

**THE SEASONAL AND LIFETIME INCIDENCE OF
LOW BACK PAIN IN SOUTH AFRICAN MALE
FIRST LEAGUE SQUASH PLAYERS**

Thesis submitted for the degree of Master of Science (Med) Exercise Science

by

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DEDICATION

To my dearest Heather; thank you for your love, support, encouragement
and all you gave up in order that I might achieve my goal.

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DECLARATION

I, *Stephen Barry Burden*, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other University.

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ABSTRACT

Previous studies have been conducted to determine the incidence of low back pain (LBP) in both the general population as well as in participants of different sporting activities. The purpose of this study was to determine the seasonal and lifetime incidence of LBP in male first league squash players.

Eighty two open first league players aged 18 - 44 year (yr) and 69 veteran first league players aged 45 - 63 yr from the Western Cape Squash Racquets Association first league, completed a questionnaire. Of these players, 44% reported that they experienced LBP during the squash playing season. During the player's lifetime the incidence of LBP while playing squash at first league level rose to 56%. However, no significant difference was found in the seasonal or lifetime incidence of LBP between the open players and the veteran players. This finding is surprising as the veteran players had played squash at first league level for nearly twice as long as the open players (23.5 ± 7.7 yr versus 12.5 ± 5.0 yr; $P < 0.05$). On the other hand, the open players played squash for a significantly longer period each week than the veteran players (5.5 ± 4.4 hrs/wk versus 3.2 ± 1.3 hrs/wk; $P < 0.05$). It has to be assumed that the combined effect of years and hours per week playing squash at this level lead to the high incidence of LBP found in this study.

Eighty five players reported LBP during their lifetime while playing squash. Of these 85 players, 70 (82%) were prevented from playing squash at some stage in their career because of their LBP. Fifty seven percent of these players took between one and seven weeks and 19% took longer than seven weeks to recover and return to play. In this study, 36% of the open players returned to playing squash within one

week. This is significantly quicker than the veteran players, where only 12% of players with LBP were able to play squash again within one week ($P < 0.05$). Only 35 (23%) players surveyed reported that they had never experienced LBP.

To establish whether any physiological or anthropometrical factors were associated with the incidence of LBP in these squash players, a second study was undertaken. Only players who played squash more than three times per week were then assigned to LBP and no LBP (controls) sub-groups. Thirty one players completed a second questionnaire which covered aspects of their participation in squash, training, playing and injury history. Each player also underwent anthropometric measurements and physiological tests to determine repeated and maximal range of movement of the spine, hamstring and iliopsoas flexibility, leg length and lean thigh volume, abdominal and back muscular endurance.

The movements that elicited the highest incidence of pain responses in all the players with LBP were maximal hyperextension and both repeated and maximal lateral flexion, to the left and right. Maximal as well as repeated lateral flexion movements, with pain, to the right side were significantly more in the open players with LBP, compared to the veteran players with LBP. Increased trunk rotation was also found to be significantly different on both the right and left sides in both the open and veteran LBP groups, compared to the controls ($P < 0.05$). Further, the veteran players were found to have reduced flexibility with respect to forward and lateral flexion as well as during the sit and reach and trunk extension tests compared to the open players. Even though there is a loss of flexibility with age, there was no increase in the incidence of LBP. Similarly, there was no significant difference in the flexibility scores between those players with LBP and those without LBP (controls), in either age group. Therefore, it is possible that these movements are not

the cause of LBP in these players. In this study no difference was found in straight leg raise tests and tests for hamstring flexibility across the players, with or without LBP. These results indicate that any pain was probably not discogenic in origin but rather mechanical in nature.

In conclusion, the results of this thesis show that there is a high incidence of LBP in male squash players at first league level. Those players who exhibit a higher degree of trunk rotation are more at risk for developing LBP, while playing squash. It is recommended that these players as well as those with LBP, undergo a strengthening programme and assess their playing technique (using video replays) with regard to excessive trunk rotational movements.

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CHAPTER 1

REVIEW OF LITERATURE AND AIMS OF THIS THESIS

1. Historical Background

Low back pain (LBP) can be likened to a *"wilderness across whose inhospitable terrain orthopaedic surgeons, neurosurgeons, physiotherapists and, above all, general practitioners are doomed to travel"* (Kay, 1988).

A universal conclusion from authorities on LBP is that evolution seems to have played the major role in the development of man's susceptibility to this condition. Indeed it was probably when the primates stood up and used their hind legs for ambulation that low back problems started to arise (McLaughlin, 1982). Man's musculoskeletal system has had to adapt to overcome these evolutionary structural weaknesses. It is obvious from research undertaken to date, with the majority of all LBP being of a primary musculoskeletal origin, that man has failed to adapt or has overloaded this system to a point of failure. The common denominator is that the pain or injury often occurs from areas subjected to the heaviest mechanical stress, often combined with weakness in muscle-groups underused through modern sedentary lifestyles (Nachemson, 1976).

There are many other causes of LBP, which may be of a nonmusculoskeletal nature and present with the same signs and symptoms. Segments of the spine may be affected by vascular problems, inflammatory, infectious, neoplastic or traumatic diseases. Examples of these are an aortic aneurysm, intra-abdominal malignancy, perforated viscus, pyelonephritis and nephrolithiasis. Nevertheless, only 2% to 5% of all cases of LBP are of a systemic nature (Kelsey, 1980).

It is also essential in determining the aetiology of any individual's LBP that they do not present with a progressive neurological deficit. A documented loss of neurological function is a sign of ongoing damage to the neurological system which may present as a true orthopaedic and/or neurological emergency (Whitehill, 1982).

In an attempt to define the cause of LBP and to provide an effective solution, an individual(s) sets out with new apparatus, a new method or a new drug regime but often have little or no success. Consequently, it is difficult to identify precisely the origin of the pain, because even if it's characteristics may point to a given structure, the pain often remains unspecific. This often leads to a lack of uniformity in the diagnostic terminology of spinal disorders.

2 Definition of low back pain (LBP)

Low back pain has been defined as pain affecting the area between the lower rib cage and the gluteal folds (Frymoyer, 1988; Anderson, 1977).

LBP has been subdivided into three classes (Burton et al., 1989):

- (i) "transient low back pain" - occasional twinges
- (ii) "acute low back pain" - episodes of pain of relatively short duration, of varying severity and frequency.
- (iii) "chronic low back pain" - longer term disability.

Frymoyer (1988) defines acute LBP where the symptoms last for 0-6 weeks.

The majority of acute LBP is usually a self-limiting process that resolves

within 2-3 weeks. It has been reported that 60% of patients presenting with acute LBP return to work within one week (Nachemson, 1985; Roland and Morris, 1983), while 80-90% of episodes of acute LBP recover in about 6 weeks, irrespective of the administration or type of treatment (Waddell, 1987). Due to a continual increase in physiotherapy treatments for conditions affecting the spinal column, the anatomic site for approximately 20% of all work injuries in Quebec, Canada, the Workers' Health and Safety Commission requested an investigation. The Quebec Task Force on Spinal Disorders (QTFSD) was formed in 1983.

2.1 The Quebec Task Force on Spinal Disorders

The QTFSD was mandated to address the burden on workers, employees, employers and society imposed upon by disorders of the spinal column. Using The Quebec Worker' Compensation Board data base they determined the frequency of work-related spinal disorders. The distribution of compensated spinal disorders by anatomic site of symptoms showed the lumbar region to be the most common, accounting for 70% of the claims.

The duration of absence from work was less than a month for 74.2% of the workers. Only 9.4% were absent for two months and 4.3% remained absent for longer than a year. The QTFSD proposed a classification based on history, clinical and paraclinical examinations and the response to treatment. They defined LBP as being acute where absence from work was for fewer than one week; sub-acute being seven days to seven weeks and chronic being more than seven weeks duration.

Symptoms that persist for longer than seven weeks, represent a more established and chronic process which needs careful diagnosis and

management. Five to ten percent of all individuals suffering a LBP episode are reported to become chronic patients (Frymoyer, 1988; Polatin et al., 1989). Chronic LBP has been defined as recurrent episodes of pain for a period longer than 3 months (Frymoyer, 1988).

3 Pain sensitive structures and function of the lower back

The low back region is extremely complex both anatomically and functionally (Mangi et al., 1979). The lumbar spine normally consists of five vertebrae, numbered L₁-L₅, each divided into anterior and posterior components. The anterior component is the body, which is designed to bear mainly compressive loads, while the pedicles and laminae form the posterior component or neural arch. This is where a small triangular canal, found between the vertebral body, pedicles and lamina, houses the cauda equina and terminal elements of the spinal cord. The posterior component, which guides movement, consists of seven processes, namely the spinous process, two transverse processes, two superior and two inferior articular processes. These articular processes link the adjacent vertebrae by the "pars interarticularis". The areas of the articular processes where the vertebrae articulate are called the facets. Each facet is covered by a hyaline cartilage, surrounded by a capsule lined with synovial tissue and is richly innervated. Studies have shown that the facet joints transmit 20% of the total compressive load (Stanish, 1987). These joints are spatially oriented to prevent excessive rotation and lateral bending. They facilitate flexion, but their position limits extension. The spinous and transverse processes serve as sites of attachments for muscles and ligaments.

Below the lumbar spine are the five fused sacral bodies that form the sacrum and the coccyx. In about five percent of the population, L₅ is partially or

completely incorporated into the sacrum, called sacralization of L₅ (Remer and Neuwirth, 1995).

The range of motion of the lumbar spine, for flexion-extension, is greatest at the L₄-L₅ and L₅-S₁ level, while for rotation is greatest in the lumbosacral segment of L₅-S₁. These motion segments are viscoelastic materials that exhibit *coupled* motion *i.e.* motion in one segment affects motion in other directions. Motion segments have fatigue tolerance, they absorb energy and undergo *creep i.e.* a continued deformation of the viscoelastic material with time under a constant load (Remer and Neuwirth, 1995).

During physical activity and training, various demands are put on the human body. A significant demand is placed on the spine. The spine is required to support the body as well as act as a shock absorber throughout the activity. All structures in the lumbar region theoretically could cause pain (Nachemson, 1985). The exact offending structure, however, remains obscure, but the main interest has centred around the intervertebral disc.

3.1 Intervertebral discs

The intervertebral disc is the largest avascular structure in the human body and is essentially a hydraulic "shock absorber" between the vertebral bodies (Nachemson, 1985). It is composed of fibrocartilage with concentric layers of fibrous tissue forming the annulus fibrosus which surround the central, semifluid mass, the nucleus pulposus. The nucleus pulposus lies directly in the centre of all discs except those in the lumbar segments, where it has a slightly posterior position. The integrity of the nucleus pulposus depends mainly on passive diffusion pathways through both the end-plates and the

annulus fibrosis in order to maintain the proper balance of water, solutes, glycosaminoglycans, protein and collagen. Some solutes enter through the end-plates while others pass through the annulus. Several studies have been conducted and found to influence nutrition and metabolism in the disc (Nachemson et al., 1970, Maroudas et al., 1975). Half an hour of moderate exercise per day gave a 10% increase in the flow of nutrients into the disc when compared to sitting (Holm and Nachemson, 1983). Smoking and vibration are two parameters which have a negative influence on the disc (Holm and Nachemson, 1988). After the age of 20 years, the fluid within the nucleus becomes more jelly-like until it is eventually replaced by fibrous tissue. This change causes the loss of hydraulic properties and thus an impaired ability to transmit pressure evenly across the disc space. The area most deficient of nutrition is the boundary zone between the nucleus and the annulus. This is also where fissuring starts to occur as the earliest sign of disc degeneration.

