants were each asked to complete the demographic questionnaire.

Neither the researcher nor research assistant was blinded to the presence of LBP during the pilot study. Each participant was evaluated for pain on lumbar range of movement (flexion, extension, lateral flexion and rotation) by the researcher and limits in range and presence of pain were documented by the research assistant. Thereafter, each participant was asked to lie prone on the treatment plinth and his/her pelvis was secured to the plinth over the pelvis with a stabilisation strap. Starting position was with the tibial plateau of the limb to be measured parallel to the treatment plinth. The inclinometer was placed on the distal third of the fibula and the tibia was used as a lever for hip lateral and medial rotation. Each movement was performed once before measurement commenced to familiarise the participant with the procedure. Right lateral rotation was measured first then right medial rotation and thereafter left lateral rotation and Left medial rotation. Each measurement was performed a total of three times and the mean of the three measurements was taken as the final measurement. Measurements were recorded on a measurement recording form (Appendix F).

3.4.1.3 Results of the pilot study and implications

Participants reported a good understanding of both the information document and consent form and no related questions were raised.

The average time required to explain and fill in the informed consent form was three minutes per participant and it took a further one and a half minutes for each participant to complete the questionnaire. Evaluation of lumbar movement took two minutes per participant and measurement of hip rotation took on average two and a half minutes per participant. This resulted in a total time of nine minutes per participant.

Some shortcomings were identified in the questionnaire (Appendix G) and it was adjusted accordingly. Questions in the original questionnaire were not numbered. Certain questions in the questionnaire were deemed unnecessary as they had no bearing on the aims of this study. This was determined from input from participants, the statistician and on evaluation of participants' answers. Numbers were inserted and after questions 6,8,10,11,12,15 and 16 were removed, 14 questions remained in the questionnaire. As the questionnaire served purely as a demographic tool, it was not anticipated that these changes would affect the outcome of the study in any way.

Following the outcome and feedback from the pilot study, it was deemed unnecessary to evaluate lumbar movement of those participants who fell into the healthy population, as limits in lumbar ROM, if present, were not associated with LBP and hence had no relevance to this study. Furthermore, the value of evaluating participants with LBP was found to be questionable as the ROM estimate was not deemed accurate and pain reported during the movement was not always located over the lumbar spine. In addition, the inclusion criterion for the LBP population was self-reported non-specific LBP experienced within the last six months and participants did thus not necessarily complain of present pain or pain with movement. The area of pain and it's relation to LBP were documented. The initial aim of including the lumbar movement evaluation in the study was to provide an objective measure for LBP in the study. In addition, it was decided that the lumbar evaluation should be performed after the hip rotation measurements in order to blind the researchers as to the presence or absence of LBP.

Variations, of up to eight degrees, between the three measurements for each movement were encountered. This occurred when the inclinometer was not accurately aligned on the distal third of the tibia and if the hold button was pushed too soon.

Due to errors encountered in the questionnaire and measurement technique in the initial pilot study and due to the uncertainty of the value of including the lumbar movement evaluation in the study, it was decided that a second pilot study should be performed. The second pilot study also served to determine questionnaire repeatability and intra-tester reliability.

It was furthermore decided that a second research assistant should be used to hand out and explain the informed consent document and questionnaire to participants to ensure participants had a good understanding of both the information document as well as the questionnaire before participating in the study and to allow more time for the researcher and first research assistant to perform the measurements accurately.

3.4.1.4 Re-pilot study

Three of the runners used in the initial pilot study were recruited to participate in the second pilot study, two of which fell into to LBP group. The time frame between the two pilot studies was one week. The methodology used in the re-pilot study was the same as that for the initial pilot study apart from the additional research assistant and modification of the lumbar movement evaluation. The additional research assistant handed out and explained the information document and questionnaire to participants before participation. Lumbar movement evaluation was performed only on those complaining of LBP and consisted of four movements namely; flexion, extension, rotation left and rotation right. Degrees of Lumbar ROM were not evaluated but a note was made if pain was present with each movement and the location of the pain was also noted.

Repeatability of the questionnaire was determined by applying the test re-test method. Answers to the questionnaires completed by participants in the first pilot study were compared to answers of corresponding questions in the questionnaires completed by the same participants in the re-pilot study. Answers to questions that related to information that may change from day to day, such as average distance run per week, varied only slightly and there was agreement on all questions relating to demographics and LBP.

Intra-tester reliability has already been established for the use of an inclinometer for measurement of hip joint motion (Bierma-Zienstra et al 1998, Barbee Ellison et al 1990). However, due to the measurement errors detected in the initial pilot study, the measurement recordings were reviewed in the re-pilot study and were found to be consistent, varying no more than 4 degrees between readings for a particular movement.

Although the modifications of the lumbar movement evaluation were more reliable than in the initial pilot study, the lumbar evaluation was still found to be significantly participative. It was decided that the lumbar evaluation be excluded from the main study as the initial aim of including the lumbar movement evaluation in the study was to provide an objective measure for LBP.

Time taken to complete the second pilot study was eight minutes per participant for LBP participants and six minutes per participant for healthy participants.

3.4.2 Procedure of the main study

Running club members meet at the running club clubhouse every Tuesday at 6pm for a 4km time trial. Members were invited to volunteer their participation in the study via an e-mail, sent by the club administrator, the day before each time trial, as well as in an announcement upon commencement of the time trial. Data collection took place after the time trial for seven consecutive weeks until realisation of the sample size.

