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IS ILIOTIBIAL BAND FRICTION SYNDROME A RISK FACTOR FOR BUTTOCK AND/OR POSTERIOR THIGH PAIN IN COMRADES' RUNNERS?

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

Johannesburg, 2001

DECLARATION

I, Susan Lyn Fuller-Good, declare that this thesis is my own work. It is being submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.



26th day of NOVEMBER 2002.

ABSTRACT

Long distance running is characterised by a high injury rate (van Mechelen, 1995; Lysholm and Wiklander, 1987). It is an ever-growing sport, being tried by increasing numbers of people with varying degrees of athletic ability. Injuries are detrimental to training, increase the risk of sustaining another injury, and are expensive to treat placing demands on our already strained health care system. Runners are healthy people who would require less health care than most people if they could avoid injuries. Iliotibial band friction syndrome (ITBFS), is one of the most common running injuries experienced. Buttock and/or posterior thigh pain (BAOPTP) is another common condition, which is also resistant to treatment. It tends to become chronic and to result in ongoing morbidity.

This retrospective study aimed to determine whether a relationship existed between ITBFS and BAOPTP. It also sought to establish what this relationship was and what the other risk factors were for the development of one or both conditions. It was a further aim of this study to determine the incidence of these conditions. The 1999 Comrades ultra-marathon road race entrants' opinions were used for the purpose of determining the incidence of these conditions.

A questionnaire designed, tested and validated was then used to elicit information from a sample of convenience of entrants of the 1999 Comrades Marathon. Runners were approached when they registered for the race at the pre-race Durban exposition. This was held in the three days prior to the race. Respondents were asked to complete a questionnaire immediately they received it (n = 978, males = 771; females = 187). The questionnaire contained 45 questions and took approximately ten minutes to complete. The questionnaire was divided into four sections. The first questioned the runner about his/her demographic data, training schedule, body mass index (BMI), running history and the use of stretching and cross training. The second section questioned runners about the presence of ITBFS and was only to be completed by runners who had suffered from this condition. The third section questioned the runners about the presence of BAOPTP and was for completion only by runners who had ever suffered from such symptoms. The fourth section obtained general information regarding runners' attitudes to physiotherapy, what they did to treat their injuries, whether they would be interested in doing core strengthening exercises and their expected finishing time for the 1999 Comrades

Marathon. Section 4 questions were mostly for interest value. All respondents were requested to complete this section.

Thirty six percent of the total study population runners had suffered from ITBFS at some time during their running careers. Thirty four percent of the total study population had suffered from BAOPTP and 14% had had both of the injuries in their running careers.

A relationship was found to exist between ITBFS and BAOPTP, which seemed to indicate that ITBFS was a risk factor for BAOPTP. The most important risk factors identified for both conditions seemed to be inadequate stabiliser muscle control and habitual "pelvic slouching" for ITBFS. In the presence of ITBFS, both of these factors were important for BAOPTP. Resting from training for a month after Comrades was protective for BAOPTP in the absence of ITBFS. Other factors identified as being relevant were posture, BMI, age and gender. Having a flat back, a higher BMI, being over 50 years old for ITBFS and ITBFS and BAOPTP together, but being under 36 years of age for BAOPTP alone, and being male were protective factors as found in this study.

In conclusion it appears that ITBFS may be a risk factor for BAOPTP.

Keywords:
Long-distance running
ITBFS
BAOPTP
Hamstring muscles
Lumbar spine
Lumbar pelvic dysfunction
Sacroiliac joint
Stabiliser control

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GLOSSARY OF TERMS

Iliotibial band friction syndrome (ITBFS): overuse injury caused by friction of the iliotibialband (ITB) over the lateral epicondylar prominence of the femur (Noble, 1980).

Iliotibial tract: (IT tract) band of fascia latae which runs laterally down the thigh, from the ilium to the tibia.

Iliotiobial band: (ITB) another name for the same structure.

Buttock and/ or posterior thigh pain (BAOPTP): the collective name given for the purposes of this study, to pain felt in this region whatever the cause. It is incorrect to refer to pain in its area of referral as opposed to in its area of origin, however to avoid writing the entire explanation every time it was decided to use this term This term describes pain from;
Sciatic nerve irritation or tethering,
L5 dermatomal referred pain,
Somatic referred pain from one of the soft tissue structures of the lumbar spine or pelvis,
Hamstring tendonitis at the muscular- tendinous- junction,
Hamstring muscle tears or strains.

Fascia: a thin layer of connective tissue, covering, supporting or connecting the muscles or inner organs of the body.

Kinetic chain: The kinetic musculoskeletal system is broken down into many subsystems, which are described as kinetic chains. The joints form the linkages in the chain, which may be an open or a closed chain. The mobility and stability of the human body is determined by the kinematic constraints which the muscles (active elements), and the ligaments (passive elements) impose on the chain (Tullberg et al, 1998).

Servomechanism: a neuromuscular feedback mechanism, controlled centrally, which relies on afferent input from sensory nerves within joints (Huston and Wojts, 1996).

Form closure: stabilisation of the sacroiliac joint, by interlocking of the ridges and grooves of the joint surfaces (Vleeming et al, 1996). The wedge shaped sacrum is stabilised between the innominates. The most stable position is in a degree of nutation (sacral extension)(see figure 1).

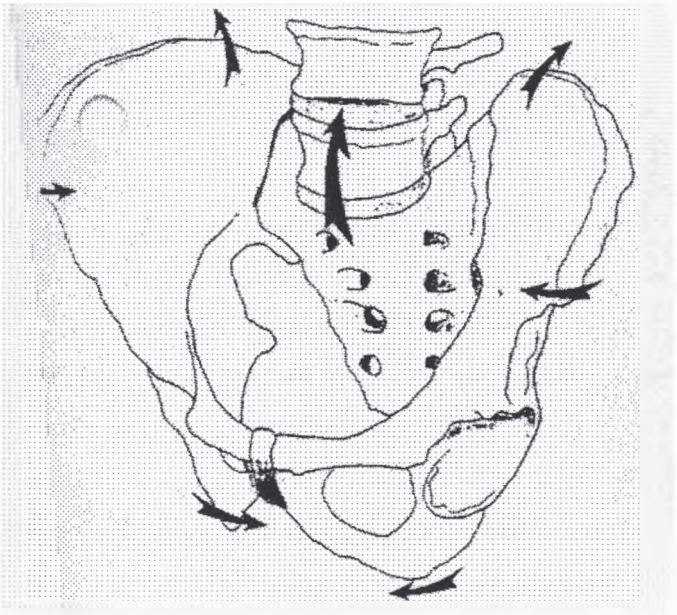

Figure 1: Anterior view through pelvic girdle.
Osteokinematic motion of the pelvic girdle during extension or lordosis
Diagram according to Hertling (1996) (with permission).

Force closure: stabilisation of the sacroiliac joint by compressive forces of the muscles, ligaments and fascia (Vleeming et al 1996). This is especially necessary during unilateral loading of the legs. Can be provided by structures with a fibre direction perpendicular to the joint. This has also been termed "the self-locking" or "selfbracing" mechanism of the sacroiliac joint (Vleeming et al 1997).

Trigger points: small, hypersensitive regions in muscle, which stimulate afferent, nerve fibres, causing pain. The sensation is a deep tenderness with an overlying increase in tone creating a palpably tender band of muscle, and eliciting a "jump sign" when palpated (Travell and Simons 1992).