Each vertebral body is joined above and below through the intervertebral disc, with surrounding longitudinal ligaments and facet joints. Thus, the mechanical integrity of the intervertebral disc influences all these structures. Therefore, when the disc degenerates, there are increased facet loads; resulting in an altered distribution of compressive stress in the end-plates, the subchondral bone of the vertebrae and possible encroachment of the nerve-root canal. Consequently there is an increased demand for the intersegmental muscles to stabilise the vertebral bodies.

When the disc is subject to a combination of forces it may be the site of numerous injuries (Nachemson, 1976). Sudden stress to the disc, particularly

forward flexion and lateral rotation, may result in a tear of the annulus fibrosus with the nucleus pulposus prolapsing posteriorly, compressing the nerve roots and causing intense pain (Norris, 1995). Kelsey et al., (1984) studied individuals performing repetitive forward bending and rotational tasks. Those performing the tasks were found to be six times more at risk for a prolapsed disc than those who did not. The disc between the fifth lumbar vertebrae (L_5) and the sacrum (S_1) is the articulation on which the mobile lumbar spine and the fixed, rigid sacrum moves and this is a frequent site of injury (Booher and Thibodeau, 1985).

3.2 Facet joints

Articular surfaces of facet joints, which are richly innervated, can play an integral role in LBP. The articular surfaces are oriented primarily in a vertical plane and from L_1/L_2 to L_5/S_1 they gradually change from a sagittal to a frontal plane orientation. This orientation of the lumbar facets permits motion, mostly in the sagittal plane, with limited motion in the frontal and transverse planes. Functionally, this prevents excessive rotation and lateral bending in the lumbar spine while facilitating flexion and checking extension. Movements of flexion and slight rotation that cause the facet joints at L_4/L_5 and L_5/S_1 to shift from their usual congruent relationship may result in a reflex spasm and "locking" of the facets. The highest facet contact pressures occur with combined motions of torsion, flexion and compression (Deusinger, 1989). When excess rotation occurs, abnormal torque is placed on the facets and soft tissues, often resulting in injury (Stanish, 1987).

3.3 Pars interarticularis

Another mechanical factor of clinical importance is segmental instability. Spinal motion is multisegmental and hypomobility of one segment is often compensated for by hypermobility of an adjacent segment (Snyder-Mackler, 1989, Herring and Weinstein, 1995). The area of the lumbar vertebrae between the superior and inferior articular processes is termed the pars interarticularis. Spondylolysis (fracture) and spondylolisthesis (forward slippage of one segment upon another) are associated with a defect in the pars interarticularis which leads to instability of that segment of the lumbar spine. This instability may be exacerbated by athletic activities that exaggerate lumbosacral stress (Deusinger, 1989). The results of research which has examined the role of exercise to provide stability for the lower back suggest that the trunk musculature plays a primary role in countering forces and torque to the intervertebral joints (Ladin et al., 1989).

3.4 Skeletal muscle spasm

The muscles adjacent to the vertebrae run mainly in a longitudinal direction, and are composed of the erector spinae, semi-spinalis, multifidus and quadratus lumborum. These are the muscles which are most often in spasm and tender in individuals with disorders of the lumbar spine (McLaughlin, 1982). Muscle ischaemia is recognised as a potent source of pain, but this is usually a secondary phenomenon to an underlying condition in patients with LBP. Similarly, acute tears of the vertebral muscles are rare, and have yet to be reported as being a significant cause of pain in LBP (Kay, 1988).

3.5 Spinal ligaments

The anterior and posterior longitudinal ligaments serve as reinforcement for the vertebral column and allow adequate physiological range of movement.

The anterior longitudinal ligament is well developed in the lumbar region, eliminates excessive extension and tends to resist increases in lumbar lordosis.

The posterior longitudinal ligament is only 50 percent as strong as the anterior and limits flexion of the vertebral column. This ligament also supports the intervertebral disc. The ligamentum flavum, also positioned posteriorly, serves to prevent hyperflexion (Stanish, 1987).

3.6 Innervation and reflex pathways

The vertebral column is supplied by two sets of nerves, namely the sensory branches from the dorsal primary rami and the sinu vertebral nerves. The dorsal primary rami innervate the articular capsule, the ligamentum flavum and the interspinous ligaments. The sinu vertebral nerves innervate the vertebral body, the adjacent intervertebral discs, the posterior longitudinal ligament, the internal vertebral plexus, the epidural tissue and the dura mater.

The origin of the motor nerves to the major muscles in the lower extremity is as follows:

- (i) flexors of the hip are innervated by L₂, L₃ and the extensors by L₄ and L₅.
- (ii) extensors of the knee by L₃, L₄ and the flexors by L₅, S₁.
- (iii) dorsiflexors of the ankle by L₄, L₅ and the plantar flexors by S₁, S₂.
- (iv) invertors of the foot by L₄ and evertors by L₅, S₁.

A neurological examination of a patient with LBP should be included to assess if there is weakness of the major muscle groups of the lower extremity and to check for any sensory loss and reflex defects.

In summary, to ensure the diagnosis and treatment regimen for each individual presenting with LBP is accurate, an assessment should include a full history of the nature of the injury and a physical examination of the systemic, functional musculoskeletal and neurological components.

4 Risk Factors associated with Low Back Pain

The vast majority of LBP patients suffer from conditions for which there is no specific diagnosis; the underlying cause of the symptoms are generally unknown, the aetiology is multifactorial, and the natural history has not been determined (Burton et al., 1989). However, a number of studies have been conducted to try and determine the risk factor(s) that predict susceptibility to developing LBP (Polatin et al., 1989; Burton et al., 1989; Frymoyer et al., 1980; Roland and Morris, 1983; Mayer et al., 1984).

Individual risk factors that have been the object of scientific inquiry in LBP include body composition (body fat and lean muscle mass) and anthropometric variables such as height weight, and body build; posture and biomechanics; physical fitness including cardiovascular endurance, muscular strength and/or endurance, flexibility or joint mobility, and sports participation or physical performance (Plowman, 1992); pregnancy, psychosocial factors including family problems, substance abuse, intellectual achievement, emotional stability; occupational characteristics and tobacco consumption (Frymoyer, 1983; Liemohn et al., 1988).

In almost all cases, it is possible to find evidence supporting and refuting an association of these selected risk factors with the incidence of LBP. However, the physical fitness components have been deemed so important that LBP has been classified as a "hypokinetic" disease (Plowman, 1992).

4.1 Physical activity and Low Back Pain

Theoretically, exercise that increases the rate of cardiac output has been shown to increase the flow of nutrients into and waste products out of the disc (Holm and Nachemson, 1983). This has been hypothesised to slow disc degeneration (Stith, 1990). Within the limitations of genetic endowment and training thresholds, an increased participation in physical activity and the attainment of physical fitness is assumed to be positive and would directly benefit the individual with LBP. However, they are not the same thing. Some studies have reported that individuals with a high maximal oxygen uptake ($\dot{V}O_{2\max}$), better flexibility and strength scores for the muscles affecting the spine, are less prone to back problems than individuals with significantly lower values (Biering-Sorenson, 1983; Cady et al., 1979). The problem with these studies is that a composite score and not the individual fitness components relationship to incidence of injury were given. Evidence has not been conclusive as to whether regular participation in physical activity prevents, protects or can be used to predict an individual developing LBP (Frymoyer, 1988; Plowman, 1992). The accurate assessment of physical activity is extremely difficult and requires documentation of the activity, the level of participation, intensity, duration and frequency. Without an accurate measure of physical activity, comparisons of results with LBP are meaningless (Plowman, 1992).

4.2 Physical characteristics and Low Back Pain

Several studies have investigated the relationship between body composition and LBP (Sward et al., 1990; Biering-Sorenson, 1984; Pope et al., 1985).

Excess body fat increases the weight that the spine must support and may lead to increased pressure on the discs and/or the vertebral structures (Plowman, 1992). The results from these studies in which indirect estimations of obesity using the body mass index, (which is the individual's weight/height²), and an association with LBP have not been conclusive. Except in the study by Biering-Sorenson (1984), where taller, heavier men were found to have had LBP, no other significant correlation or prognostic value between anthropometric values and individuals with or without LBP was found.

A mechanism that may predispose individuals to LBP is that of leg length discrepancies (LLD) (Sward et al., 1990; Biering-Sorenson, 1984; Pope et al., 1985; Giles and Taylor, 1981; Stanish, 1979). LLD may be functional (shortening secondary to muscle spasm or abnormal foot biomechanics, causing pelvic rotation during movement), anatomical (actual shortening of one limb causing pelvic tilt and a secondary compensation of the spine) or a combination of both and may be associated with an injury or be the primary cause (Subotnick, 1976). Minor LLD which would cause little difficulty in the non-athlete can cause significant symptoms in the active athlete. In running, three to eight times the body weight is transmitted through the support limb compared to approximately one (1.0 - 1.25) times the body weight in walking (Cavanagh and LaFortune, 1980; Subotnick, 1981; Jahn, 1983). Stanish (1979) states that mild LLD may lead to abnormal facet loading at the lumbosacral interface and may cause pain, particularly in the

jogger or runner. Clement et al., (1981) states that 60% of injured runners that reported back pain had LLD. However, Grundy and Roberts (1984) reported no association between short-leg syndrome and chronic low back pain in non-athletes. Unfortunately, these workers failed to report the level of activity or participation in sport for their subjects.

It is due to the repetitive nature of all physical activity and the transmission of forces through the limbs, pelvis and spine, that it is important to try to evaluate the relationship of LLD and LBP.

4.3 Flexibility

Flexibility is defined as the range of motion possible around a specific joint or a series of articulations (Shellock and Prentice, 1985). Improving flexibility through stretching has been advocated to improve physical performance, while maintaining good flexibility aids in the prevention of musculoskeletal injuries (Beaulieu, 1981)

Capsular tightness and laxity is assessed via anterior/posterior and rotational accessory motion tests. Joints are graded as either hypomobile, normal or hypermobile. The rationale for intervertebral motion testing in the absence of overt loss of motion is that the spinal motion is multisegmental and hypomobility of one segment is often compensated for by hypermobility of an adjacent segment (Snyder-Mackler, 1989). Men with hypermobile backs were found to be more liable to contract LBP (Biering-Sorenson, 1984).

The hypermobile joint presents in either a correct anatomic position or in an aberrant position. In isolation (no positional fault) an individual with

hypermobility is usually treated with bracing and muscle strengthening exercises. Research in the role of exercises to provide stability for the lower back suggests that the trunk musculature plays a primary role in countering forces and torque presented to the intervertebral joints (Ladin et al., 1989). Nadler et al. (1996) reported that athletes with lower extremity instability were more at risk for the development of LBP during athletic competition.

During the forward flexion motion, if the lower back is tight or inflexible, excessive stretch is placed on the hamstrings. This can cause pain in the lower back and pain in the hamstrings which disrupts normal functioning in the forward and lateral directions (Plowman, 1992). If the hamstrings are found to be tight or inflexible, pelvic rotation is restricted and pain may be felt in the lower back muscles and ligaments. Inhibition of pelvic forward rotation during flexion increases the compressive stress on the spine.

While sitting, the hips are flexed and the pelvis is tilted posteriorly which brings the ischial tuberosities into a weight-bearing position. The posterior tilt reduces the lumbar lordosis and flattens the back. Tight hamstrings can further exaggerate this posterior tilt which increases lower back muscle and ligament tension and compresses the spine.