Informed consent forms were handed out on the same day as data collection, before data collection commenced. A number was assigned to each participant upon signing of the informed consent form. To ensure confidentiality, these numbers were used when completing the questionnaires and on the data collection sheets. Participants were assigned to the healthy or LBP group according to the short demographic questionnaire which was completed by each participant before objective measurement commenced. It was only revealed whether or not participants fell into the healthy group or the LBP group when data was captured by the researcher on the same day as measurement.

The measurement procedure used was similar to that used by Van Dillen et al (2008) and Barbee Ellison et al (1990):

One research assistant was responsible for handing out and explaining the information document and questionnaire to each participant and allocated each participant with a participant number to ensure confidentiality.

The researcher and a second research assistant were involved in testing each participant. The researcher positioned the participant according to the following specifications: the participant was placed prone on the treatment plinth. The pelvis was then securely strapped to the plinth with a stabilisation strap to prevent any trick movements. The hip to be measured was placed in neutral hip abduction and neutral hip adduction and the knee was flexed to 90º with the foot in a relaxed position. The other lower limb was placed in slight abduction in a relaxed position so as not to interfere with the measurement procedure. The participant’s arms were placed at his/her sides with the participant’s head in a comfortable position.

Starting position was with the tibial plateau of the limb to be measured parallel to the treatment plinth. The inclinometer was placed on the distal third of the fibula. Using the tibia as a lever, the lower limb was then moved into lateral rotation to end range, which is defined as the point at which the tibia can no longer be moved towards the supporting surface without pelvic rotation. The same procedure was followed for medial rotation. Each measurement for lateral and medial rotation respectively was taken a total of three times. Passive ROM was reflected as the inclinometer reading in degrees, averaged across the three measurements. The right lower limb was measured first and the same procedure was then repeated to measure the left lower limb.

The research assistant read and recorded the measurements. All measurements were recorded on the data recording sheet. The researcher did not read the final measurement values from the inclinometer and was thus blinded to the values recorded by the research assistant. Both the researcher and research assistant were blinded to the presence or absence of LBP in the participant being measured as the questionnaires kept by the first research assistant until the measurement procedure was completed.

As suggested by Van Dillen et al (2008), each participant was first familiarised with the method by taking the limb to be measured into medial rotation and lateral rotation once before measurement commenced.

3.5 Ethical considerations

An application was made and ethical clearance was granted by the University of the Witwatersrand Human Research Ethics Committee (Number M090535) prior to commencement of the study (Appendix H). An informed consent form was voluntarily signed by all participants and it was emphasised that refusal to consent to participate in the study would not be detrimental to them in any way. All participants were assigned participant numbers which were used on the questionnaires and the data recording sheets to ensure confidentiality. Furthermore, treatment advice and feedback was given to participants if LBP was present.

3.6 Data analysis

- Data was captured using an Excel spread sheet. The continuous parameter, i.e. rotation ROM, was summarized using mean, standard deviation and 95% confidence interval.
- Comparisons of hip rotation ROM, between NLBP and LBP groups were done using the student's t-test for independent groups to determine significant difference between groups. The t-test was employed since the response variable, i.e. hip rotation ROM in degrees, is a continuous variable as it measures on an interval. While, if the response variable was categorical (e.g. gender) groups will have been compared using the chi-squared test.
- Significant difference between the two groups for hip medial and lateral rotation ROM on both left and right sides was then used as an indication of association between hip rotation ROM and LBP. Symmetry between left and right sides was measured by means of a mean symmetry value. The mean symmetry was calculated by subtracting the mean rotation value on the left from the mean rotation value on the right. This was done for both medial and lateral rotation. A mean difference value of zero would show perfect symmetry.
- The mean symmetry values for both groups were then compared using the student's T-test for significant difference.
- Due to the large standard deviation found when testing for the mean symmetry value with the student's T-test, the Wilcoxon Rank-Sum Test

was done. This was used to confirm the results of the t-test done on the mean symmetry values with parameters excluded.

- Testing was done using the 0.05 level of significance.

CHAPTER 4

RESULTS

4.1 Introduction

In this chapter, results of the study are presented under the following sub-headings:

- Sample size and participant distribution
- Prevalence of low back pain
- Demographic factors
- Hip rotation range of motion
- Hip rotation symmetry
- Other factors
- Conclusion

4.2 Sample size and participant distribution

A total of 101 participants participated in this study. Fifteen participants were excluded from the study of which eight were over the age of 50, four had previous severe trauma to the hip, pelvis or lumbar spine, two had hip pain at the time of the study and one participant was pregnant. The remaining 86 participants were sub-divided into either the healthy population (NLBP) (n = 51) or the LBP population (those with LBP in the past six months) (n = 35) according to their responses on the questionnaire. The following figure depicts the sample size and participant distribution:

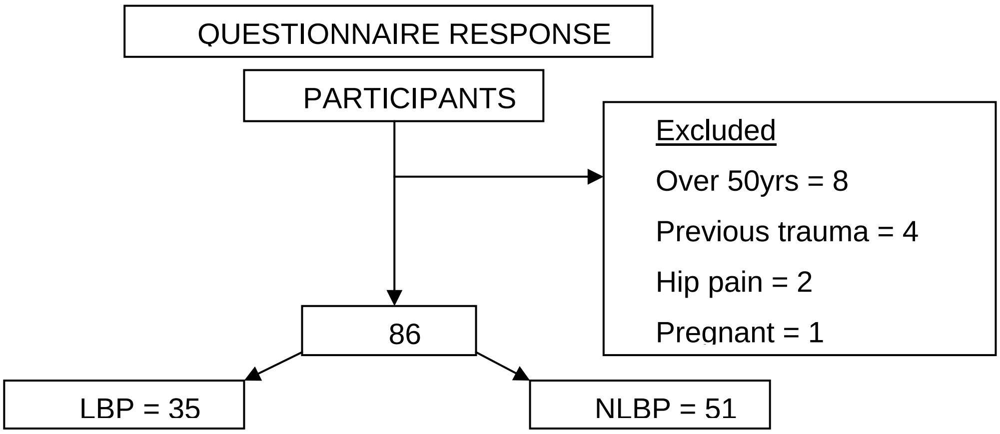

Figure 4.1: Participant distribution

4.3 Prevalence of low back pain

The point prevalence of LBP in the study population was 10.5% and the 6 month prevalence of LBP in the study population was found to be 40.7%.

4.4 Demographic data

Distribution of participants according to the presence or absence of LBP throughout the various age groups is depicted in table 4.1 and table 4.2.

Table 4.1: Gender distribution of pain

Male N = 53		**Female N = 33**	
NLBP n(%)	**LBP n(%)**	**NLBP n(%)**	**LBP n(%)**
29 (55)	24 (45)	22 (67)	11(33)

The demographic data depicted in the table above shows that there was a smaller female to male ratio in both the NLBP (22:29) and LBP (11:24) groups. Results show that more male runners (45%) had LBP than their female counterparts (33%).

Table 4.2: Age distribution of NLBP vs. LBP

Age	Frequency distribution n(%)	NLBP n (%)	LBP n (%)
	n = 86	**n = 51**	**n = 35**
18 – 30 yrs	28 (33)	18 (64)	10 (36)
31 – 40 yrs	37 (43)	20 (54)	17 (46)
41 – 50 yrs	21 (24)	13 (62)	8 (38)

The above table depicts the age distribution of the NLBP and LBP groups. The majority of participants for both groups fell into the 31-40 years age category (n=37). No specific trends were noted throughout the age categories.

4.5 Hip rotation range of motion

Table 4.3 represents the mean values, standard deviations, confidence intervals and p-values for medial, lateral and total rotation for the two groups.

Table 4.3: Comparison of the two groups with respect to rotation parameters

Variable	Normal values (deg) (Magee et al 1987)	NLBP n = 51			LBP n = 35			p-Value
		Mean (deg)	SD (±)	95% CI	Mean (deg)	SD (±)	95% CI	
Med Rot R	**30 – 45**	52.7	8.4	50.4-55.1	52.2	9.4	49.0-55.4	0.6
Lat Rot R	**40 – 60**	29.8	8.6	27.4-32.2	28.0	8.9	24.9-31.1	0.6
Med + Lat Rot R	**70 – 105**	**82.5**	**9.5**	**79.9-85.2**	**80.2**	**7.7**	**77.6-82.8**	**0.3**
Med Rot L	**30 – 45**	48.5	9.1	45.9-51.1	48.8	6.9	46.4-51.1	0.9
Lat Rot L	**40 – 60**	30.4	8.4	28.1-32.8	29.5	8.0	26.8-32.3	0.9
Med + Lat Rot L	**70 – 105**	**78.9**	**9.3**	**76.3-81.6**	**78.3**	**9.1**	**75.2-81.5**	**1.0**

*****Normal values are those described for the general population*

The results show that the mean values for medial rotation ROM for both groups were greater than the normal range found by Magee et al (1987) and more greater on the right side. In contrast, the mean values for lateral rotation ROM for both groups were below the normal range. Although, neither medial nor lateral rotation ROM values fell into the normal range, there was no statistical difference between the two groups.

4.6 Hip rotation symmetry

Table 4.4a and 4.4b show the mean difference in rotation between right and left sides and between the NLBP and LBP groups.

Table 4.4a Mean difference in medial rotation between right and left sides relative to NLBP or LBP

Group	Mean difference	SD	95%CI	p-Value
NLBP n=51	4.2	7.0	2.2/6.2	0.6
LBP n=35	3.4	8.2	0.6/6.2	

The mean difference values for medial rotation were calculated by subtracting the medial rotation value obtained on the left from the medial rotation value on the right. This produced a positive value for both groups indicating a greater medial rotation on the right side as opposed to the left. The mean difference in the NLBP group (4.2) was greater than that of the LBP group (3.4) indicating potentially more asymmetry in medial rotation values in the NLBP group. It was found that symmetry for medial rotation had no statistically significant difference between the NLBP and LBP groups (p=0.6).

Table 4.4b Mean difference in lateral rotation between right and left sides relative to NLBP or LBP

Group	Mean difference	SD	95%CI	p-Value
NLBP n=51	(-)0.6	5.7	(-)2.2/1.0	0.5
LBP n=35	(-)1.5	7.8	(-)4.2/1.2	

The mean difference values for lateral rotation were calculated by subtracting the lateral rotation value found on the left from the lateral rotation value found on the right. These values were found to be negative for lateral rotation in both groups indicating a greater amount lateral rotation on the left as opposed to the right. The mean difference for lateral rotation in the LBP group (1.5) was greater than that for the NLBP group (0.6), indicating a potentially greater asymmetry in the LBP group. However, no statistically significant difference was found between hip lateral rotation asymmetry in the NLBP and LBP groups (p=0.5).