Lumbosacral angle: the angle formed by the first sacral segment and the horizontal. The size of the angle varies depending on pelvic position and it affects the lumbar curvature. (Hertling 1996)

Dysfunction: abnormal mobility, either hypermobility, instability, or hypomobility, despite the presence of pain (Lee 1996). By itself pain is a poor indicator of dysfunction as it may be seen distant to the site of dysfunction.

Instability: a loss of the functional integrity of a system which provides stability (Lee, 1996). Or the presence of an excessive range of abnormal movement, for which inadequate protective muscular control exists (Willard 1997).

Postural or tonic muscles: stronger muscles which tend to tighten in response to physical stress or injury, usually biarticular, reduce range of movement and tend to develop painful trigger points. These muscles have a lower irritability threshold, when tightened. This causes them to be activated earlier than normal in a movement sequence (Richardson and Jull 1995).

Phasic muscles: are antagonistic to the postural type. Tend to weaken and lengthen with inactivity and injury, This causes stretch weakness as the muscle remains in a lengthened position, beyond its normal resting length, but within its normal range, it is also reciprocally inhibited by its antagonist (Richardson and Jull 1995).

Anteriorly rotated innominate: innominate torsion, in which the ilium is rotated forward in the sagittal plane.

Posteriorly rotated innominate: innominate torsion in which the ilium is rotated backwards in the sagittal plane.

Sway back posture: long kyphosis with pelvis the most anterior body segment, flattened low lumbar area, hyperextended knees (Norris 1995).

Flat back posture: loss of lordosis with pelvis in posterior tilt, hip and knee joints hyperextended, forward head posture (Norris 1995).

Neutral lumbo-pelvic posture: anterior superior iliac spines in same horizontal plane, pubis and anterior superior iliac spines in same vertical plane. A neutral pelvic tilt is implied by the term. A situation of perfect postural balance in the lumbo-pelvic area in which state the body mass is distributed so that the muscles are in a state of normal

tonus and ligamentous tension is balanced against compressive forces (Richardson. and Jull 1995).

Lower quadrant: the area of the body below the thoracolumbar junction, or there about, this is a loose term.

Self-bracing: Several muscles are supposed to contribute to force closure of the sacroiliac joint. These muscles have been described as comprising three muscle slings, the longitudinal, the posterior oblique, and the anterior oblique slings. Contraction of these muscles can directly optimise stabilisation of the sacroiliac joints (Pool-Goudzwaard et al 1998).

"Pelvic Slouch": the name given by Evans (1979) to the position in which the pelvis hangs on the IT tract, and locks the knee into hyperextension in order to make it a solid "pillar". There is some hip adduction and some extension in the supporting leg. Resting on the hip ligaments provides the support in the supporting leg. The centre of gravity is close to the supporting leg. This is seen in Figure 10.

LIST OF ABBREVIATIONS

BAOPTP	-	Buttock and/or posterior thigh pain
ES	-	Erector spinae
IT	-	Iliotibial
ITB	-	Iliotibial band
ITBFS	-	Iliotibial band friction syndrome
ITBS	-	Iliotibial band syndrome
LD	-	Latissimus dorsi
MRI	-	Magnetic resonance imaging
QL	-	Quadratus lumborum
SI	-	Sacro iliac
SIJ	-	Sacro iliac joint
TFL	-	Tensor fascia lata

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CHAPTER 1

1.1 BACKGROUND TO THE SUBJECT

Long-distance running is a popular sport among all population groups in South Africa. Road running is accessible to everyone and does not require specialised or expensive equipment to get started. All it requires, according to Cottrell, is a desire to run, and a lot of determination and perseverance (Cottrell, 1999). It is especially ultra-marathon running which has captured the imagination of so many South African people. This is largely due to the Comrades Marathon, which for 74 years has been run by thousands of athletes through the gruelling terrain between Durban and Pietermaritsburg. This "Race of Heroes" was entered by approximately 14000 runners in 1999 (Falconer and Collins, 1999 p11). To some, the Comrades Marathon is a painful experience; others see it as a great mountain to be climbed. "To non-runners it is an inexplicable juggernaut of moving humanity" (Falconer and Collins, 1999 p11). Perhaps this quotation by Falconer and Collins captures the spirit of the event. Professor Tim Noakes writes in the introduction to his book, *The Lore of Running*: "This year I would finally defeat the coward within, and so commence the hero's life" (Noakes, 1992 p8). Since its inception in 1921, the Comrades Marathon has, according to Cottrell grown and become recognised as the greatest ultra-marathon road race in the world (Cottrell, 1999).

Approximately 11% of Americans are joggers and more than 70 000 Americans have completed a marathon (Lehman, 1984). These statistics would be even higher for South Africans (Cottrell, 2002). Paralleling the increase in amateur sports participation, there has been a marked increase in the incidence of overuse syndromes (Lehman, 1984). Running is a healthy form of recreation that encourages cardio-vascular fitness, and it is a highly effective form of stress-management (Noakes, 1992; van Mechelen, 1995). Injury, however, is enormously destructive, especially to a runner, and therefore any information that can be used to prevent and more effectively treat running injuries is valuable and should be disseminated among medical personnel, coaches and athletes. Cottrell states that South Africa's long-distance runners have proved that they are among the best in

the world, and he maintains that it is important that aspiring athletes get a chance to develop into future champions, if they have the potential to do so (Cottrell, 1999).

Ultra-distance athletes suffer from a high injury rate. According to Lysholm and Wiklander (1987) in their retrospective study of 60 runners followed for a year, the injury rate was two and a half injuries per thousand hours of training in long-distance runners, and 40% of these injuries were due to intrinsic risk factors. Since no control group was used for comparison of risk factors it was unclear how mal-alignment was determined. Training errors have been implicated as the most common cause of injury (Lysholm and Wiklander, 1987). It is a widely accepted fact that a previous injury is the greatest risk factor for sustaining a new or recurrent injury (Krivickas et al, 1996). Lysholm and Wiklander (1987) found that the incidence of injuries in long-distance runners was lower than in middle-distance runners or sprinters. Despite this fact, an equal number of involuntary rest days were found in all groups over a twelve month period, suggesting a longer duration of symptoms in long-distance runners. These findings should be considered with caution as this study was poorly researched and the method section was described in a very unscientific manner.

By applying stress to the body in excess of homeostatic demands, physiologic changes are induced to cope with the stress. However, the borderline between the training load that induces the right level of stress to induce the desired effect and the training load that over-stresses the collagenous tissue and produces injury, is poorly defined and very fine (Lehman, 1984).

According to Sahrmann, musculoskeletal pain syndromes are the consequences of habitual imbalances in the movement system rather than isolated precipitating events (Sahrmann, 1990). There is a contribution to pathology made by both static and dynamic postures, body alignment and neuromotor function. Watson (1996), wrote a paper on "Neuromusculoskeletal physiotherapy: Encouraging self management", in which he states that perhaps previous microtrauma related to mal-aligned posture and poor biomechanics irritates the tissues, eventually producing a nociceptive pain syndrome which may present as an overuse syndrome. It is as essential for the cause of pathology to be understood as for the correct diagnosis to be made, if treatment is to be of maximum benefit and healing is to be complete.

Iliotibial Band Friction Syndrome (ITBFS) is one of the most common running injuries reported in long-distance athletes (Orchard et al, 1996). Under diagnosis of the condition results in prolonged morbidity and inadequate understanding of the aetiology of the condition often renders the treatment ineffective. According to Linenger and Christensen (1992, p100), "the pain, loss of training time, disruption of training schedules, increased health care expenditures, permanent disability and extensive rehabilitation time sometimes caused by Iliotibial Band (ITB)" are potentially eliminated with quick and accurate diagnosis.