Tight or short hip flexors may exaggerate anterior pelvic tilt which can be counter-balanced with strong abdominal muscles. However, if the abdominal muscles are weak hyperlordosis will result. This excessive lordosis puts compressive stress on the vertebral facets, encroaches on the nerves as they exit from the vertebrae and cause the discs to bulge posteriorly. All these changes may cause pain (Plowman, 1992).

Battie et al. (1990) reported that differences in flexibility between subjects with and without a history of LBP were too small to be of practical significance. On the other hand, Chandler et al. (1990) concluded that flexibility differences in tennis players were due to the musculoskeletal demands of the sport. Therefore, it seems appropriate that in order to determine possible causes of LBP in a homogeneous, sporting population, that flexibility tests are undertaken.

4.4 Muscular Strength and Endurance

Based on anatomical knowledge, effective functioning of the back requires coordination of the 24 vertebrae comprising the spine, the pelvis and the muscles, fascia and ligaments of the anterior and posterior trunk and thigh. This coordination is task specific and, to be normal, should be executed in a way that the stresses within the spine are minimised and equalised.

Investigations have been conducted on the relationship of LBP and the strength/endurance of the abdominal muscles and back extensors. Plowman (1992) conducted a review of retrospective studies which assessed the relationship between trunk flexion strength, trunk extension strength and/or trunk endurance and LBP. An analysis of these studies showed that when using static measurements of trunk flexion strength, 69% of the studies were able to distinguish a significant difference between those with and without LBP. These studies, however, were conducted on predominately non-athletic population groups. The dynamic strength measures were not tests of maximal strength (one repetition maximum) but rather tests with combinations of strength and endurance (Plowman, 1992). Nicholaisen and Jorgensen (1987) tested trunk extension endurance using two methods. During the first method

the subject held a position for a maximum period of 240 seconds while in the second the length of time that the subject was able to sustain a 60% maximal voluntary contraction was measured. Female subjects with LBP were found to have significantly lower times than females without LBP, using method one. Male subjects with LBP had significantly lower times, using method two, than the control group, despite there being no difference in extension strength between the groups.

Results from retrospective studies do appear to show a relationship between low trunk strength/endurance, flexibility and LBP. These results should be interpreted cautiously because of a number of factors including:

- (i) Pain. It is virtually impossible to be certain that voluntary muscular measures requiring active participation on the part of the subject is not limited by pain or fear of pain, in individuals who have suffered from LBP even if the pain is no longer acute.
- (ii) Detraining. Most LBP sufferers reduce their level of activity. Hence, the lower values on any physical test may be as a result of detraining.
- (iii) Statistical analysis. The statistical analyses performed do not identify cause and effect, just relationships (not necessarily causal) between groups. The differences in the raw values between the LBP subjects and the controls are often small and have large areas of overlap between groups that they have no practical significance.

To further understand the relationship of muscle function to LBP, more efficient assessment procedures needed to be developed and tested for clinical use. The relationship between surface electromyographic (EMG) recordings

and LBP showed a high increased electrical activity between those who do and do not have LBP, when sustained isometric contractions of the erector spinae muscle to fatigue and recovery periods were tested (Roy et al., 1988; Moffroid et al., 1994; Derman et al., 1995; Shirado et al., 1995). However, patterns of paraspinal and abdominal EMG were found only to be different during flexion, for LBP patients compared to pain-free controls (Nouwen et al., 1987; Shirado et al., 1995).

5 Incidence of Low Back Pain in the general population

It has been reported that between 60 and 85% of the general population, experience low back pain (LBP) during their lifetime (Frymoyer, 1988; Peterson and Renstrom, 1986; Kelsey and White, 1980; Cailliet, 1981). Over the past two decades the importance of physical activity and fitness has been promoted for longevity and quality of life. Therefore, it is likely that there has been corresponding increase in the incidence of LBP by individuals participating in sporting activities at both recreational and professional levels (Deusinger, 1989).

5.1 Incidence of Low Back Pain in athletes

There are athletes who had never reported LBP or pain in any other joints before participating in sporting activities (Stanish, 1987). The mechanical stress of athletic activities (abnormal, extrinsic loads) may trigger LBP in ostensibly normal spines. There are also athletes with intrinsic spinal abnormalities (*e.g.* scoliosis) who will experience LBP under normal athletic conditions, as well as those athletes who have both an abnormal spinal architecture and become symptomatic under abnormal exogenous loads (Stanish, 1987).

The cause and location of an athlete's back pain are frequently related to their specific sport (Keene and Drummond, 1985). The physical requirements for certain sports are such that the increased load on the spine can predispose athletes to significant back problems (Rovere, 1987). Examples of sporting activities where specific forces act on the spine are:

- (i) vertical loading - e.g. jogging; running
- (ii) flexion-extension forces - e.g. gymnastics, cycling
- (iii) rotational forces - e.g. racquet sports
- (iv) combinations of these forces - e.g. cricket bowlers; triathletes

5.2 Incidence of Low Back Pain in Runners

Low back pain may be related to running or it may develop in an unrelated activity but be accentuated or prolonged by running (Pagliano and Jackson, 1980). In a prospective study of 1000 adult runners reporting musculoskeletal injuries, Pagliano and Jackson (1980) reported that only 1.1% had LBP, with most of these being found in the 30-50 year old age group. Clement et al. (1981), in a retrospective survey of runners over two years, found that 68 out of 1819 (3.7%) had lower back injuries, with 54 (2.96%) of these found to have non-specific back pain. Bach et al. (1985) reported 20 out of 45 (44%) runners had experienced LBP, but only ten (22%) associated their pain with running. It was not reported whether the incidence of LBP was for that year or experienced during the runner's lifetime. Sixty seven percent of the runners investigated spent more than half the day in a sitting position and also participated in activities other than running.

Possible mechanisms, that may produce LBP in runners, include lack of shock absorption, leg length discrepancies, lateral and/or anterior-posterior pelvic tilt (James et al., 1978; Voloshin and Wosk, 1982; Subotnick, 1981; Stanish, 1979; Pagliano and Jackson, 1980; Beal, 1950; Clement et al., 1981).

Recent literature on running injuries suggests that the accumulated cyclical impact loading absorbed on heel-strike, may play an important role in various chronic injury mechanisms (James et al., 1978; Voloshin and Wosk, 1982; Jahn, 1983; Pratt, 1989). Studies have shown that running (dynamic axial loading) resulted in greater intervertebral disc height shrinkage than with equivalent static loading (Tyrrell et al., 1985; Koeller et al., 1986).

Decreased disc height is also related to a decreased ability to absorb shock which may result in increased stress and damage to the vertebral bodies (Koeller et al., 1986). Similarly, a significant association between the decreased shock absorbing capacity of the skeletal system and LBP has been reported (Voloshin and Wosk, 1982; Fauno et al., 1993). Clinical symptoms of LBP improved in 83% of subjects, after 18 months treatment, using viscoelastic inserts in their shoes to reduce the amplitude of the incoming shock waves (Wosk and Voloshin, 1981).

5.3 Incidence of Low Back Pain in Gymnasts

In other sporting activities such as gymnastics, which increases the flexion-extension forces on the lumbar spine, a high "incidence" of spondylolysis, spondylolistesis and discogenic back pain have been reported (Micheli, 1987; Rovere, 1987; Jackson et al., 1976; Goldstein et al., 1991; Mackie and Taunton, 1994; Kujala et al., 1996).

5.4 Incidence of Low Back Pain in Cyclists

Prolonged cycling with the lumbar spine in flexion, combined with shock transmitted from the road surface, may result in backache usually in the lumbar and sacroiliac regions (Mellion, 1994). Bohlman (1981) reported a 10% incidence of "pain and discomfort" for the lower back in competitive cyclists. In recreational male cyclists, Wilber et al. (1995) reported 31.6% experienced low back discomfort. LBP was statistically significant in the cyclists who reported a higher weekly mileage and using fewer gears.

5.5 Incidence of Low Back Pain in Cricket bowlers

In cricket, the action during fast bowling involves a rapid movement which subjects the back to a combination of vertical, flexion-extension and rotational forces. This causes many injuries to the facet joints in the lumbar spine (Crisp and King, 1994). In their study of club and high school fast bowlers, Foster et al. (1989) reported, that 11% of the bowlers sustained a stress fracture to a vertebrae (L_4 to S_1), while 27% sustained a soft tissue injury to the back, in one season. Stretch (1989), in a study of first-class cricketers reported that 13% of the injuries were to the lower and middle back. These were mainly muscle, ligament and tendon injuries, with the majority being sustained while bowling. In a further study (Stretch, 1993), found the seasonal incidence of injuries to the back and trunk to be 19.3%.

5.6 Incidence of Low Back Pain in Triathletes

The training patterns and injuries sustained by competitive triathletes was investigated by Williams et al. (1988). They reported a 17% incidence of lower back injuries. Fifty-three percent of the triathletes associated their injuries with running, 50% with cycling and 11% with swimming. The most

common sites of injury associated with each of the component sports were: swimming - shoulder; cycling - lower back; running - knee. Since most triathletes train in two or more of the component disciplines each day, it is difficult to ascertain the specific event causing the injury. However the majority of the athletes believed that their injury was brought about by an increase in overall training mileage.

5.6 Incidence of Low Back Pain in racquet sports

In racquet sports there are many movements that affect the lumbar spine and it seems reasonable to assume that LBP can be seen as a secondary effect of these movements (Marks et al., 1988). It has been reported that the combination of hyperextension and rotation is responsible for LBP in racquet sports (Marks et al., 1988). In a survey of 143 players on the Men's Professional Tennis Tour, 38% missed at least one tournament that year because of back problems, with 43 players reporting chronic LBP (Marks et al., 1988).

Over a four year period, Cannon and James (1984) observed an increase in the number of patients presenting to their clinic with back pain, with over 70% of these cases involving participants of six sports, one of which was squash.

Berson et al. (1978) found that 10% of players, from 49 squash facilities in the New York City area reported back injuries. Chard and Lachmann (1987) studied the injury patterns of players participating in racquet sports, over an 8-year period, and found that of 631 injuries reported, 372 (59%) were related to squash, 131 (21%) to tennis and 128 (20%) to badminton. Estimated participation figures for these sports show similar numbers involved in each discipline, yet squash players were three times as likely to present with an

injury. The most frequent sites of injury for squash players were the knee (23%) and the lumbar region (17%).

5.6.1 Physical demands of squash

Squash is played within a four wall 9.75 x 5.0 m court, enclosed by a ceiling. The game is considered a moderate- to high-intensity intermittent exercise (Monpetit, 1990). Grade A players have been found to be active more than 60% of the playing time, which may last from 30 to 90 minutes (Monpetit, 1990). Heart rates have been found to increase rapidly in the first minutes of play and remain stable at approximately 160 beats/min for the whole match, irrespective of the player's level (Montgomery et al., 1981). The energy expenditure for A grade players is over 3000 kJ/hr which is similar to that of moderate intensity running (Monpetit, 1990).

Squash is a vigorous activity where the body is subjected to sudden repeated sprints which could be traumatic for major joints, ligaments and musculature. Common injuries include sprains and strains to the ankle, gastrocnemius and back, achilles tendon rupture and medial meniscus tears in the knee (Berson et al., 1978, 1981). Due to striking velocities of over 230 km/hr, non-orthopaedic injuries (facial lacerations and eye injuries) have also been reported (Berson et al., 1981).

From the evidence presented above, injury to the back and LBP have been reported in squash players. These studies have not shown the differences in seasonal and/or lifetime incidence of LBP, nor have they been conducted on a homogeneous sample of players. It has not been clearly shown whether it is the nature and physical demands of playing squash on the lumbar spine, or if

it is due to differences in physical characteristics that place certain individuals, playing the game, at risk for developing LBP.