Due to the relatively large standard deviation detected for both groups for both medial and lateral rotation mean difference, non-parametric testing was performed via the Wilcoxon Rank Sum-Test. This additional testing confirmed that there was indeed no statistically significant difference between either medial rotation mean difference (p=0.7) or lateral rotation mean difference (p=0.9) in the NLBP and LBP groups. It was thus concluded that hip rotation symmetry was not associated to LBP in distance runners

4.7 Other factors

Other factors examined constituted runs per week (RPW), running surfaces and additional activities. Initially weight training and stair climbing were included under other factor examined but when evaluated, it became apparent that neither of the two activities had a bearing on the focus of this study and any related data was hence discarded.

4.7.1 Runs per week

Table 4.5 below depicts the stratification of RPW within the NLBP and LBP groups.

Table 4.5 Runs per week (RPW)

RPW	2	3	4	5	6	p-Value
NLBP n (%)	15 (29)	18 (35)	10 (20)	6 (12)	2 (4)	0.6
LBP n (%)	7 (20)	10 (29)	12 (34)	5 (14)	1 (3)	
Total n (%)	22 (26)	28 (32)	22 (26)	11 (13)	3 (3)	

The results show the largest number (34%) of participants in the LBP group reported running four times per week whereas most of the NLBP group (35%) ran three times per week. The amount of runs per week showed no statistically significant difference between NLBP and LBP groups (p=0.6). It was therefore concluded that the presence of LBP was not associated with the number of runs per week in distance runners.

4.7.2 Running surfaces

The runners were requested to indicate the surfaces they usually used for their running. These are illustrated in Table 4.6 below.

Table 4.6 Running surfaces

Running Surface	NLBP N n = 51		LBP n = 35		p-Value
	Yes n(%)	No n(%)	Yes n(%)	No n(%)	
Treadmill	18 (32)	33 (68)	13 (37)	22 (63)	0.9
Street	50 (98)	1 (2)	34 (97)	1 (3)	0.8
Side walk	15 (29)	36 (71)	10 (29)	25 (71)	0.9
Trail	12 (24)	39 (76)	6 (17)	29 (83)	0.5
Track	4 (8)	47 (92)	7 (20)	28 (80)	0.1

All participants, save for one in each of the NLBP and LBP groups, reported that they included street running in their training routines. The largest percentage difference, when comparing the running surfaces other than street, was noted for track. A larger percentage of LBP participants reported track training (20%) as opposed to the NLBP participants (8%). None of the running surfaces showed any significant difference between NLBP and LBP groups ($0.1<p<0.9$). There was thus no association between running surfaces and LBP in distance runners

4.7.3 Additional activities

Participants were requested to indicate whether or not they participated in certain additional activities. The results are depicted in table 4.7 below.

Table 4.7 Additional activities

Activity	NLBP N = 51		LBP N = 35		p-Value
	Yes n(%)	No n(%)	Yes n(%)	No n(%)	
Cycling	22 (43)	29 (57)	14 (40)	21 (60)	0.8
Swimming	12 (24)	39 (76)	10 (29)	25 (71)	0.6
Stretches	7 (14)	44 (86)	7 (20)	28 (80)	0.4
Other	5 (10)	46 (90)	4 (11)	31 (89)	0.8

Cycling was found to be the most common additional activity with similar proportions of participants participating in this activity from both groups (NLBP =.43%; LBP = 40%). Only a small percentage of participants (NLBP = 14%; LBP = 20%) reported stretching as an additional activity. None of the additional activities investigated showed any statistically significant difference with respect to the presence or absence of LBP ($0.4<p>0.8$). It was therefore found that there was no association between cross training and LBP in distance runners.

4.8 Conclusion

The results have shown that hip rotation ROM in healthy distance runners and distance runners with non-specific LBP was generally within the normal limits of hip rotation ROM. Therefore, if both groups were within normal limits of hip rotation ROM, the pain in the LBP participants is not associated with hip rotation ROM. There was also no statistically significant difference between the two groups. Furthermore, no association was found between hip rotation ROM and non-specific LBP in distance runners. None of the other factors examined were found to be associated with LBP.

CHAPTER 5

DISCUSSION

5.1 Introduction

This study set out to assess hip rotation ROM in healthy distance runners and distance runners with LBP. It furthermore set out to determine whether there is an association between limited hip rotation ROM and LBP in distance runners. The findings of the current study however suggest that there is no association between hip rotation ROM and LBP in distance runners. These findings will be discussed in the following paragraphs.

5.2 Prevalence of low back pain among distance runners

The point prevalence of LBP in the study population was 10.5%. The prevalence of LBP experienced amongst participants in the last 6 months was found to be 40.7%. No recent studies were found that reported on the point prevalence and six month prevalence of LBP amongst distance runners. Although lifetime prevalence was not assessed in this study, the six month prevalence was similar to the lifetime prevalence found in the literature. Boniolo et al (2003) found a lifetime prevalence of LBP to be 51.8% amongst male elite runners. Similarly, Gonzalez et al (2006) found the lifetime prevalence of LBP to be 58% amongst recreational runners.