1.2 STATEMENT OF THE PROBLEM

ITBFS is a very common running injury, and it often becomes a chronic problem, which produces ongoing pain and inhibits performance (Aronen et al, 1993). Buttock and/or Posterior Thigh Pain (BAOPT) is an almost equally common injury, which is very resistant to treatment (Lysholm and Wiklander, 1987). Inadequate assessment and poor diagnosis of the causes of injury result in prolonged morbidity (Satterthwaite et al, 1999, van Mechelen, 1995).

It is necessary to establish whether the two conditions are related in any way. Are there any aetiological factors, which have not yet been identified which, if identified, could lead to more effective treatment, less chronicity, and less chance of ITBFS leading to BAOPTP at a later stage? The risk factors for the injuries need to be identified.

1.3 SIGNIFICANCE OF THE PROBLEM

Long-distance running is an ever increasingly popular sport in the world today (Wen et al, 1997) and especially so in South Africa. The number of Comrades entrants increases every year, and with the increase in participants goes a corresponding increase in injuries (Wen, 1997). Injury rates in runners as reported in several studies are estimated to be at a yearly incidence of 37-56% (Wen et al, 1997). Injuries are detrimental to running, are costly to treat, and should be prevented at all costs, and if not prevented, then should at least be effectively managed. Preventive measures should be based on the outcome of research that has identified risk factors according to the well-described introduction to Van Mechelen's study (1995).

According to Van Mechelen et al (1996), sports injuries can result from a complex interaction of identifiable risk factors at a given point in time, however only a fraction of these risk factors has been identified. These risk factors need to be identified and quantified if the risk of injury is to be reduced. Research is necessary to accomplish this and make available the knowledge medical professionals need in order to assist athletes.

ITBFS has been described as one of the most common lower limb injuries seen in long-distance runners (Orchard et al, 1996). It has also been described as being one of very few injuries which actually prevents running, due to the nature and intensity of the pain it causes (Noakes, 1992). BAOPTP has been the source of much less interest and research. It is a problem that is also extremely resistant to treatment (Heiser et al, 1984). Noakes (1992), describes chronic hamstring injuries as the most common injury seen in really elite long-distance runners.

Muscle imbalance occurs when muscles become constantly shortened or lengthened in relation to each other (Norris, 1995). Muscle imbalance is the ratio between the strength or flexibility of the agonist and antagonist muscles acting over a joint (Kendall et al, 1993). The stabiliser system is the system which comprises the stability synergists (Richardson, 1992). These are single joint muscles, aligned to oppose gravity and approximate joints. These muscles are prone to waste with disuse and to become more fast twitch-type muscles with limited endurance (Norris, 1995). Long - distance runners are prone to develop muscle imbalances (Noakes, 1992). Heiser et al (1994) found that isokinetic testing and rehabilitation of muscle imbalances can prevent hamstring strains, it can be assumed that muscle imbalances are a major causative factor in hamstring injury development as well as in ITBFS development.

There is inadequate information regarding whether the poor postural habits and muscle strength imbalances commonly seen in the running population are relevant to the development of injuries.

1.4 JUSTIFICATION FOR THE RESEARCH

Chronic running injuries result in pain, loss of training time, disruption of training schedules, increased health care expenditures, possible permanent disability and

extensive rehabilitation time. Knowledge of the risk and perpetuating factors makes quick treatment and accurate intervention possible, which must prevent the problem from becoming chronic. Inadequate research has been done into the subject of BAOPTP in long-distance athletes. The existence of a relationship between ITBFS and BAOPTP has not been explored.

1.5 THE PURPOSE OF THE STUDY

The purpose of the study was to establish:

1. Whether a relationship exists between ITBFS and BAOPTP.
2. To ascertain what relationship exists.
3. To establish what the incidence of either and both injuries is in the ultra-marathon population.
4. To identify the risk factors for either and both of the injuries.

It was the sub-purpose of this study to use the information obtained from the runners themselves to make recommendations for how these injuries can be prevented and most effectively treated should they arise.

1.6 REASONS FOR STUDY

Much research has been done on the subject of ITBFS, less has been done on the subject of BAOPTP. However, to the author's knowledge, no previous research has been done to establish whether the two injuries are connected in any way.

The contribution of poor posture and inadequate stabiliser control to the development of ITBFS and hamstring pain has not been studied. It has been suggested that gluteus maximus weakness contributes to ITBFS development (Anderson, 1991). It has been found that imbalance between quadriceps strength and hamstring strength contributes to the incidence of hamstring muscle tears (Heiser et al, 1984; Huston and Wojtys, 1996). The contribution of imbalance between the gluteal muscles and the hamstrings does however not appear to have been studied. If a relationship is found to exist between ITBFS and BAOPTP, then knowledge of this relationship, should be used to attempt to prevent an injury cycle from developing in future ultra-distance runners.

It was suspected that a lack of stabiliser strength was a fundamental predisposing factor for one or both of the injuries. If stabiliser control can be proven to be an

important causative factor, then exclusive running in a training programme, failure to stretch, poor training techniques and excessive distance training, as well as allowing de-conditioning to occur in the off season, may be less important as predisposing factors. This is contrary to what has previously been understood (Sutker et al, 1981; Noble, 1979; Noble, 1980; Orchard et al, 1996).

The relation of low back, gluteal or hip pain and disorders of Sacoiliac Joint (SIJ) mobility has not been not well investigated. Nevertheless its existence is recognised (Egund et al, 1978). It is possible that the SIJ and pelvic region may be the connecting factor between these two seemingly unrelated injuries. Knowledge of the connection provided by the pelvis makes a relationship between the two a feasible possibility. Cibulka et al (1998), in their very accurate and complex study on the changes in innominate tilt after SIJ manipulation, concluded that SIJ disease may be responsible for many cases of altered muscle length. An anterior tilt of the innominate bones could stretch the hamstring muscles, which would predispose them to injury. Conversely a posteriorly tilted innominate would shorten the hamstrings, which would produce an effect on the ITB (biceps femoris tendon is connected to the band) (Marshall et al, 1972), as well as on the lower back and possibly even on the sciatic nerve (Elvey, 1995). Carmody and Prietto (1995) reported a case study, as well as a literature review, in which they demonstrated that injury to the hamstrings could lead to entrapment of the sciatic nerve, with a resultant neuropathy.

The questionnaire was also to be used to ask the runners for their opinions on the use of physiotherapy, in the face of injuries. This is very relevant at a time when our profession is under threat from other disciplines. Knowledge of the public's opinions about physiotherapy is critical to our profession.

1.7 STATEMENT OF THE RESEARCH QUESTION

1. Is there a relationship between ITBFS and buttock and or posterior thigh pain?
2. What is the relationship between ITBFS and BAOPTP?
3. What is the incidence of each of these two injuries in the ultra-distance running Community?
4. What is the incidence of concurrence of both injuries?
5. What are the risk factors for each and both injuries?

1.8 APPROACH TAKEN TO ANSWER THE RESEARCH QUESTION

It was decided to use the Comrades running community as a sample of ultra-distance runners. A questionnaire was designed which asked the runners about the commonly accepted risk factors. It also asked them about their postural habits, and about certain signs which were considered to be a reasonable measure of the presence of "poor stabiliser control". Sahrmann (1990) described the inhibitory effect that assumption of these postures would have on the stabiliser system. The answers to the questionnaire were analysed so that the presence of these risk factors and poor postural habits were compared to the presence of the symptom of either ITBFS and/or BAOPTP. In this way it was ascertained what the actual risk factors were, according to the opinions of the runners. It was also possible to establish what the incidence of the injuries was, and to quantify the numbers of runners who had both injuries.