6 Aims and scope of this thesis

In South Africa (S.A.), squash is played at league level by 21 000 registered players but, to date, there have been no investigations to determine the incidence and severity of LBP in these players. In order to ascertain whether or not a relationship exists between LBP and squash, only first league squash players will be included. Therefore the purpose of this study was firstly, to determine the seasonal and lifetime incidence of LBP in male first league squash players, and secondly, to establish if any physiological or anthropometrical factors are related to the aetiology of LBP in these players.

CHAPTER 2

SUBJECTS, MATERIALS AND METHODS

1. Subjects, Materials and Methods

A retrospective study of all open and veteran (> 45 yr) male first league squash players playing in the Western Cape, South Africa, was undertaken by written questionnaire. A total of 163 players were asked to complete a questionnaire either before or after one of their league matches.

In the questionnaire (Appendix A) the players were asked to report any LBP they had experienced during the 1992 playing season, both while playing matches and/or within 12 hrs of a game. If a player had experienced LBP while playing squash, he was asked to indicate whether it was severe enough to prevent him from playing squash. If so, he was asked the duration of time before he was able to return to playing squash without LBP. In order to differentiate between LBP induced by squash and LBP from other causes, players were also asked to report LBP experienced at work or during activities of daily living (ADL), during the same season. The players they were also asked to indicate any LBP that they had experienced in their lifetime.

One hundred and fifty one players completed the questionnaire of whom 82 (out of 85 players) (93%) played in the open first and first reserve leagues and 69 (out of 75 players) (92%) played in the veterans first league. From this information, the players were then divided into two groups for each of the respective age categories:

- (i) those players presently experiencing LBP, during or after playing squash.
- (ii) those players who had never experienced LBP, who formed the control group.

The inclusion criteria, for the second phase of the study, also required players to have been playing squash more than three times/wk. In order to ascertain if any relationship existed between LBP and playing squash at first league level it was deemed necessary to include only those players who participated at least three times/wk. Players who met these criteria were then assigned to a further four sub-groups, namely:

- (i) open players with LBP
- (ii) open players with no LBP (controls)
- (iii) veteran players with LBP
- (iv) veteran players with no LBP (controls)

Once players had been assigned to the sub-groups, they were randomly selected before being contacted and asked to participate in the second phase of the study. When these criteria had been applied, a maximum of 10 players per sub-group were eligible for participation (see Figure 1). Unfortunately, despite written and verbal communication, several of the control players failed to arrive for the second phase testing.

After giving their written informed consent, in accordance with the guidelines of the American College of Sports Medicine (1991), thirty one players completed a second questionnaire (Appendix B) for phase two of the study. This questionnaire covered aspects of their participation in squash; training, playing and injury history. Following research undertaken by Frymoyer et al., (1980) information about each player's occupation, absenteeism from work and smoking habits was also included in the questionnaire.

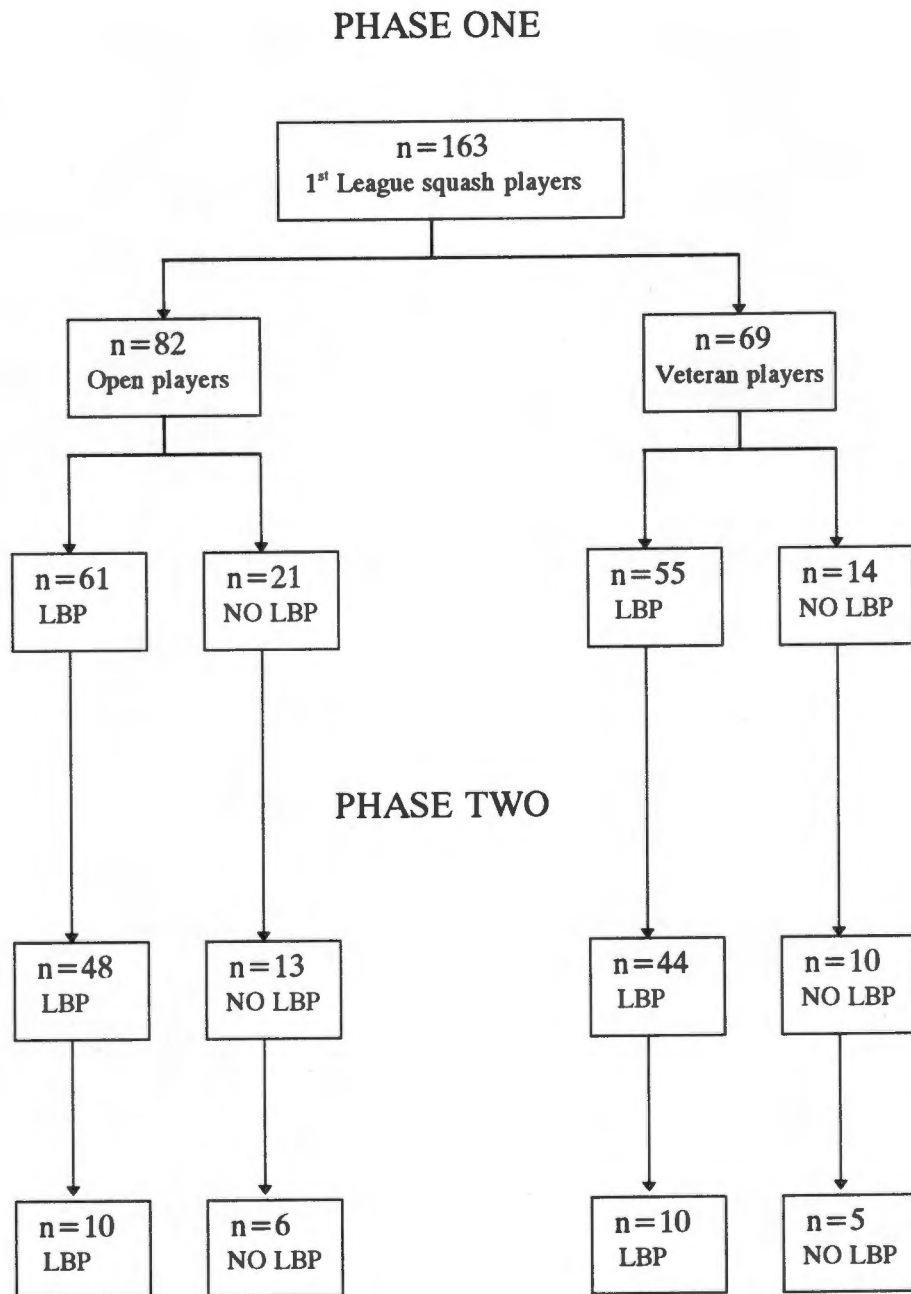


Figure 1 Schematic breakdown of the squash players that participated in phase one and phase two of the investigation

Following completion of the questionnaire, players subsequently reported to the clinic and completed physiological testing which included measurements for the determination of body mass (kg), height (cm), flexibility of the spine and hamstrings, hip flexion and iliopsoas tightness, leg length (cm), skinfold thickness (mm), lean thigh volume (l), muscular endurance of both the abdominal and back extensors (described subsequently). All the tests were conducted by the principal investigator.

Body mass was recorded to the nearest 0.1 kg, on a Seca digital balance and their height to the nearest 0.1 cm, while standing in the anatomical position, back to the wall. Each player was then examined to ascertain the presence or absence of scoliosis, kyphosis or other skeletal abnormalities.

Flexibility of the spine was determined by measuring the end-point of voluntary maximum stretch in flexion, extension, lateral flexion and rotation, with an anthropometric tape measure. Ten repetitions of each movement were performed prior to the single maximum attempt, which was measured and recorded. Any LBP experienced during the movements was noted. Flexion of the lumbosacral spine was measured using the modified Schober test (Macrae and Wright, 1969). With the player standing erect, a mark was placed at the lumbosacral junction, as indicated by the posterior superior iliac spines. A second mark was placed five centimetres below the lumbosacral junction and a third mark 10 cm above the junction. The player was then asked to bend forward as far as possible, in an attempt to touch the toes. The distance between marks two and three was measured. Lumbar flexion was expressed as the difference between this measurement and the initial distance of 15 cm.

Trunk extension was measured using a technique previously described by Johnson and Nelson (1986). Lying prone the player placed their hands, palm down, under the forehead. The player then raised his trunk as high as possible, keeping the hips on the floor. Using a kinanthropometric measuring arm, the maximum vertical height from floor to chin was measured.

Sit and reach measurements were taken to assess overall flexibility in forward flexion. Each player assumed a long sitting position placing their feet against the crossboard of the flexometer. The zero mark on the tape was 23 centimetres from the crossboard of the feet and extended to a maximum of 60 centimetres. With the researcher assisting each player to keep their knees fully extended, the player reached forward with arms evenly stretched palms down as far as possible along the tape. The maximum flexed position was held for approximately two seconds. The best of three attempts made, to the nearest 0.5 cm, was recorded.

Hamstring flexibility and nerve root entrapment was assessed using the straight leg raise and Lasègue tests (Carron, 1982; McCombe et al., 1989). With the subject supine, on an exercise mat on the floor, the subject's leg was passively raised to the maximum tolerated angle or 90°. The subject was asked to report whether the movement caused pain in the back, the leg or both. The Lasègue maneuver was performed with the subject's thigh flexed to 90°; the one arm of the goniometer was positioned along the thigh, following the line of the femur while the other arm was positioned along the length of the fibula. The centre of the goniometer was placed directly over the point of rotation of the knee. The researcher then extended the lower leg to the

maximum tolerated angle or 180°. The subject reported any position or onset of pain. The tests were then repeated on the contralateral limb.

Hip flexion deformities or tightness of the iliopsoas muscle was tested using the Thomas test (Beck and Day, 1985). The subject lay supine, on an exercise mat on the floor, with both knees and hips in full flexion (*i.e.* knees maximally held against the chest). One leg was then actively extended until resistance was met or reached full extension, with the thigh on the mat. If the thigh remained in a flexed position the amount of flexion indicated a deformity. From the start position, the other leg was also assessed. Subjects were also asked to indicate if any back pain was experienced.

The Patrick's test (Teitz and Cook, 1985) was performed to test for pain in an inflamed sacroiliac joint. The subject lay supine, on an exercise mat on the floor. The researcher passively moved one leg through external rotation with abduction in order that the heel was placed on the opposite knee. The hip was stabilised by placing the heel of one hand on the opposite anterior-superior iliac spine while an external rotation force was placed on the flexed knee. The force was stopped if pain was felt in the back or until the muscles reached the player's maximum range. Only back pain was recorded.

Leg lengths were measured from the anterior-superior iliac spine (ASIS) to the ipsilateral medial malleolus, using an anthropometric tape measure, with the player in the supine position (Teitz and Cook, 1985). Where a difference between leg lengths was found, a measurement was also taken from the femur-tibia joint line to the ipsilateral medial malleolus to establish whether the difference was in the upper or lower leg.

Using Harpenden skinfold calipers, biceps, triceps, subscapular, suprailiac, mid-thigh, medial calf and abdominal skinfold thicknesses were measured, for the subsequent determination of fat mass and muscle mass (Ross and Marfell-Jones, 1991). Girth measurements of the thigh were taken bilaterally in order to estimate lean thigh volume, using the assumption of the thigh being a truncated cone (Katch and Katch, 1974).