In contrast to the above studies, Räty et al (1997) found that, compared to other sporting disciplines, long distance runners reported the lowest incidence of LBP (7%). It was not stated whether this prevalence was the point prevalence or lifetime prevalence of participants examined.

The differences found in prevalence rates found in this study and those found in other studies may be explained by the fact that the other studies (Boniolo et al 2003; Gonzalez et al 2006) studied lifetime prevalence and this study assessed six month prevalence. Räty et al (1997) did not specify what prevalence rate they studied but it is slightly lower than the point prevalence found in this study. Further reasons as to prevalence rate discrepancies may be...

5.3 Hip rotation range of motion

The results of this study showed that hip medial rotation ROM values obtained in the LBP population were greater than reported normal values. Hip lateral rotation values obtained in this study were less than reported normal values. The mean values for hip medial rotation ROM for the NLBP population and hip lateral rotation ROM for both the LBP and NLBP populations obtained in this study did not differ significantly.

Barbee Ellison et al (1990) stated that a difference of 18 degrees in rotation would signify a clinically relevant difference between healthy participants and participants with LBP. However, in this study, the differences between mean hip medial rotation ROM in the NLBP and LBP groups for right and left sides were 1.8 degrees and 0.9 degrees respectively. The differences between mean hip lateral rotation ROM in the NLBP and LBP groups for right and left sides were 0.5 degrees and -0.3 degrees respectively. Therefore, when comparing the NLBP and LBP groups the values obtained for both hip medial rotation ROM and hip lateral rotation ROM showed no significant difference and was therefore not clinically significant.

As revealed in the literature review, there are conflicting reports of normal values. In 1987, Magee et al reported hip medial rotation ROM to be between 30 – 40 degrees and hip lateral rotation ROM to be between 40 – 60 degrees. Some earlier studies report similar values (Corrigan and Maitland 1983; Kapandji 1974). Where the above sources show Medial rotation to be less than lateral rotation, other sources show medial rotation (35-45 degrees) and lateral rotation (45 degrees) to be closer in value (Kendall and McCreary 1983; Hoppenfeld 1976). However, the original sources of the values and the instruments used for measurement were not mentioned in any of these studies.

As stated previously, in 1998 Bierma-Zienstra et al compared two devices for measuring hip joint motions and found a definite discrepancy between the use of a goniometer and the use of an inclinometer when measuring hip rotation ROM. There was also a poor correlation with hip rotation ROM measurements when measured in prone versus sitting. Barbee Ellison et al measured all their subjects with both an inclinometer and a goniometer in both the sitting and prone positions. No significant difference was found between the two measurement positions or between the use of a goniometer or inclinometer. Opinions on whether there is a difference between goniometric and inclinometric measurements are thus conflicting. The results found in this study were therefore compared with caution to those commonly used for reference in physiotherapy reference texts as methodology (measurement tool and measurement position) to determine these values is not readily stated.

Within this study, when comparing values found for hip medial rotation ROM and hip lateral rotation ROM, it is noted that hip medial rotation ROM in both participant groups was significantly more than hip lateral rotation ROM. These findings are in agreement with those of Hollman et al (2003). Hollman et al (2003) found hip lateral rotation ROM to be limited when compared to hip medial rotation ROM in distance runners. This was explained to occur as an adaptation in runners based on the findings of Novacheck (1998). Novacheck (1998) found that the hip medial rotation to occur during the absorption period of the stance phase during running. Maximal hip medial rotation is reached at midswing after which, the hip returns to neutral rotation at the end of the swing phase. Therefore, according to Hollman et al (2003), it would seem that hip lateral rotation ROM beyond neutral is not necessary during the running cycle. Hollman et al (2003) hence found it feasible for hip lateral rotation ROM in runners to be reduced as a result. If hip rotation ROM beyond neutral is not necessary during running, it may be arguable that reduced hip rotation ROM may be advantageous in distance runners (Craib et al 1996; Gleim et al 1990). According to Craib et al (1996), musculoskeletal inflexibility in the hip region may increase the recoil of elastic energy and in so-doing, decrease the need for stabilising muscle activity.

The results of this study support the findings of the above studies i.e. hip lateral rotation ROM in distance runners is limited.

5.4 Association between low back pain and hip rotation range of motion

The hip medial rotation ROM values obtained for both study groups were comparable to each other. Similarly, hip lateral rotation ROM values obtained for both study groups did not differ significantly between right and left sides respectively. This indicates that there is no significant difference with regards to hip rotation ROM between the two study groups.

An association between LBP and hip rotation ROM would be expected because lumbar spine, pelvis and hips are biomechanically associated to form a lumbo-pelvic complex and a kinetic chain. This means that movement at one joint affects movement at another joint of the same chain, as explained by Levangie and Norkin (2001). Various authors have reported an association between injury and disturbances in the normal kinetic pattern of the lumbo-pelvic-hip complex during running (Schache et al 1999). However, investigations specific to the effects of altered hip rotation ROM on the kinematics of the lumbo-pelvic-hip complex during running are limited. Running is associated with a high load as runners are continuously exposed to large external forces such as the ground reaction force (Zifchock et al 2008). Although a high load may be linked to a higher risk of injury, normal loading coupled with abnormal kinetic patterns may also be associated with a higher injury risk (Zifchock et al 2008).