1.9 VALUE OF FINDING AN ANSWER TO THIS RESEARCH QUESTION

Injuries should be prevented wherever possible, especially in the ultra-distance running population where injuries are very destructive. So much time, effort and energy is invested in training for an ultra-distance event, and an injured runner will be unable to participate at all or at best will be severely disabled in the pursuit of their goal to complete the event. Knowledge of the risk factors for injuries enables medical professionals, coaches and athletes themselves to prevent injuries, treat them effectively should they arise, and avoid injury cycles from developing. "Running- related injuries call for prevention" (van Mechelen, 1995 p161). "Preventive measurers should be based on the outcome of research that has identified risk factors for running injuries" (van Mechelen, 1995 p161). This can only save the resources of our overloaded medical services, and enable essentially healthy individuals to remain healthy both physically and mentally (James et al, 1978).

1.10 TYPE OF STUDY

A retrospective study was performed to determine the prevalence and associated risk factors for ITBFS and BAOPTP. The study was performed by means of a questionnaire, completed by 978, of the 1999 Comrades runners. The data obtained from the questionnaires was computed and analysed. The analysis determined the

frequency of coexistence of these injuries as well as quantifying the risk factors associated with them.

CHAPTER 2

LITERATURE REVIEW

This chapter will explain the concept of distance running and the nature of the training required for the Comrades Marathon. It will examine the existing literature on ITBFS, hamstring problems and chronic posterior leg pain. It will conclude by offering an explanation for why the two injuries may be connected to one another.

The literature search was conducted largely through the Internet, using "Pubmed" as a search engine, as well as "Medline". Articles were sought from 1990 onwards. The keywords searched for included: ITBFS, ultra-distance running injuries, hamstring pain, pelvic dysfunction, SIJ dysfunction, stabiliser muscle system, muscle imbalance and poor stabiliser control causes. The remainder of the literature was searched by means of utilising the reference lists included in the articles produced by the Internet search. This increased the time span through which articles were used.

In this study, the symptoms of ITBFS and that of BAOPTP are both considered to be symptoms of dysfunction. Essentially, all injuries are a sign that dysfunction exists. Dysfunction may result from many causes: training incorrectly, biomechanical factors, incorrect footwear, to name a few (Noble, 1992).

These two injuries are related biomechanically. Their relationship to the pelvis needs exploration in order to understand this. The other important relating factor is the close anatomical relationship between the biceps femoris and the iliotibial (IT) tract.

A description of the relevant anatomy and the biomechanics of the lumbopelvic-hip and posterior thigh region are given, using the literature. The subjects of muscle imbalance and inadequate stabiliser control will also be examined.

2.1 LONG-DISTANCE RUNNING

This sport is ill defined. It usually describes athletes who run distances longer than middle-distance. These distances often amount to marathon and ultra-marathon distances (Lysholm and Wiklander, 1987). Training is aimed largely at increasing endurance and stamina (Lysholm and Wiklander, 1987). Regularity of training is the

key to success, and a rigid training schedule is followed in order to teach the body to be able to run excessive distances (Noakes, 1992; Fordyce, 1996).

In South Africa, the running calendar culminates in the Comrades Marathon which is the ultimate goal of many long-distance runners in the country and abroad (Fordyce, 1996). Running is usually characterised by a quest to run ever further, faster, which is the driving force behind many runner's continued motivation and need to run. This is an impirical observation and has not been scientifically proven. Long-distance runners suffer a high injury rate (van Mechelen, 1995; Lysholm and Wiklander, 1987).

2.2 LONG-DISTANCE RUNNING INJURIES

Wen et al (1997) did a study on runners enrolling in a marathon-training programme. They performed alignment measurements and the runners completed a questionnaire regarding training practices and injuries experienced over the preceding twelve months. They were able to conclude from their study that lower extremity alignment is not a major risk factor for running injuries. This was contrary to the findings of other researchers (Lysholm and Wiklander, 1987; van Mechelen et al, 1996). Wen et al's study (1997) did contain potential selection biases, and no mention was made of the inter-tester reliability of the tests used to ascertain malalignments.

Stanley et al (1978) attributed 60% of injuries seen in the runners they studied to training errors. They did not quantify the effect of biomechanics, although they did discuss its importance. The article was poorly researched, although it was a comprehensive paper.

Van Mechelen et al (1996) reported an injury incidence rate of 3,7 per 1000 hours of sports participation. They determined that predictors of risk included vital exhaustion, stressful life events, previous injury, and exposure time. This was a well-conducted trial and can be compared to Lysholm and Wiklander's finding (1987) of 2,5 injuries per 1000 hours of running, seen in marathon runners. It would seem from this that the injury rate might be lower in marathon runners than in other sports people, if their results are to be accepted.

Most running injuries are musculoskeletal injuries of the lower extremities and are of an overuse nature (van Mechelen, 1995). Van Mechelen has already been quoted as saying that running related injuries call for preventative action.

2.3 THE ANATOMY OF THE LUMBAR-PELVIC-HIP REGION

Much of what has been written about the sacroiliac joint (SIJ) and pelvis has been based on cadaveric studies, which have been performed on cadavers that are not fresh. These studies have been used because they are all that is available. However, their limitations are recognised since they have made use of preserved tissues in their investigations.

The pelvic girdle is the link between the lower limbs and the spine (Friberg, 1983). Ligaments and fascia connect the lumbar spine, pelvis and the femur. In order for humans to walk bipedally certain adaptations have been made, one important adaptation being the gluteus maximus, which has become extremely enlarged and its attachment has become extensive when compared to, for example, the chimpanzee (Vleeming et al, 1997).

Aside from muscular connections, between the spine and the pelvis, there are numerous fibrous connections. Owing to these fibrous connections, any movement of the sacrum with respect to the iliac bones also affects the joints between L5 and S1 and the joints of the higher spinal levels (Vleeming et al, 1996). Due to the tightness of these fibrous connections and the architecture of the SIJ, only limited mobility of the joint is possible (Don Tigny, 1993). However, there may be a greater than normal amount of movement due to trauma, repetitive overload, inflammation, hormonal laxity or heredity. It is possible for concurrent hyper and hypomobility to exist, with decreased mobility being demonstrated in one direction and excessive mobility in the other direction (Hesch, 1997).

Sturesson et al (1988) did a study in which they accurately examined SIJ movement as seen on roentgen stereophotogrammetry in normal physiologic positions as well as in the extremes of physiologic positions. They found the movements to be small and they found no difference between symptomatic and asymptomatic joints. They concluded that mobility under load could not be used to identify a sacro Iliac (SI) dysfunction.

The sacrum is mechanically associated with the spine and the ilium with the femur, both being affected by the movement of the other (Hertling, 1996). Hertling's chapter provides a succinct and thorough examination of the sacoroiliac and lumbar-pelvic hip complex; she has searched the literature, and summarised the findings of most of the most prominent writers on the subject. The SIJ's are flat joints, making them inherently unstable. The anatomy was poorly delineated until recently, due to the difficulty in dissecting the area (Bellamy, 1986). There was much dispute about the nature of the joint as well as about its classification. Also controversial was its contribution to lower back pain. Bellamy's article is not preceded by an introduction, and it is therefore difficult to know what his aim was in writing the paper. However, he summarised much of the early information available on the subject of the SIJ.