The isometric endurance of the abdominal muscles was assessed with the player supine, on an examination couch, with the knees flexed at 90°, feet flat on the couch. The player then performed a partial curl-up sit-up, arms extended with thumbs in line with the mid-point of the knee, and their lower back in contact with the couch (Hyytiainen et al., 1991). The player aimed to maintain this position, for a maximum period of two minutes, during which time they were motivated by the principal investigator. The position of the thumbs was checked during the test and if they moved from the starting position, the test was stopped and the time taken.

The isometric endurance of the lower erector spinae muscles was assessed with the player placing the upper body, up to the ASIS, prone on the examination couch. The player was allowed to hold on to the examination couch while raising the legs to a horizontal position, for a maximum period of two minutes, while the principal investigator gave verbal encouragement (Humphrey, 1988). The time was stopped if the player was unable to maintain the horizontal position or reported LBP.

A ratio, using the abdominal endurance time and the erector spinae endurance time, was calculated.

Players with LBP reported the nature, severity, cause, treatment and recurrence of LBP and completed a drawing (Waddell, 1987) depicting the area of pain.

2. Statistical analysis

Data were analysed using the software package "Quattro Pro 4.0" and basic descriptive statistics were calculated for the overall sample and for the groups, with Statgraphics (version 5).

Data for the second phase of the study was forwarded to the statistical centre of the South African Medical Research Council (Cape Town) for in-depth analysis. Frequencies and univariate (continuous variables) procedures were calculated. All categorical variables were compared (using Chi-squared tests) for interaction with LBP and across the leagues. Frequencies were calculated for all tests requiring a pain/no pain response.

Chi-squared, Wilcoxon scores and Kruskal-Wallis tests were used on the individual's results from all measured tests, to establish if any significant differences existed across the leagues. A multivariate analysis of variance (MANOVA) was performed to determine if any significant difference existed between the LBP and no LBP groups for any of the physiological tests and measurements. The MANOVA was also used to establish if any significant difference existed between the open and veteran groups. The tests were considered statistically significant if $p \leq 0.05$. All values are expressed as mean $\pm$ standard deviation (S.D.).

CHAPTER 3

RESULTS

3. Results

3.1 Phase One

Correctly completed questionnaires were obtained from 151 male first league squash players which represents a 94% return from the participants in the open and veteran first leagues. The mean ($\pm$ SD) age was 39 ± 11.6 yr for all the players (range 18 to 63 yr). The physical characteristics of these players are shown in Table I.

TABLE I Mean ($\pm$ SD) physical characteristics of male first league squash players in the Western Cape

	Open	Veterans	All Players
	(n=82)	(n=69)	(n=151)
Age (yr)	29.8 ($\pm$ 7.0) *	50.0 ($\pm$ 3.5) *	39.0 ($\pm$ 11.6)
Height (cm)	179.2 ($\pm$ 6.1)	177.7 ($\pm$ 5.9)	178.5 ($\pm$ 6.1)
Body mass (kg)	75.6 ($\pm$ 8.1)	78.2 ($\pm$ 7.9)	76.8 ($\pm$ 8.1)
Body mass index (Wt/Ht ²)	24.1 ($\pm$ 2.4)	24.4($\pm$ 2.5)	24.3 ($\pm$ 2.9)

Abbreviations: yr, years; cm, centimetre; kg, kilogram; Wt/Ht², weight (in kilograms) divided by height (in centimetres) squared

* $p < 0.05$ between open and veteran players

Table I shows that there was no significant difference in the height, weight and body mass index between the players.

The veteran players had played squash at first league level for a significantly longer time than the open players (23.5 ± 7.7 vs. 12.5 ± 5.0 yr ; $p < 0.05$). Although there was no significant difference in the number of times that both

groups played squash (4.3 ± 1.7 vs. 3.6 ± 0.9 times/wk), the open players played for significantly longer than the veteran players (5.5 ± 4.4 vs. 3.2 ± 1.3 hrs/wk ; $p < 0.05$).

The seasonal and lifetime incidence of LBP in the squash players under investigation are presented in Table II.

TABLE II Incidence of low back pain in male first league squash players

	Open	Veterans	All Players
	(n=82)	(n=69)	(n=151)
Seasonal incidence LBP (playing squash)	38 (46%)	29 (42%)	67 (44%)
Lifetime incidence LBP (playing squash)	44 (54%)	41 (59%)	85 (56%)
Overall lifetime incidence LBP	61 (74%)	55 (80%)	116 (77%)
Never experienced LBP	21 (26%)	14 (20%)	35 (23%)

Abbreviations: LBP, low back pain

There was no significant difference in the seasonal and lifetime incidence of LBP between the open players and the veteran players. The overall lifetime incidence of LBP was slightly lower in the open group, but not significantly different to that of the veteran players.

Eighty five players reported LBP during their lifetime, while playing squash. Of these 85 players, 70 (82%) were prevented from playing squash because of their LBP. Only 35 (23%) players had never experienced LBP.

Table III shows the nature and duration of LBP before the players were able to return to playing squash. In both the open and veteran leagues 80% of the players were prevented from playing squash for up to seven weeks due to LBP. In the open group there were 13 (36%) players who were able to return to squash in less than a week, which was significantly different ($p < 0.05$) compared to the 4 veteran players (12%). Twenty three (68%) of the veteran squash players experienced LBP that took them between one and seven weeks to recover from, and eventually return to play.

TABLE III The time until return to play for male first league squash players with low back pain

	Open	Veterans	All Players
	(n=36)	(n=34)	(n=70)
Acute (< 1 week)	13 (36%) *	4 (12%) *	17 (24%)
Sub-acute (1 - 7 weeks)	17 (47%)	23 (68%)	40 (57%)
Chronic (> 7 weeks)	6 (17%)	7 (20%)	13 (19%)

* $p < 0.05$ between open and veteran players

3.2 Phase Two

The 31 players that participated in this phase completed a questionnaire (Appendix B). With regard to pre-game activity, 22 (71%) of all players reported that they warmed up before playing, while only six (19%) actively used a cool down and stretching session after playing. Of the 20 players who had experienced LBP, ten (50%) felt that their pain was severe enough to consult a medical doctor, five (25%) had radiographic studies, while 16 (80%) had undergone treatment with a physiotherapist or a chiropractor.

Smoking habits, type of work and absenteeism from work showed no correlation with LBP. Eighteen (90%) players with LBP indicated pain or aching in the lumbar region, as indicated by the pain drawing (Appendix B). Two (10%) players indicated pain in the buttocks, while one had pain referred down the leg.

TABLE IV The number of male first league squash players reporting low back pain during repeated and maximal range of movements of the spine

	Open		Veterans		All Players	
	LBP	No LBP	LBP	No LBP	LBP	No LBP
	(n=10)	(n=6)	(n=10)	(n=5)	(n=20)	(n=11)
Repeated forward flexion	1	0	2	0	3	0
Max. forward flexion	1	0	3	0	4	0
Repeated extension	3	0	2	0	5	0
Hyperextension	4	0	4	0	8	0
Repeated lateral flexion (L)	5	0	1	1	6	1
Repeated lateral flexion (R)	6 *	0	1 *	1	7	1
Max. lateral flexion (L)	5	0	2	0	7	0
Max. lateral flexion (R)	6 *	0	0 *	0	6	0
Max. rotation (L)	1	0	0	0	1	0
Max. rotation (R)	1	0	1	0	2	0

Abbreviations: Max., maximum; L, left; R, right

* $p < 0.05$ = significant difference between open and veteran players with LBP

Movement and Low Back Pain

Table IV displays the number of players reporting pain during repeated and maximal range of movements of the spine.

The number of open and veteran players with LBP were not significantly different for all movements except during the repeated and maximal lateral flexion, to the left and right sides, where more pain responses were elicited in the open players (Table IV). Only the repeated and maximal lateral flexion movements to the right produced significantly more pain responses in the open (LBP) players than in the veteran (LBP) players (6 vs.1 and 6 vs.0 ; $p < 0.05$).

Flexibility and Low Back Pain

Table V shows the flexibility scores for the players

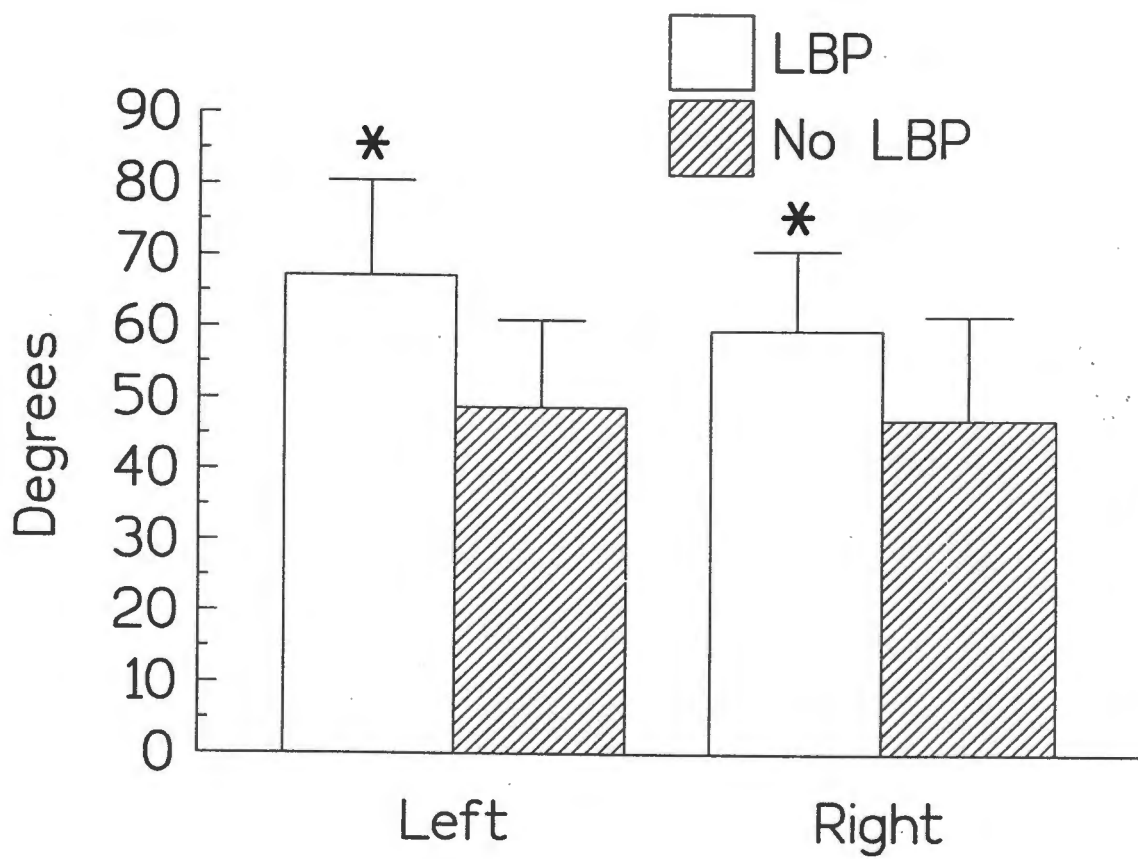
TABLE V Mean ($\pm$ SD) flexibility scores for male first league squash players