Lee and Wong (2002) assessed the relationship between the movements of the lumbar spine and hip. With rotational or twisting movements of the lumbar spine, it was found that the hips were the predominant sources of movement. This implies that if the rotational component at the hips is altered, the rotation at the lumbar spine will be affected. Lee and Wong (2002) concluded that altered movement patterns of the lumbo-pelvic-hip complex may possibly be a contributing factor to the development of LBP. It was furthermore stated that altered movement patterns of the lumbo-pelvic-hip complex may even be a result of LBP to avoid pain or to avoid further damage to possibly injured tissues in the lower back. According to Sahrmann (2002), external forces may be successively distributed from a distal body segment to a more proximal segment during movement. When relating this concept to the lumbo-pelvic-hip complex, it can be seen that external forces experienced at the hip may be distributed proximally to the lumbar spine. Hip movement may hence influence movement and loading at the lumbar spine. Altered hip rotation ROM, when performed in a repetitive fashion as with running, may lead to the lumbar spine being placed under excess load of which the end result may be LBP (Sahrmann 2002).

The findings of this study suggest that there is no significant difference with regards to hip rotation ROM, between runners with LBP and runners without LBP. One possible reason for this may be that runners with reduced hip rotation ROM have been shown to have a better running economy than those with greater hip rotation ROM (Craib et al 1996). Gleim et al (1990) postulated a reason for this association between limited hip flexibility and running economy. If the hip joint is less flexible in the transverse plane, with foot strike, the pelvis may be more stable resulting in a reduced requirement for muscle stabilizing activity. If this is true, by creating a more stable pelvis, limited hip rotation may be beneficial in runners with LBP.

From the above discussion, one can see that there is a definite biomechanical association between the lumbar spine and the hip. This may motivate for research in greater depth into the causative links which may exist between hip ROM and LBP.

5.6 Association between low back pain and other factors specific to running

This study found there to be no association between LBP and other factors specific to LBP. Although fairly dated, one study conducted by Jacobs and Berson (1986), found that the factors affecting injured runners were significantly different to the same factors affecting non-injured runners. It was found that injured runners were more likely to have run more miles per week, run more days per week, run at a faster pace, run more races in the last year, stretched before running and not participated regularly in other sports. A possible reason for the discrepancy in findings of this study and that of Jacobs and Berson (1986) may be that, as the main focus of this study was the association between hip rotation ROM and LBP, the other factors were not explored fully.

Although the study showed some relationship between these factors, these factors were not statistically significant and therefore cannot be attributed to association with LBP.

5.6 Clinical implications for physiotherapists

Currently, evaluation of hip rotation ROM in runners complaining of LBP is not routine. The results of this study suggest that, when measured in the prone position, runners may have decreased passive hip medial rotation. This may be due to shortened hip lateral rotators. Although it is not clear whether this limited ROM is disadvantageous or beneficial, running economy may be influenced by even slight ROM limitations (Craib et al 1996). Hip rotation ROM limitations should thus be considered in the clinical setting. Furthermore, if limited or altered hip rotation ROM is detected, one may be able to predict biomechanical compensatory patterns in the closed kinetic chain formed between the fixed foot and the functionally fixed head during running.

5.7 Limitations of the study

- No objective measure was used to evaluate LBP in the participants who participated in this study.

- The depth of the questionnaire was not significant to identify the factors that predict LBP in distance runners.
- Relevant aspects of LBP which may affect hip mobility measures, namely history and symptomatology of LBP were not taken into consideration.
- Each measurement was taken a total of three times and the average of the three measurements was used however, reflex muscle relaxation of the hip rotators may have played a role in varied values between measurements of the same movement.
- Only passive hip rotation ROM was measured as opposed to active hip rotation ROM. Active hip rotation ROM measurements were excluded as active contraction of the hip rotators may have influenced LBP in participants where it was present.

5.8 Conclusion

No statistically significant difference was found with regards to hip rotation ROM between the two participant groups. There was also no statistically significant difference found with regards to other factors specific to distance running between the two groups. There was therefore no association between hip rotation ROM in the distance runners that participated in this study. Further research into factors specific to distance running and their association to LBP is needed.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The aim of this study was to determine whether there is an association between limited hip rotation ROM and LBP in distance runners as well as to determine normative hip rotation values for distance runners

- The point prevalence of LBP within the population was found to be 10.5%.
- No statistically significant association was found between limited hip rotation ROM and LBP in distance runners
- No statistically significant association was found between hip rotation asymmetry and LBP in distance runners
- It was ascertained that the runners in this study had values for medial hip rotation slightly less than values previously reported to be normal

6.2 Recommendations

6.2.1 Clinical Recommendations

Clinical recommendations arising from this study are:

- Strength of the hip rotator muscles was not considered in this study. One may therefore consider focusing on assessing strength of hip rotators in runners with LBP in place of assessing ROM limitations.
- Limited hip rotation may improve running economy and hence one should be cautious not to over-stretch the hip rotator muscles

- A full biomechanical evaluation of running gait in the injured runner is essential when LBP is present and limited hip rotation is suspected

6.2.2 Recommendations for further research

Recommendations for future studies are:

- Assess active hip rotation in distance runners with and without LBP as the running gait involves active hip rotation as opposed to passive hip rotation
- Assess effects of hip rotation ROM on running economy
- Assess effects of training on different running surfaces on hip rotation ROM and LBP in more detail
- Assess the position of measuring hip rotation ROM (i.e. prone versus sitting) in relation to lumbo-pelvic biomechanics

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APPENDIX A

COMPREHENSIVE FUNCTIONAL EVALUATION 625

RUNNER'S EVALUATION FORM

Training History

Level of Competition:
- ☐ Recreational only
- ☐ Recreational competitive
- ☐ Competitive (HS/college)
- ☐ Elite

Running Surface:
- ☐ Treadmill
- ☐ Street (asphalt)
- ☐ Sidewalk (concrete)
- ☐ Trail
- ☐ Track

Cross-Training:
- ☐ Biking
- ☐ Swimming
- ☐ Weights
- ☐ Stairs
- ☐ Yoga/Stretching
- ☐ Other:

Years of running: ________
Running Club: ________
Pace/mile: ________
Mileage/week: ________
Long run: ________
Runs/week: ________
Shoe type: ________
Miles on shoe: ________

Shoe Insert or Orthotics: ☐ Yes ☐ No
Are you in training?: ☐ Yes ☐ No *Race and Date:* ________

Recent change in your training?
- ☐ Increased mileage
- ☐ New shoes or inserts
- ☐ Speed work or track work
- ☐ Hill training
- ☐ Change in terrain

When you run, when do symptoms occur?
- ☐ Every step of the run
- ☐ Worse toward the end of the run
- ☐ Worse at start & then improves
- ☐ Only after the run ends (next day)

Medical History

Date and Description of Injury: ________
Previous Treatments for Injury: ________
Past Medical & Surgical History: ________
Medications: ________
Allergies: ________
Prior Musculoskeletal Injuries: ________

History of stress fractures: ☐ Yes ☐ No
- steroid use: ☐ Yes ☐ No
- osteoporosis: ☐ Yes ☐ No
- eating disorders: ☐ Yes ☐ No

Female History: ☐ N/A
- reg. periods: ☐ Yes ☐ No
- pregnant: ☐ Yes ☐ No
- age of 1st period: ________
- date of last period: ________

Fig. 1. Runner's evaluation intake sheet.

APPENDIX B

RUNNER'S EVALUATION FORM

Participant number: ___________ *Age:* ___

Gender: □M □F *Dominant Side:* □Left □Right

Medical History:

1. *Are you currently pregnant?*

   □Yes □No

2. *Have you had any previous severe trauma to the lumbar spine, pelvis or hip?*

   □Yes □No

3. *Have you had any previous hip or spinal surgery?*

   □Yes □No

4. *Do you have any hip pain at this moment?*

   □Yes □No

5. *Have you been diagnosed by a physician with any of the following conditions?*

□Cancer □Rheumatoid arthritis

□Recent serious infection □Osteoporosis

Training History

6. Years of running: _______ *7. Runs/week:* _______ *8. Mileage/week:* _______

9. Running Surface: *10. Cross-training:*

□Treadmill

□Street (tarmac)

□Sidewalk (concrete)

□Trail

□Track

□Biking

□Swimming

□Weights

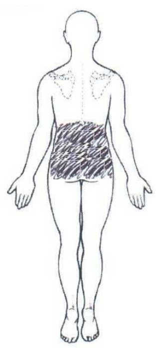
□Stairs

□Yoga/Stretches

□Other

11. Have you experienced any pain in the shaded area (Low back pain) within the last 6 months?

□Yes □No



12. Is this low back pain ever present whilst running?

□Yes

□No

13. Is this low back pain present at this moment?

□Yes

□No

14. If yes, mark on this line the intensity of your pain that you are experiencing at this moment:

No pain I____I Worst possible pain

APPENDIX C

PERMISSION FOR RESEARCH

DATE: **05/05/2009**

NAME OF RESEARCH WORKER: **Tracy Taljaard**

TITLE OF RESEARCH PROJECT: **The association between hip rotation range of motion and non-specific low back pain in distance runners from a running club in central Gauteng**

OBJECTIVES OF STUDY:

- **To evaluate hip rotation ROM in healthy distance runners and distance runners with non-specific LBP; and**
- **To compare hip rotation ROM patterns in healthy runners and runners with non-specific LBP**

METHODOLOGY:
Research procedure will require of subjects:

- **To read though and sign an informed consent form for participation;**
- **To fill in a short questionnaire on their training and symptoms of low back pain should it be present;**
- **To perform six lumbar movements before evaluation; and**
- **To lie prone on a treatment plinth whilst the researcher and research assistant measure hip rotation range of motion a total of three times each for both medial and lateral rotation on each leg**

CONFIDENTIALITY OF SUBJECTS MAINTAINED: **Each subject will be assigned a number which will serve to conceal their identity for the duration of the study**

PERMISSION FROM OF RUNNING CLUB CHAIRPERSON:

Robin E Kha

Signature: [signature] Date: 5/5/2009

Signature of Researcher: [signature] Taljaard Date: 5/05/2009

APPENDIX D

INFORMATION DOCUMENT

Study Title: The association between hip rotation range of motion and non-specific low back pain in distance runners from a running club in Central Gauteng

Good day.

I, Tracy Taljaard, am doing research on hip rotation range of motion in distance runners as partial fulfilment of the requirements for the completion of the degree MSc Physiotherapy at WITS University. In this study, I aim to determine whether there is an association between limited hip rotation range of motion and low back pain in distance runners.