The confusion he described was clarified by Vleeming et al at the end of the 1980's when they managed to study the joint more thoroughly (albeit also on preserved specimens from their dissection room). They explained the previous findings of the ridges and grooves in the joint surface. He developed the current understanding that these are not pathologic changes as had been previously thought, but are functional adaptations (Vleeming et al, 1989). They established that the ridges and grooves provided stability in the joint due to their complimentary nature, and that the coarse texture of the articular surfaces as well as these roughenings lead to a high friction coefficient. These were dynamic developments for stability. They used 47 specimens for their study, and although most of the specimens were old (over 60 years), all of the younger specimens demonstrated the same phenomena, making their results very credible. They coined the phrase "form closure" to describe this adaptation for stability (Vleeming et al, 1997).

"Force closure" (Vleeming, 1995; in Lee, 1996), involves the compression of the SIJ in order to enhance its stability by increasing the friction coefficient (Vleeming et al, 1990). Spinal and pelvic muscles are either involved directly or indirectly in force closure of the SIJ. Indirect involvement includes the modulation of the tension of the ligaments and fascia (Dorman, 1997). Direct involvement involves contributing to force closure of the SIJ. Bellamy et al (1983) stated, in their lack of understanding of the intricate anatomy of the joint; the SIJ's are surrounded by the largest and most powerful muscle groups in the body, yet none of these directly influence joint movement.

With the benefit of the concept of force closure that subsequent literature has provided, the following are now described as directly involved muscles: erector spinae (ES), gluteus maximus latissimus dorsi (LD), and biceps femoris (Vleeming et al, 1997).

The ES has a dual function: the iliac component pulls the ilia together posteriorly, and the sacral component nutates the sacrum and tenses the sacroiliac ligaments (Vleeming et al, 1997). Gluteus maximus muscle is ideally suited to compress the SIJ (Pool-Goudzward et al, 1998), owing to its perpendicular orientation to the joint (see Figure 2) (Hertling, 1996). It is a short, multipennate muscle designed for power and since its bony attachments are close to the SIJ's and the hips, its action involves a large trans-articular force (Vleeming et al, 1996).

Vleeming et al (1995) found that in all their specimens, parts of the gluteus maximus fascia were continuous with the superficial lamina of the posterior layer of the thoracolumbar fascia. Also that the deep fascia of the gluteus maximus, as well as the muscle itself, showed multiple connections with the sacrotuberous ligament, as well as with the long dorsal SI ligament. Its connections to the sacrotuberous ligaments augment its ability to compress the SIJ and therefore add to force closure, as well as modulating the tension of the ligaments and the fascia themselves.

Two explanations have been offered by Pool-Goudzwaard et al (1998) in their article's introduction, for the presence of mobility in the SIJs. One is for shock absorption (Snijders et al, 1993), and the other, as suggested by Grob et al (1995), is that proprioception is provided by the innervation of the joint capsule by the dorsal rami of the first to fourth sacral nerves.

Building an understanding of the thoracolumbar fascia has taken work by many researchers over a period of time. Bogduk, Macintosch (1984) and Twomey (1987), described the bilaminar structure of the posterior layer of the thoracolumbar fascia. The orientation of the fibres was described as caudomedial in the superficial layer and caudolateral in the deep layer. They describe the LD as the structure from which the superficial layer originates. Vleeming et al in 1995 established that the gluteus maximus also functions as the origin for the superficial lamina. They confirmed the crossing of the fibres at the lower end, stating that the level can vary from L2-S2. Some controversy

exists between the findings of these researchers regarding the existence of bands of collagen fibres in the deep layer. Vleeming et al (1995) found the thoracolumbar fascia to be a continuous layer of tissue which, according to their research, is connected to the sacrotuberous ligament. It would seem that Vleeming et al's model (1995) is simply a more complete model than that of the earlier researchers. They concluded that the thoracolumbar fascia has a bracing effect on the lower lumbar spine and SI joints. Its existence is essential for proper load transfer between the spine and the legs. Vleeming et al's research (1995) involved tractioning various structures and muscles and noting the effect on the thoracolumbar fascia as well as on the lumbar spine and pelvis. They thereby established the function of these structures with respect to this region.
Vleeming et al (1995) concluded that the gluteus maximus and contralateral LD tense the posterior layer of the fascia. They also established the effect of ES on the fascia. It inflates the fascia as it contracts, as well as increasing tension in the longitudinal direction in the deep layer.

Vleeming (1995), maintains that force closure can be generated by any structure with a fibre direction perpendicular to the joint, and conversely can be diminished by any structure which is dysfunctional and which is in a position to stabilise the joint. The authors succinctly termed this "the shear prevention system", characterised by the combination of these forces, the "selfbracing" or "selflocking" mechanism of the SIJ.

The gluteus maximus muscle and the contralateral LD muscle contract to form the oblique system. They pull on the thoracolumbar fascia, and this tension is enhanced by the contraction of ES muscle, which effectively inflates the thoracolumbar fascia, thereby stretching it (Vleeming et al, 1990). This system counteracts anterior shear (sacral nutation), and is supported by the sacrotuberous ligament and reinforced by the biceps femoris muscle. This oblique system provides stability during walking and running. There is an indirect contribution to force closure, by gluteus medius and minimus and the contralateral adductor muscles laterally and the abdominals and contralateral adductors anteriorly

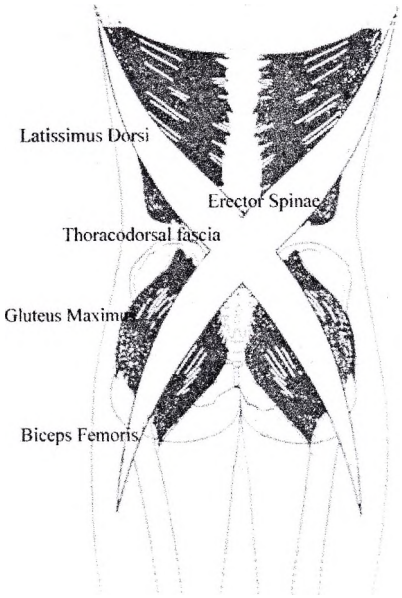


Figure 2: **Diagram to show the posterior oblique system**

Diagram according to Lee (1996) reproduced with permission.

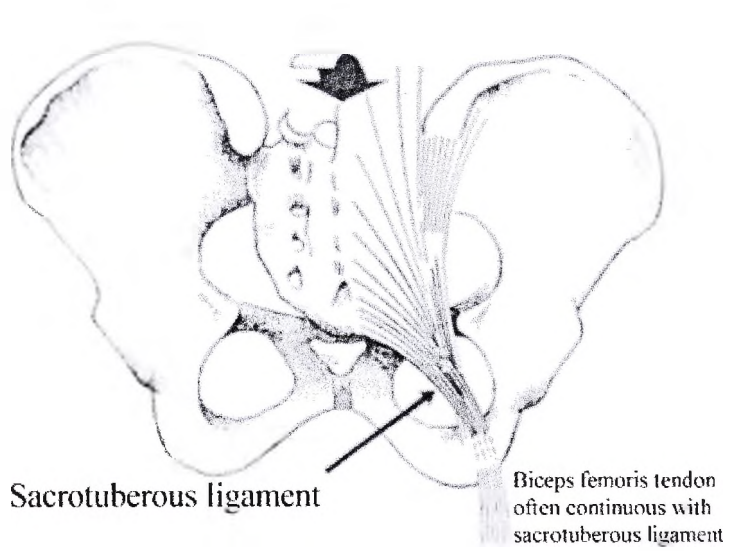


Figure 3: **Diagram to show the posterior view of the pelvis and the position of the sacrotuberous ligament**

Nutation winds up the sacrotuberous ligament.