	Open		Veterans		All Players	
	LBP	No LBP	LBP	No LBP	LBP	No LBP
	(n=10)	(n=6)	(n=10)	(n=5)	(n=20)	(n=11)
Forward flexion (cm)	19.8 ($\pm$ 3.7)	16.9 ($\pm$ 3.3)	15.1 ($\pm$ 1.3)	14.2 ($\pm$ 0.5)	17.4 ($\pm$ 3.6)	15.7 ($\pm$ 2.7)
Lateral flexion (cm) (L)	21.8 ($\pm$ 3.6)	22.2 ($\pm$ 3.8)	20.3 ($\pm$ 3.7)	17.4 ($\pm$ 4.5)	21.0($\pm$ 3.6)	20.0 ($\pm$ 4.6)
Lateral flexion (cm) (R)	21.6 ($\pm$ 3.0)	22.0 ($\pm$ 5.2)	19.6 ($\pm$ 4.7)	16.9 ($\pm$ 3.1)	20.6 ($\pm$ 4.0)	19.7 ($\pm$ 5.0)
Straight leg raise ($^{\circ}$) (L)	80.5 ($\pm$ 8.0)	86.5 ($\pm$ 6.7)	80.3 ($\pm$ 11.0)	72.4 ($\pm$ 12.9)	80.4 ($\pm$ 9.4)	80.1 ($\pm$ 12.0)
Straight leg raise ($^{\circ}$) (R)	80.7 ($\pm$ 11.5)	88.3 ($\pm$ 2.6)	83.3 ($\pm$ 6.6)	79.2 ($\pm$ 10.4)	82.0 ($\pm$ 9.2)	84.2 ($\pm$ 8.4)
Hamstrings ($^{\circ}$) (L)	163.9 ($\pm$ 13.8)	165.3 ($\pm$ 15.9)	164.6 ($\pm$ 13.5)	149.0 ($\pm$ 8.5)	164.3 ($\pm$ 13.3)	157.9 ($\pm$ 15.1)
Hamstrings ($^{\circ}$) (R)	168.1 ($\pm$ 11.5)	170.3 ($\pm$ 8.4)	167.0 ($\pm$ 12.4)	160.6 ($\pm$ 13.0)	167.5 ($\pm$ 11.6)	165.9 ($\pm$ 11.3)
Sit and reach (cm)	28.6 ($\pm$ 8.6)	29.0 ($\pm$ 9.7)	22.0 ($\pm$ 11.8)	17.2 ($\pm$ 9.7)	25.3 ($\pm$ 10.6)	23.6 ($\pm$ 11.1)
Trunk extension (cm)	28.4 ($\pm$ 4.2)	32.7 ($\pm$ 7.7)	23.3 ($\pm$ 6.2)	21.5 ($\pm$ 2.4)	25.9 ($\pm$ 5.8)	27.6 ($\pm$ 8.2)

Abbreviations: cm, centimetre; L, left; R, right; $^{\circ}$, degrees

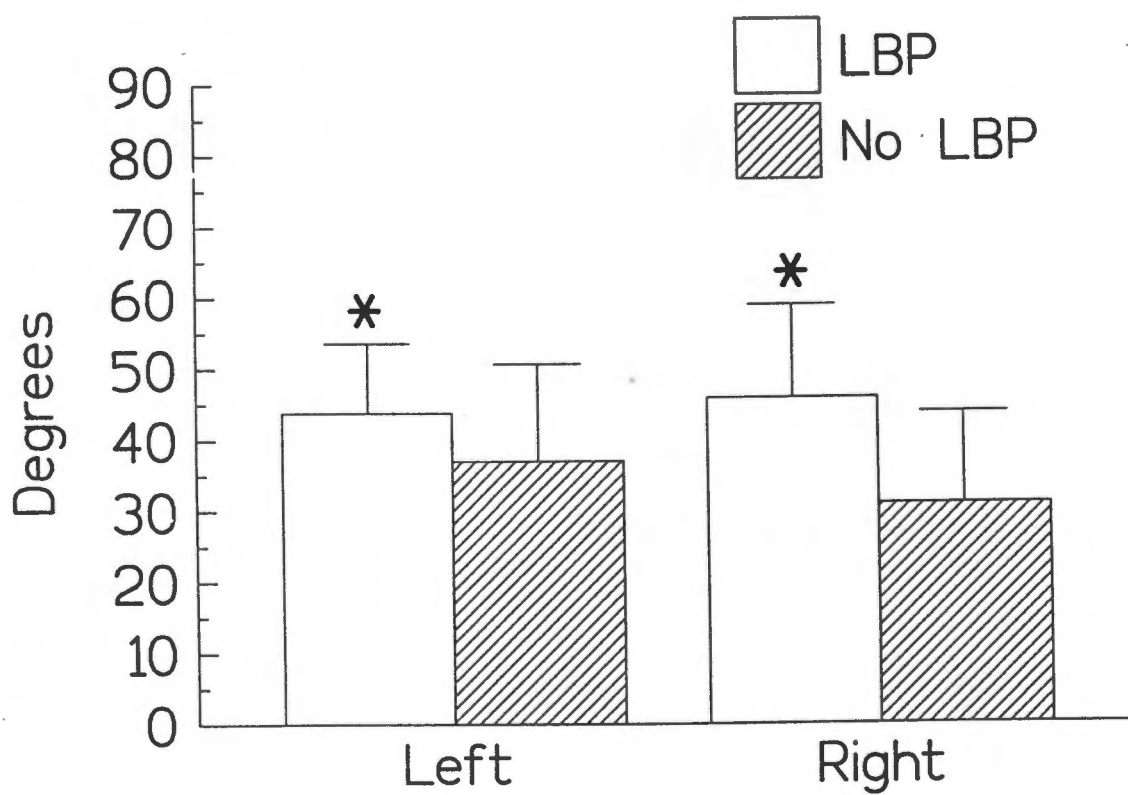
Significant differences were found for measures of forward flexion (18.7 ± 3.7 vs. 14.8 ± 1.1 cm ; $p < 0.05$), lateral flexion [both left (21.9 ± 3.6 vs. 19.3 ± 4.1 cm ; $p < 0.05$) and right (21.7 ± 3.8 vs. 18.7 ± 4.4 cm ; $p < 0.05$)], sit and reach (28.8 ± 8.7 vs. 20.4 ± 11.1 cm ; $p < 0.05$) and trunk extension (30.0 ± 5.9 vs. 22.7 ± 5.2 cm ; $p < 0.05$), between the open and veteran league players. However, no differences were found between the players with LBP and those without LBP (controls) for the same tests.

Maximal trunk rotation to the left (Figure 2) was found to be 67.1 ± 13.4 vs. 48.7 ± 12.2 degrees ; $p < 0.05$ and to the right (Figure 2) was 59.5 ± 11.1 vs. 47.0 ± 14.5 degrees ; $p < 0.05$, for the open players with LBP compared to the controls. Figure 3 shows the veteran players with LBP compared to the controls for maximal trunk rotation to the left (43.8 ± 9.8 vs. 37.0 ± 13.7 degrees ; $p < 0.05$) and to the right (45.9 ± 13.0 vs. 31.0 ± 12.8 degrees ; $p < 0.05$). Similarly, all players with LBP were found to have significantly different scores for maximal trunk rotation to the left (55.5 ± 16.5 vs. 43.4 ± 13.7 degrees ; $p < 0.05$) and right (52.7 ± 13.7 vs. 39.7 ± 15.5 degrees ; $p < 0.05$) compared to the players with no LBP (Figure 4). No differences were found in flexibility scores of the hamstrings and for the straight leg raise tests.



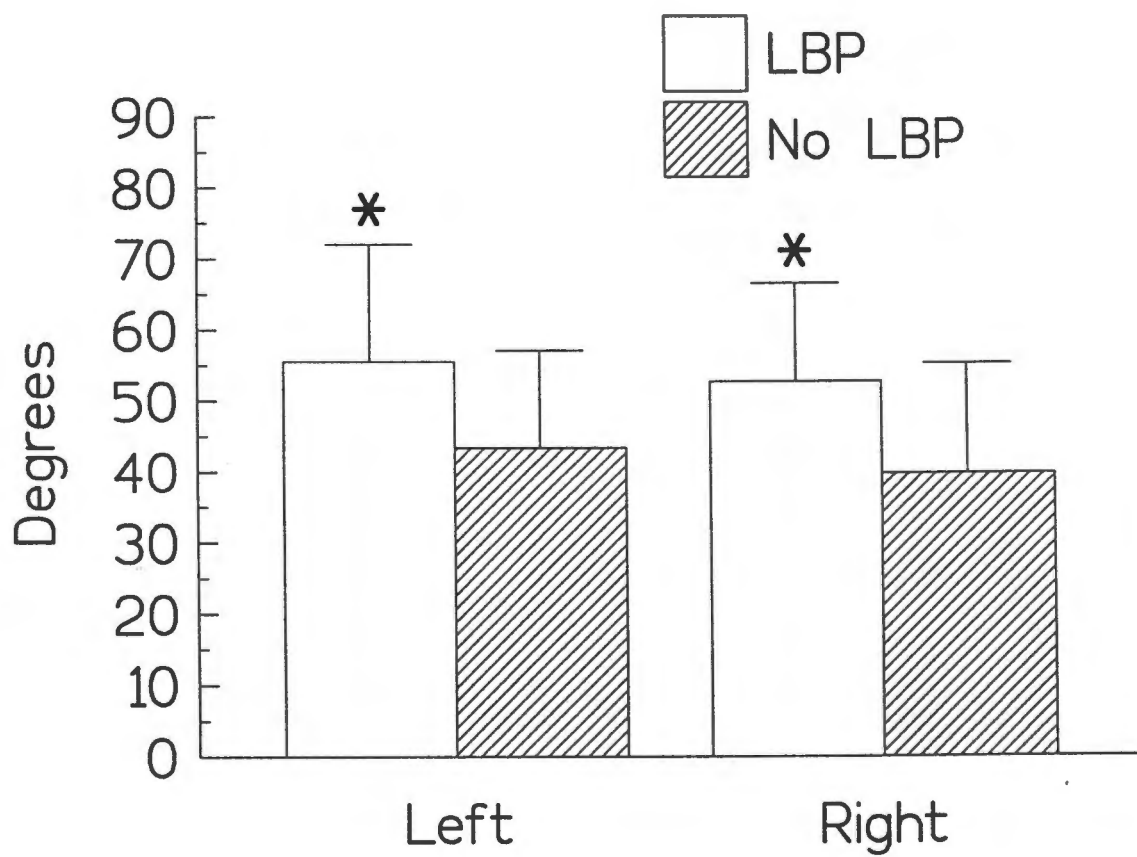
* $p < 0.05$

Figure 2: Mean ($\pm$ SD) maximal trunk rotation scores to the left and right for male open first league squash players



* $p < 0.05$

Figure 3: Mean ($\pm$ SD) maximal trunk rotation scores to the left and right for male veteran first league squash players



* $p < 0.05$

Figure 4: Mean ($\pm$ SD) maximal trunk rotation scores to the left and right for all male first league squash players

TABLE VI Mean ($\pm$ SD) estimated body fat percentage, lean thigh volumes and leg length differences in male first league squash players

	Open		Veterans		All Players	
	LBP	No LBP	LBP	No LBP	LBP	No LBP
	(n=10)	(n=6)	(n=10)	(n=5)	(n=20)	(n=11)
Sum of skinfolds (mm)	55.6 ($\pm$ 28.9)	59.7 ($\pm$ 23.5)	68.7 ($\pm$ 21.1)	80.1 ($\pm$ 20.6)	62.2 ($\pm$ 25.5)	68.9 ($\pm$ 23.7)
Body fat %	11.2 ($\pm$ 5.0)	11.8 ($\pm$ 4.0)	16.0 ($\pm$ 4.1)	18.4 ($\pm$ 3.4)	13.6($\pm$ 5.0)	14.8 ($\pm$ 5.0)
Lean thigh volume (l) (L)	5.3 ($\pm$ 0.8)	4.9 ($\pm$ 0.4)	4.7 ($\pm$ 0.8)	4.6 ($\pm$ 0.6)	5.0 ($\pm$ 0.8)	4.8 ($\pm$ 0.5)
Lean thigh volume (l) (R)	5.6 ($\pm$ 0.7)	5.2 ($\pm$ 0.6)	5.0 ($\pm$ 0.7)	4.9 ($\pm$ 0.6)	5.3 ($\pm$ 0.8)	5.1 ($\pm$ 0.5)
Lean thigh volume (l) (diff)	0.36 ($\pm$ 0.3)	0.26 ($\pm$ 0.3)	0.34 ($\pm$ 0.6)	0.31 ($\pm$ 0.3)	0.35 ($\pm$ 0.2)	0.28 ($\pm$ 0.3)
Leg length difference (cm)	0.7 ($\pm$ 0.8)	0.4 ($\pm$ 0.5)	0.6 ($\pm$ 0.4)	0.4 ($\pm$ 0.4)	0.6 ($\pm$ 0.6)	0.4 ($\pm$ 0.4)
Upper leg length (cm) (diff)	0.5 ($\pm$ 0.6)	0.2 ($\pm$ 0.3)	0.4 ($\pm$ 0.3)	0.0 ($\pm$ 0.0)	0.4 ($\pm$ 0.5)	0.1 ($\pm$ 0.2) *

Abbreviations: mm, millimetre; l, litre, L, left, R, right, cm, centimetre, diff, difference between left and right legs of the players

* p < 0.05 = significant difference between all players with LBP and no LBP

Body fat (%), thigh muscle volumes, leg length and Low Back Pain

Estimated body fat percentages, lean thigh volumes and leg length differences are shown in Table VI.