Low back pain is a common problem in modern society and the prevalence amongst the running population is estimated to be 10-13%. From the data collected in this study, we hope to learn more about low back pain in distance runners in order to better diagnose and treat the cause of the problem.

I would like to invite you to participate in this study which will only require from you; two minutes to complete a short questionnaire, two minutes to observe the movements at your lumbar spine and four minutes to measure your hip range of motion (approximately 8 minutes in total). The questionnaire encompasses information regarding your general health, training programme, the presence or absence of low back pain and information surrounding low back pain symptoms should they be present. You will also be required to perform 6 lumbar movements to assess your spinal movement before measurement commences. The study furthermore entails a once-off measurement procedure where the researcher and one research assistant will measure your hip rotation range of motion on each leg, a total of three times each. The measurements will be taken with a measurement tool called an inclinometer and we anticipate that the movements performed at the hip may result in mild discomfort but should not provoke pain in any way. Should you suffer from low back pain, the movements performed at the lumbar spine may slightly provoke pain temporarily.

The population being studied are runners who are members of the Sunninghill Striders Running Club.

The study procedures involve no foreseeable risks apart from possible discomfort or temporary pain provocation. Although you will not benefit directly from participation in this study, the data collected will provide information regarding proper diagnosis, treatment and management of low back pain in runners.

Your participation in this study is entirely voluntary. You are under no obligation to participate and should you agree to partake, you have the right to withdraw at any time. Each participant will have access to their own results.

All possible efforts will be made to keep personal information confidential, and your identity will not be disclosed in any published or written material resulting from this study.

Should you have any questions, complaints or concerns about this research study, the procedures involved, risks or benefits, please do not hesitate to contact the researcher, Tracy Taljaard on 082 699 5472.

APPENDIX E

CONSENT FORM

I ____ hereby declare that I have read the participation leaflet and I understand all its contents. I agree to all the terms and give voluntary consent to participate in this study.

___________________________ ____________________

Participant Date

I have explained the study to the above participant and have sought his/her understanding for informed consent.

____________________________ ____________________

Researcher Date

____________________________ ____________________

Witness Date

APPENDIX F

MEASUREMENT RECORDING FORM: HIP ROTATION

Participant number: ___________

Range

(R) Lateral rotation

1st Reading	
2nd Reading	
3rd Reading	

(R) Medial rotation

1st Reading	
2nd Reading	
3rd Reading	

(L) Lateral rotation

1st Reading	
2nd Reading	
3rd Reading	

(L) Medial rotation

1st Reading	
2nd Reading	
3rd Reading	

APPENDIX G

RUNNER'S EVALUATION FORM

Participant number: ___________

Age: ___

Gender: □Male □Female

Dominant Side: □Left □Right

Medical History:

Are you currently pregnant?

□Yes □No

Have you had any previous server trauma to the lumbar spine, pelvis or hip?

□Yes □No

Have you had any previous hip or spinal surgery?

□Yes □No

Do you have any hip pain at this moment?

□Yes □No

Have you been diagnosed by a physician with any of the following conditions?

□Cancer

□Rheumatoid arthritis

□Serious infection

□Ankylosing spondylitis

□Osteoporosis

Training History

Level of Competition:	*Running Surface:*	*Cross-training:*
□Recreational only	□Treadmill	□Biking
□Recreational competitive	□Street (tarmac)	□Swimming
□Competitive	□Sidewalk (concrete)	□Weights
	□Trail	□Stairs
	□Track	□Yoga/Stretches
		□Other

Years of running: ______________________

Pace/Km: ______________________

Mileage/week: ______________________

Usual long run: ______________________

Runs/week: ______________________

Shoe type: ______________________

Miles on shoes: ______________________

Recent change in your training?

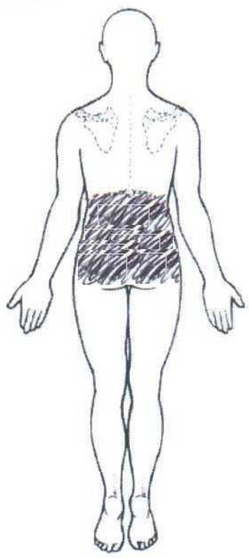
□Increased mileage □New shoes or inserts

□Speed work or track work □Hill training

□Change in terrain □Other ________________

Have you experienced any pain in the shaded area within the last 6 months?

□Yes □No



Is this pain ever present whilst running?

□Yes

□No

If yes, when you run, when do your symptoms occur?

□Every step of the run

□Worse toward the end of the run

□Worse at the start and then improves

□Only after the run ends (next day)

□Other ___________________________

Mark on this line the intensity of *your pain* that you are experiencing *at this moment*:

No pain I____I Worst

possible pain

APPENDIX H

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ms Tracy Taljaard

CLEARANCE CERTIFICATE	**M090535**
PROJECT	The Assocation between Hip Roation Range of Motion and Non-specific Low Back Pain in Long Distance Runner from a Club in Central Johannesburg
INVESTIGATORS	Ms Tracy Taljaard.
DEPARTMENT	Department of Phsyiotherapy
DATE CONSIDERED	09.05.29
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 09.05.29 **CHAIRPERSON** ....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr N Mambo

DECLARATION OF INVESTIGATOR(S)

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

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...