Diagram according to Vleeming et al (1996) reproduced with permission.

Although these muscles have been found to be very important to pelvic stability, Wilke et al (1995) used a spine tester that allows for simulation of up to five symmetrical muscle forces. They determined the three-dimensional monosegmental motion of the spine by using an instrumental spatial linkage system. They concluded that multifidus has more effect than any other muscle in reducing the neutral zone and therefore stabilising specifically L4-L5 of the lumbar spine. The importance of this muscle must therefore not be overlooked.

Instability occurs when the functional integrity of a system that provides stability is lost (Lee, 1996). In the pelvic girdle, two systems contribute to stability: the osteoarticular-ligamentous and the myofascial systems.

Weakness or non-synergistic recruitment of the muscle groups, diminishes force closure, and leads to myofascial instability, with compensatory movement strategies to accommodate the weakness. Schneider (1994) proposes that the restraining structures of an individual lumbar segment may become weakened by degeneration. This causes a loss of stiffness in the restraints, and excessive or abnormal quality of movement may result at the affected segment. The stiffness of the soft tissues provides constraint to distorting forces, limiting excess displacement, and providing restoring stresses (Schneider, 1994).

2.4 ANATOMICAL CONNECTIONS BETWEEN THE ITB AND THE HAMSTRING MUSCLES

1. The gluteus maximus muscle, as well as the tensor fascia latae (TFL) muscle insert into the ITB (Renne, 1975), and the gluteus maximus fascia connects to the sacro-tuberous ligament (Vleeming et al, 1989), which in turn connects to the biceps femoris tendon (Vleeming et al, 1989; 1996).

2. The biceps femoris tendon has a fibrous attachment to the ITB at its distal end, as described in the detailed findings of Marshall et al (1972); tightness in one structure may be transferred to its neighbour.

3. The sacrotuberous ligament runs from the posterior anterior spine of the ilium and the third, fourth and fifth sacral segments to be inserted into the tuberosity of the ischium (Bellamy et al, 1983). Bellamy et al, stated that the function of these ligaments was to prevent backward displacement of the sacrum within the ring of the pelvis. This thought was developed

considerably by Vleeming et al (1989 and 1996). They described it as a triangular structure, which attaches to the posterior iliac spines, the SIJ joint capsule, and the coccygeal vertebrae. They described its function as being a resister of nutation of the sacrum, ascribing to it a dynamic role in pelvic stability, owing to its contribution to self bracing (1989).

Vleeming et al's (1989) in-depth dissection studies led them to uncover the common connection of the tendon of origin of biceps femoris to the ligament (see Figure 3), as well as to reveal that the tendons of the deepest laminae of multifidus extend into the ligament. These connections mean that both of these muscles contribute to the self-bracing of the SIJ (Vleeming et al, 1989).

4. The fascia of the posterior aspect of the piriformis muscle was also found to be continuous with the posterior SI ligament (Mooney, 1997). Thus, straining of the ligament could produce an effect in the piriformis muscle creating muscle spasm and its associated syndrome. Piriformis muscle attaches to the sacrum, sacrotuberous ligament, the margin of the greater sciatic foramen and the medial edge of the SIJ capsule. Distally it passes through the greater sciatic foramen to attach to the greater trochanter of the femur. Its contraction laterally rotates the thigh, as well as stabilising the head of the femur in the acetabulum. Since it attaches to the SIJ capsule, it also pulls the sacrum against the ilium, thereby contributing to force closure (Vleeming et al, 1989). Piriformis syndrome can produce "sciatica", due to the common passage of the nerve through or beneath the muscle.

5. Miesenbach, as early as 1911 (Miesenbach, 1911), knew that sciatica could be caused by direct pressure on the lumbar sacral plexus from a relaxed, subluxed or diseased SIJ. The gluteus maximus muscle which attaches to the ITB is inhibited in the face of SIJ pathology (Lee, 1996). Lee states that the gluteus maximus muscle is to the SIJ what the quadriceps muscle is to the knee joint. Any irritation or dysfunction inhibits the muscle. However, she does not substantiate this critically important statement, which is disturbing. If Lee's statement were correct, then a diseased SIJ would have an indirect effect on the ITB.

2.5 THE BIOMECHANICAL CONNECTION BETWEEN THE ILIOTIBIAL BAND AND THE SYMPTOM OF BUTTOCK AND/OR POSTERIOR THIGH PAIN

2.5.1 The Relationship in the Gait Cycle

The occurrences during the gait cycle have been succinctly and carefully examined by Hertling (1996), Vleeming et al (1995), as well as by Diane Lee (1996), among others. Each has examined different aspects of the pelvic girdle in the gait cycle, and this author has taken out what seems most relevant to the subject of the inter-relationship between the lumbar spine, pelvis, the hamstring muscles, the ITB and the soft tissues which connect to them.

Efficient gait requires both mobility and stability (Lee, 1996). Although Lee's article is well researched, much of her information has not been scientifically proved, as is the case with much that is written on the SIJ. She describes the compensatory strategies adopted when either mobility or stability is lost. Lee (1996) did a study on specific tests, which could differentiate between dysfunction being as a result of loss of form closure as opposed to loss of force closure. Her abstract states that efficient gait requires both stability and mobility within the pelvic girdle, and a variety of compensatory strategies are adopted when either is lost. The compensatory strategies themselves or the dysfunction within the pelvic girdle, which would result, may lead to pain or injury, either in the SIJ or elsewhere.

The fact that the tendons of gluteus maximus muscle and biceps femoris are connected to the sacrotuberous ligament enables these two muscles to support its function. They have a reciprocal action in the gait pattern (Lee, 1996). Weil and Weil showed in 1966, as quoted by Vleeming et al in their chapter on "The Coupling Role of the SIJ's" in the book *Movement Stability and Low Back Pain* (1997), that the hamstrings become active before heel strike in the gait cycle. As the biceps femoris relaxes the gluteus maximus contracts and takes over the role of hip extension. If the gluteus maximus is weak, according to Lee (1996), this is "catastrophic" to the gait. The stride length shortens, and the hamstrings are overused. They compensate for the loss of hip extensor power, and they develop repetitive strains.

The gluteus maximus should also fire with the LD of the opposite side to provide nutation, and force closure in the normal weight-bearing limb (Vleeming, 1989). A weakness of gluteus maximus, or a failure of either form or force closure would overload the biceps femoris. The biceps femoris would be overactive in its attempt to tighten the sacrotuberous ligament and thereby produce some force closure and stability.

The sacrotuberous ligament is helical in structure (Vleeming et al, 1996) The downward pull of biceps femoris on its tendinous attachment to the sacrotuberous ligament tightens the ligament and therefore adds to the force closure and stability of the SIJ (Don Tigny, 1993). The compensatory strategy for diminished force closure caused by weakness in the gluteus maximus muscle is overworking of the hamstring muscles.

Don Tigny (1993) wrote an eloquent, although complicated paper which aimed to review and revise the biomechanics and the pathomechanics of the SIJ. His purpose was to describe a new model, which accommodated the findings of many researchers who had presented their findings at the First Interdisciplinary World Congress on Low Back Pain and its Relationship to the SIJ. He achieved his aim and the model has been used in this study.