Estimated body fat percentages were significantly different between the open and veteran players (11.4 ± 4.5 vs. 16.8 ± 3.9 % ; $p < 0.05$). The lean thigh volume (LTV) tended to be greater, but was not significantly different, for the right leg than the left leg in both the open players (5.5 ± 0.7 vs. 5.2 ± 0.7 l) and the veteran players (5.0 ± 0.7 vs. 4.7 ± 0.7 l). This finding also shows that the open players had larger LTV than the veteran players. There was no difference in LTV between the LBP and no LBP groups. Leg length differences were not significantly different between the groups. However, there was a significant difference between all players with LBP and the controls, for upper leg length difference (0.4 ± 0.5 vs. 0.1 ± 0.2 cm ; $p < 0.05$).

The isometric tests used for the abdominal and back extensor muscles, when calculated as a ratio (abdominal time/back time) showed no differences to exist between the LBP and the control groups (0.96 vs. 0.93).

CHAPTER 4

DISCUSSION

4. Discussion

This study investigated the seasonal and lifetime incidence of LBP in 151 male first league squash players. Of the players surveyed 44% experienced LBP during that season. This is significantly higher than the incidence of LBP reported in other studies of squash players in which the incidence of LBP was reported to range from 9% (Cannon and James, 1984); 10% (Berson et al., 1978; Berson et al., 1981) to 17% (Chard and Lachmann, 1987). It must be noted, however, that these studies were conducted on a cross-section of players, whose playing level varied from beginners to tournament participation. Therefore, the results of the current study show that squash players at first league level are more susceptible to LBP during the playing season. It has to be assumed that the physical demands of playing squash, at this level leads to a higher incidence of LBP. Monpetit (1990) reported finding Grade A players to be active for more than 60% of the playing time, which lasted from 30 to 90 minutes. Also, the players in this study were found to have an average weekly playing time of 4.5 hrs which is higher than the 3.1 hrs/wk reported by Berson et al. (1978).

The incidence of LBP that occurred during the player's lifetime while playing squash, was found to be 56% for the players in this study. However, there was no significant difference in the seasonal or lifetime incidence of LBP between the open players and the veteran players. This finding is of interest as the veteran players had played squash at first league level, for nearly twice as long as the open players (23.5 yr vs. 12.5 yr ; $p < 0.05$). Nevertheless, the open players played squash for a significantly longer period each week than the veteran players (5.5 vs. 3.2 hrs/wk ; $p < 0.05$). Therefore, maybe the combined effect of years and hours per week (23.5 yr and 3.2 hrs/wk vs.

12.5 yr and 5.5 hrs/wk) playing squash could account for the higher lifetime incidence of LBP found in this study. Berson et al. (1978) reported a 10% incidence of LBP with their players who had played on average for 13.1 years and for 3.1 hours per week. The overall lifetime incidence of LBP for all the players in this study was 77% which is similar to all other reported levels of LBP in the athlete or non-athlete, as being between 60% - 85% (Nachemson, 1976; Micheli et al., 1979; Hainline, 1995).

Forty percent of all players who had ever experienced LBP while playing squash continued to play. Of the players whose LBP prevented them from playing, 57% took between one and seven weeks and 19% took longer than seven weeks to recover and to return to play. Similarly, Berson et al. (1981) reported that with conservative treatment, the range of disability for squash players ranged from two to 16 weeks, while in another study (1978), that 50% of the players were disabled for longer than two weeks. In the present study, 36% of the open players returned to playing squash within one week. This was significantly quicker than the veteran players, where only 12% of their players with LBP were able to play squash again within one week. This finding is similar to that reported by Berson et al. (1981) who found that players over 40 yr tended to stay out for longer periods of time when injured. This shows that a high level of physical stress can be less tolerated by the body tissues as they age and healing takes longer.

Of the 31 players who completed the second phase of this study, 71% reported having used an active warm-up prior to playing, which is similar to that reported by Berson et al. (1978). This sport-specific warm-up appears to be the best method of increasing the temperature of the body parts that will be

used in the subsequent, more strenuous activity or event. The majority of the benefits of warm-up are related to temperature-dependent physiological processes and also appears to reduce the incidence of sports-related musculoskeletal injuries (Shellock and Prentice, 1985). Similarly, Berson et al. (1981) and Chard and Lachmann (1987) suggested that inadequate warming-up, (although not objectively assessed), was a common factor in their injured players.

The movements that elicited the highest incidence of pain responses in all the players with LBP were maximal hyperextension and both repeated and maximal lateral flexion, to the left and right. Maximal as well as repeated lateral flexion movements, with pain, to the right side were significantly more in the open players with LBP, compared to the veteran players with LBP. However, Berson et al. (1981) reported that the LBP in the players in his study, resulted from reaching and hyperextension movements. These findings are not surprising as squash is a vigorous game during which the body is subjected to repeated sprints. Besides the stop/start, rapid movements in all directions, the player strikes the ball with a racquet using a variety of strokes, the most common of which is the volley. In order to play the volley, the player's feet and legs must provide the foundation for the body to rotate around. This results in torque forces being placed on the spine, lower back and abdominal muscles. In torsion or twisting of the spine caused by an applied moment or torque, there is a concomitant increase of contact pressure between the articular surfaces of the lumbar facet joints. The lumbar spine is not adequately structured to control rotational movements although the facet joints are spatially oriented to prevent extremes of this movement. If excess rotation does occur, undue forces are placed on the facets and soft tissues,

which is often sufficient to trigger low back pain (Deusinger, 1989). Chard and Lachmann (1987) reported a similar frequency of injuries to the lumbar region in squash and tennis players, but felt that the higher proportion of disc prolapses in the tennis players was due to the serving techniques in that game.

The second important finding was that increased trunk rotation was found on both the right and left sides in both the open and veteran LBP groups, compared to the controls. Biering-Sorenson (1984) also reported that men with hypermobile backs were more liable to contract LBP. Norris (1995) reported that in movements when the trunk is moving slowly, tissue tension would be felt at end-range and a subject would be able to stop a movement short of full end-range and protect the spinal tissues from over-stretch.

However, rapid movements of the trunk build up large amounts of momentum which push the spine to full end-range and stress the spinal tissues. In squash, movements are rapid, ballistic in nature and repeated often, which can lead to excessive flexibility and a reduction in passive stability of the spine.

In studies that used ligamentous laxity (LL) testing in order to determine whether an increase in LL predisposed an athlete to injury or not, Nicholas (1970) and Nadler et al. (1996) reported an increased likelihood of injury in players with LL and recommended proper screening and specific exercises to strengthen them. Berson et al. (1978) also concluded that a loose-ligamented player may benefit from a programme of resistance exercises. However, Grana and Moretz (1978) found no correlation between LL and the occurrence of injury in secondary school students, and concluded that their results should not be compared or extrapolated to those obtained from professional sportsmen.

The veteran players under investigation were found to have reduced flexibility with respect to forward and lateral flexion as well as during the sit and reach and trunk extension tests compared to the open players. It is interesting to observe that even though there is a loss of flexibility with age, there was no increase in the incidence of LBP. Similarly, there was no significant difference in the flexibility scores between those players with LBP and those without LBP (controls), in either age group. Therefore, it is possible that these movements are not the cause of LBP in these players. This finding is supported by Battie et al. (1990) who reported that the differences in flexibility between subjects with and without LBP were too small to be of practical significance.

Flexibility, or the lack thereof, especially of the hamstrings has been proposed by many researchers to have a direct relationship with LBP (Deusinger, 1989; Rovere, 1987; Battie et al., 1990; Plowman, 1992). If the lower back is inflexible, complete reversal of the lumbar curve is prevented in the forward flexion motion. This places excessive stretch on the hamstrings, can cause pain in both the lower back and in the hamstrings, and disrupts normal functioning in the forward and lateral directions. Conversely, if the hamstrings are tight or inflexible, pelvic rotation is restricted and pain may be felt in the lower back muscles and ligaments because of attempted overstretch in that region. In addition, inhibition of pelvic forward rotation during flexion increases the compressive stress on the spine (Gracovetsky et al., 1989). Significantly, in this study no difference was found in straight leg raise tests and tests for hamstring flexibility across the players, with or

without LBP. These results indicate that any pain was probably not discogenic in origin but rather mechanical in nature.

It has been hypothesised that skeletal muscle imbalances between the left and right leg may also be a cause for LBP (Deusinger, 1989). When playing squash, the majority of players are right-handed and play "off the right foot" *i.e.* whether a shot is played along either side-wall, the player tends to take his weight on the right leg. This causes a greater stress on the lumbar spine because forced rotation is applied against a relatively fixed pivot point (Hainline, 1995; Stanish, 1987). For this reason, lean thigh volume (LTV) was calculated for each leg. Although the results in this study show a trend for the right LTV to be larger than the left LTV, in all the groups, they were not significantly different. Further research using this technique, on larger subject numbers may produce significant findings.

Body composition measures were performed, as a reasonable relationship exists, in the general population between excess body fat and LBP (Plowman, 1992). A large excess of body fat increases the weight that the spine must support and may lead to increased pressure on the discs and/or other vertebral structures. In a review of top class squash players, Jaski and Bale (1987) found that the skin fold measurements of squash players was lower than for the general male population. The open first league players estimated body fat, at 11.2% and 11.8% respectively, compares with those reported by Copley (1983) but are slightly higher than those reported by Jaski and Bale (1987) at 10.2%. Although the veterans body fat percentages were significantly higher than the open players, BMI's are identical.

The results of previous studies which have assessed the association of LBP with leg length differences (LLD) (Giles and Taylor, 1981; Grundy and Roberts, 1984; Pope et al., 1985; Clement et al., 1981) have been equivocal. As varied testing methods and different population groups (sedentary vs. athletic) were studied it is not possible to come to a definite conclusion. Minor differences in leg lengths are common, but seldom cause significant back pain (Keene and Drummond, 1985). In the present study no differences were found between the sub-groups, although there was a significant finding between the LBP and no LBP group overall, in comparisons made between the upper LLD.