Don Tigny (1993) looks further at the contraction of the biceps femoris muscle, and its co-contraction with the quadriceps muscle. This co-contraction functions to pull the knee posteriorly into extension and decelerate and stabilise the pelvis concurrently. This is made possible by its tendinous insertion in the sacrotuberous ligament.

In the swing phase of the right leg, the sacrum nutates (see Glossary) on the right and counternutates (see Glossary) on the left (with respect to the ilia) (Lee, 1996) (see Figures 4, 5). The nutation is increased just before heel strike, when the hamstrings become active. As has been seen, this produces tension in the sacrotuberous ligament and adds to stability by enhancing force closure. The biceps femoris is connected to the head of the fibula and to the fascia of the peronei, and therefore, at this point, there is a concurrent tension in the fascia and the fibula

moves downward. This further tenses the biceps femoris and therefore the sacrotuberous ligament (Lee, 1996).

Vleeming takes this one step further by analysing the anatomy of the entire lower limb. The tibialis anterior contracts simultaneously to dorsiflex the foot and it attaches to the plantar side of the first metatarsal bone where it blends with the peroneus longus muscle, thereby forming a longitudinal muscle-tendon-fascia sling (Vleeming et al, 1997) (see Figure 6). The swing limb is thrown out ahead of the body and as it reaches the end of its range of movement, the body weight is pulled forward towards it. Body weight therefore acts as the prime mover.

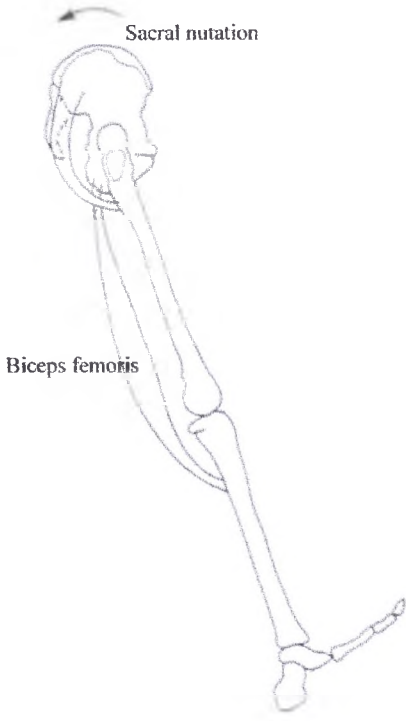


Figure 4: Diagram to show the relative forces during the early stance phase of gait

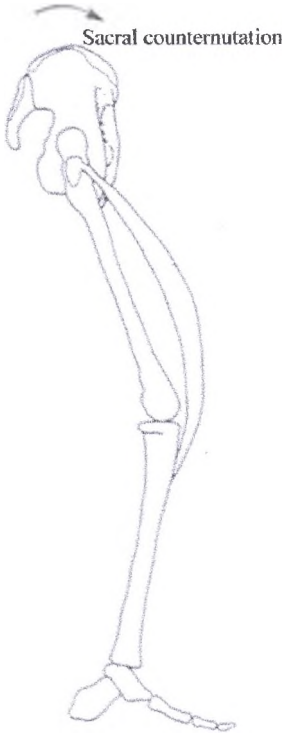


Figure 5: Diagram to show the relative forces during the swing phase of gait

Diagrams according to Hertling (1996), reproduced with permission.

From heel strike through midstance, the ipsilateral gluteus medius, minimus, TFL and contralateral adductors are active to stabilise the pelvic girdle on the femoral head. In the single leg stance phase, the right innominate begins to anteriorly rotate

relative to the sacrum, which counternutates on the right. This movement is resisted by the dorsal sacroiliac ligament (Lee, 1996; Vleeming et al, 1997). In the single support phase, the action of biceps femoris decreases and is replaced by the action of gluteus maximus, which is better placed to compress the SIJ (Lee 1996). The trunk counter rotates and the arm anteflexes, tensing the LD and the thoracolumbar fascia, (using the oblique sling), and producing a dorsal muscle fascia-tendon-sling (Vleeming et al, 1997) (see Figure 7).

2.5.2 The Iliotibial Band In The Gait Cycle

The tension in the gluteus maximus is partly transferred down in the vast IT tract (Ober, 1936). Evans (1979), who maintains that the gluteus maximus is not involved with the ITB since it does not insert into the vertical fibres of the tract, has contested this fact. The tract can indesputably be tensed by contraction of the tensor fascia latae muscle, and Evans asserts that this muscle has the greatest effect on the tract. None of these statements has been proven except by dissection study on preserved cadavers. These statements are based on interpretation of the anatomy. Many of the multipennate central fibres of gluteus medius arise from the overlying tract Evans does not dispute that this enables it to indirectly affect the tension in the tract (Evans, 1979).

The vastus lateralis muscle has also been implicated as being involved with the tract. It moves the tract by causing its expansion, when it contracts (Vleeming et al, 1997; Kujala et al, 1986). It is active in the single support phase of gait to counteract flexion of the knee. This contraction pushes the ITB laterally, thereby stretching it. The distal end of the ITB is part of the outer lateral capsule of the knee joint, and the direction of its collagen fibres lie perpendicular to the patellar tendon. In full loading of the knee with weight bearing, forward shear of the joint is prevented by tension through the thoracolumbar fascia, gluteus maximus and the ITB (Vleeming et al, 1997).

The presence of muscle slings allows for storage of energy. This energy can be used to minimise muscle action in gait, according to Dorman's theory (Dorman, 1992) (see Figure 7). Dorman, has conclusively proved his theory in his article. This energy storage is of critical importance to reduce the work of running. Any

dysfunction that interferes with this energy storing system vastly increases the work required to run. For summary of gait see Figure 6 (Greenman, 1997).