In a review of retrospective and prospective studies of the trunk musculature (*i.e.* abdominal/back strength and endurance), Plowman (1992) states that due to the interaction of many factors the best way to measure and evaluate this area had not yet been found. Consequently, the relationship between these measurements and LBP is inconclusive. In the present study, a modified test was used in preference to the method used by Biering-Sorenson (1984). In that study, subjects were asked to maintain the unsupported upper part of the body horizontal while the legs and buttocks were fixed to the couch for a maximum period of 240 sec. Using this method, only 76% of his subjects were able to complete the test. Lack of motivation, back pain, cramps and discomfort in the hamstrings and buttocks were given as the main reasons for the subjects not completing the test.

Due to the abovementioned problems experienced by Biering-Sorenson (1984) and other investigators, both the isometric abdominal and erector spinae muscle tests were reduced to a time interval of two minutes. They were

included to assess gross weakness and to establish if LBP was reproduced with these movements. No differences were found to exist between the players with LBP and the controls. No tests for maximal strength were included in the present study.

One of the limitations to the second phase of this study was the small sample size within the four sub-groups, consisting of ten players in each group. However, from the initial sample of first league, male squash players only ten met the playing criteria and were available to participate in the veterans no LBP sub-group. Of these, only five reported for testing. Similarly, only six open players who had never had LBP were tested.

In trying to establish the incidence of LBP related to playing squash it was not possible, within this study, to establish how many first league male squash players had given up playing the game due to chronic LBP.

The results of the current investigation show that South African first league male squash players are susceptible to LBP during the playing season. The high incidence of LBP found in these players appears to be due to a combination of the duration and intensity of playing squash at this level. LBP was significantly associated with high trunk rotation values to the left and right sides, in players of all ages. The practical implication would be for these players to undergo rehabilitation exercises aimed at stabilising the hypermobility in the motion segments of the trunk.

CHAPTER 5

SUMMARY & CONCLUSIONS

5. Summary and Conclusions

The two studies described in this thesis were undertaken to determine both the seasonal and lifetime incidence of low back pain (LBP) in a homogeneous group, namely first league, South African male squash players; and to establish whether any physiological or anthropometrical factors are related to the aetiology of LBP in these players

The first study established a seasonal incidence of LBP in these players, while playing squash, to be 44% which was much higher than reported in the literature. The overall lifetime incidence of LBP (77%) was similar to the incidence of the athletic and non-athletic population.

In the second study, the major finding was that maximal trunk rotation to the left and right sides was significantly higher across both age groups as well as between those with LBP and the controls. Repeated and maximal lateral flexion movements to the right also produced significant differences in the open LBP players. The trend of the larger LTV found for the right leg may have been significant had more players been assessed. It would be of interest to use this technique in a prospective study to determine its predictive value with LBP. Any muscular imbalances could also be corrected with strengthening programmes and assessed for efficacy on players with LBP.

In conclusion, the results of this thesis show that there is a high incidence of LBP in squash players at first league level. Those players who exhibit a higher degree of trunk rotation are more at risk for developing LBP, while playing squash. It is recommended that these players as well as those with

LBP, undergo a strengthening programme and assess their playing technique (using video replays) with regard to excessive trunk rotational movements.

CHAPTER 6

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APPENDIX A

PHASE ONE QUESTIONNAIRE SEASONAL/LIFETIME INCIDENCE OF LOW BACK PAIN

I am presently undertaking a Masters research project to establish the incidence/prevalence of low back pain in males participating in different sports. I would be grateful if you would complete the questionnaire below as accurately as possible. All information provided will be kept strictly confidential.

Name _____ Age _____ (yrs)

Address _____

Tel _____ (w) _____ Height _____ (cm)

_____ (h) _____ Weight _____ (kg)

Doctor _____

A.1. How many years have you been playing 'competitive' squash? _____ yrs

2. Do you participate in more than one sport? Y N

3. If yes, name the other sports _____

B.1. Did you experience any low back pain while playing squash last year (i.e. June 1991 - June 1992)? Y__ N__

2. Did you ever experience low back pain while playing squash before June 1991? Y N

3. Have you ever had low back pain which prevented you from playing squash? Y N

4. If yes, how long did the pain take to subside?
(i.e. able to return to playing squash "pain-free")

<1wk ____ 1-2wks ____
3-12wks ____ > 12wks ____
Have not yet recovered ____

5. Does playing squash aggravate your low back pain? Y N N/A

6. Does playing squash help your low back pain? **Y** **N** **N/A**

WILLING/NOT WILLING TO FURTHER PARTICIPATION (circle whichever is applicable).

APPENDIX B

PHASE TWO QUESTIONNAIRE AND EVALUATION SHEETS

UNIVERSITY OF CAPE TOWN

MRC/UCT BIOENERGETICS OF EXERCISE

RESEARCH UNIT

CASE REPORT FORM

**A STUDY TO TRY AND DETERMINE IF THERE ARE COMMON
CAUSES OR FACTORS THAT PREDICT OR PREVENT THE
INCIDENCE OF LOW BACK PAIN AMONG FIRST LEAGUE
SQUASH PLAYERS IN THE WESTERN CAPE.**

CASE NUMBER_____

INVESTIGATOR:	S.B. BURDEN (UCT)
SUPERVISOR:	DR G. IRVING (GSH)

CONSENT FORM

In order to try and help determine any common causes or factors, if any, for Low Back Pain in top League Squash players, I hereby consent voluntarily, to undergo a series of tests and non-invasive measurements and to complete a questionnaire.

The tests to be completed include tests for flexibility and muscular imbalances between abdominals and back extensors. Measurements will be taken of height, weight, skinfolds, leg lengths and girths.

The questionnaire covers aspects of my training, playing and injury history while playing squash and other sports.

I understand that the information from my tests and questionnaire may be used for reports and research publications. I understand that my identity will not be revealed.

I _____ hereby declare that I have read and understand the details of the above-mentioned tests, measurements, questionnaire and have had all of my questions answered to my satisfaction. I agree to participate in these tests to the best of my ability in compliance with the protocol.

SIGNED: _____

DATE: _____

INVESTIGATOR: _____

DATE: _____

QUESTIONNAIRE

Club _____

Team/League _____

At what age did you start playing Squash? _____ yrs

At what age did you start playing Senior League Squash? _____ yrs

How many years have you been playing 1st League? _____ yrs

How many years have you missed playing 1st League

through business, ill health, injury etc _____ yrs

Actual no. of years playing 1st League Squash _____ yrs

TRAINING (June 1991 - June 1992)

Did you play Squash all year round? Y__ N__

only during League season? Y__ N__

Besides playing the game and courtwork skills, did you do other forms of training
for your Squash? Y__ N__

If yes, please indicate which: Endurance (road running) _____

Strength (weight trg) _____

Flexibility (stretching) _____

Speed (sprints/fartlek) _____

During League, how many times do you play per week _____

Total time playing _____ hrs/wk

Do you warm up before training/playing? Y__ N__

Do you cool-down/stretch after playing? Y__ N__

Are you presently participating in more than one sport? Y__ N__

If yes, name the other sports:

_____ Team/social _____ x/wk _____

_____ Team/social _____ x/wk _____

_____ Team/social _____ x/wk _____

_____ Team/social _____ x/wk _____

Have you experienced any low back pain in the last year

i.e. June 1991 - June 1992; while playing other sports? Y__ N__

Did you ever experience low back pain, before June 1991, while playing other sports? Y__ N__

Have you consulted your doctor/hospital about your low back pain? Y__ N__ N/A__

Did your doctor confirm the cause(s) of your low back pain? Y__ N__ N/A__

If yes, what was the cause of your low back pain?

Bone_____

Ligament_____

Muscle_____

Disc problems_____

Tension_____

Overweight_____

Inherited_____

Arthritis_____

Abnormality_____

Sciatica_____

Spondylolisthesis_____

Spondylolysis_____

Inflammation_____

Sporting activity_____

Other_____

Has your lower back been X-Rayed? Y__ N__

If yes, when were they taken? this year__ 1-2yrs ago__

>2yrs ago__

Have you had any other investigations on your lower back? Y__ N__ Date

If yes, please indicate which of the following and when: CAT Scan _____

Mycelography _____

NMR _____

other _____

Have you had any treatment for low back pain? Y__ N__ N/A__

If yes, which of the following provided treatment?

General Practitioner__ Specialist__ Physician__

Surgeon__ Hospital__ Physiotherapist__ Chiropractor__

Other (describe)_____

Was an operation performed?

Y__ N__

If yes, what was the nature of the operation?

After treatment, have you had further episodes of low back pain again?

Y__ N__ N/A__

Have you ever suffered any other injury, while playing sport, which has prevented you from participating for longer than 2 weeks?

Y__ N__

If yes, please give details of the injury i.e. R arm, fractured wrist, POP 4 weeks, no physio, returned to sport

Occupation

Have you ever been absent from work as a result of low back pain?

Y__ N__ N/A__

If yes, (i) how many times in the last year

(ii) for what length of time?

At work, how do you spend most of your time?

Sitting_____ Standing_____ Driving_____ Working with heavy machinery_____

Other_____

Do you smoke at present?

Y__ N__

On average, how many cigarettes do you smoke/day?

For what period of time have you smoked?

_____yrs

If you did smoke, when did you give up?

EVALUATION

Name _____

Date of Birth ____

Height _____ cm

(Age _____ yrs)

Weight _____ kg

Posture:

Lumbar lordosis

Scoliosis:

upper

lower

mobile

fixed

_____ R / L

_____ R / L

postural / compensatory

Flexibility / Pain:

Repeated forward flex

Forward flexion _____ cm

Repeated Ext / Hyperext

Single Ext / Hyperext

Repeated lat flex R _____

L _____

Lateral flexion: R _____ cm

L _____ cm

Rotation: R _____ °

L _____ °

SLR: R _____ °

L _____ °

Hamstrings: R _____ °

L _____ °

Thomas test R _____

L _____

Patrick's test R _____

L _____

Patient Report

Pain PL

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Y N _____

Leg Length:

ASIS - MM

TT - MM

R _____ cm L _____ cm

R _____ cm L _____ cm

	Sit, reach & hold		_____ cm	
	Trunk extension		_____ cm	
Anthropometry:	Iliac Ht	R_____	L_____	
	Trochanterion Ht	R_____	L_____	
	Tibiale Ht	R_____	L_____	
	Subgluteal G	R_____	L_____	
	Mid-thigh G	R_____	L_____	
	Supra-patella G	R_____	L_____	
	Subpatella G	R_____	L_____	
	Mid-calf-G	R_____	L_____	
	Ankle G	R_____	L_____	
	Subglut - suppat	R_____	L_____	
	Subpat - ankle	R_____	L_____	
	Skinfolds:	Bicep		_____
		Tricep		_____
		Subscap		_____
	Suprailiac		_____	
	D & W		_____ %	
	Pec		_____	
	Abdom		_____	
	Thigh	R_____	L_____	
	J & P		_____ %	
	AVE		_____ %	
	Calf	R_____	L_____	
	Vol thigh	R_____	L_____	
	Lean Vol thigh	R_____	L_____	
	Vol calf	R_____	L_____	
	Lean vol calf	R_____	L_____	
Muscular endurance:	Abdominals		_____ sec	
	Back extensors		_____ sec	
	Abdom/back ratio		_____	

Please indicate, using the given key, where you experience your pain/discomfort.

- KEY:**
- || - *pain*
 - - *pins and needles*
 - × - *ache*
 - = - *numbness*