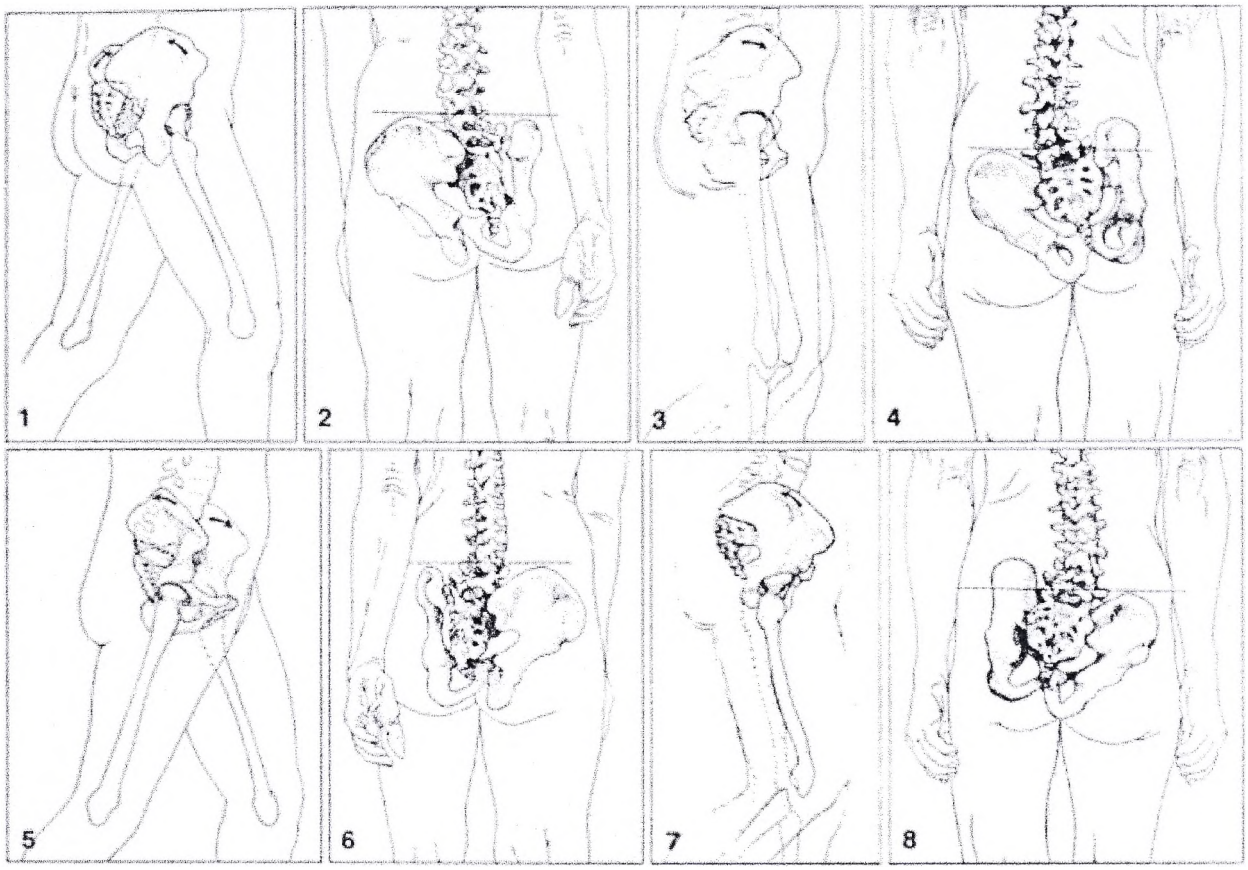


Figure 6: **Diagram to show combined activities of the right and left inmominates, the sacrum and the spine during walking**
Diagram according to Greenman (1997) reproduced with permission.

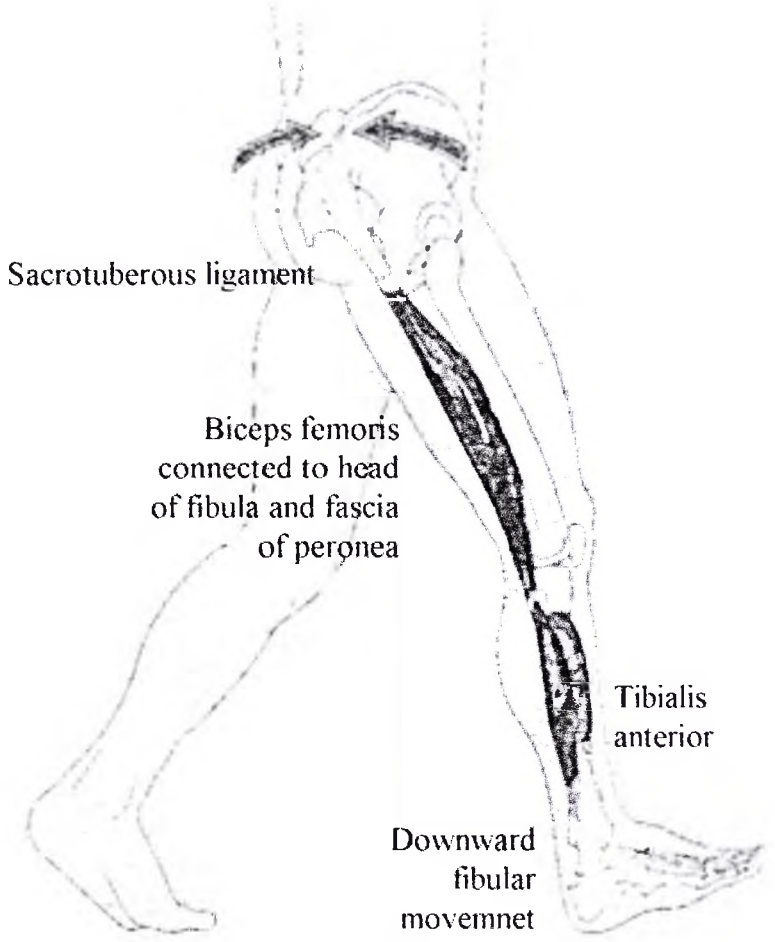


Figure 7: Diagram to show heel strike.

Diagram according to Vleeming et al (1997), reproduced with permission.

2.5.3 The ITB and the Hamstring Muscle Group in the Gait Cycle

The synchronicity of motion of the lower extremity and lumbosacral spine are essential (Pool-Goudzwaardt et al, 1998). Muscle weakness and insufficient ligament tension can diminish compression and cause dysfunctional load-transfer, with continuous strain and pain (Pool-Goudzwaardt et al, 1998).

As any step occurs, the weight-bearing thigh will progressively extend at the hip joint until the contralateral limb heel strikes. With this extension, the angle between the posterior thigh and the ischial tuberosity closes and biceps femoris needs to relax in order to maintain the appropriate pelvic and sacral angles (Dananberg, 1995). If the biceps femoris fires prematurely, it will resist the anterior rotation of the pelvis and

the gait cycle would become dysfunctional (Dananberg, 1995). The biceps becomes active just prior to the opposite limb heel strike and as heel strike occurs the pelvis rapidly reverses direction. The energy from the impact loads are stored for later use in the step (Dananberg, 1995). As the pelvic rotation reverses, the long dorsal ligament becomes taut, the sacrum counternutates and the pelvis posteriorly rotates. Danenberg's article is succinct, well researched and informative.

If the gait is for the purpose of running, then this motion becomes perpetual and rhythmical. Failure of hip extension results in increased fatigue, as this process is interfered with and additional muscular input is required to create forward motion (Dananberg, 1995). Diminished hip extension will result in compensatory strategies. The trunk will lateral bend, and the gluteus maximus/ITB complex will be overused (Lee, 1996).

Several pain patterns could be created by this compensation:

1. Pain in the quadratus lumborum (QL).
2. Greater trochanteric bursitis.
3. Lateral knee pain (ITBFS).
4. Disc compression pain related to rotation of the L5 motion segment, this latter response being due to QL's partial insertion into the iliolumbar ligament (Dananberg, 1997).

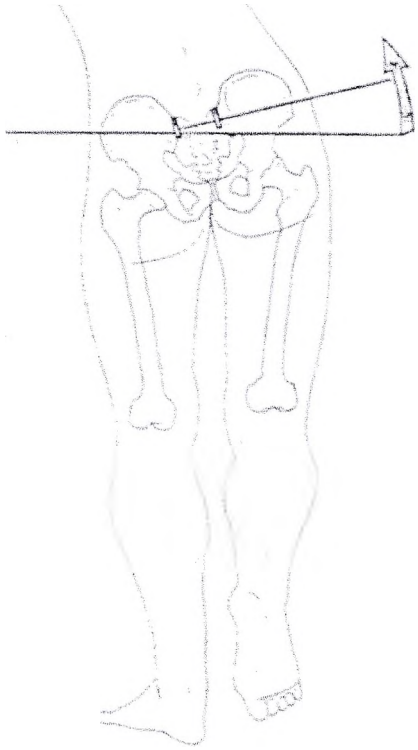


Figure 8: Non-compensated Trendelenberg

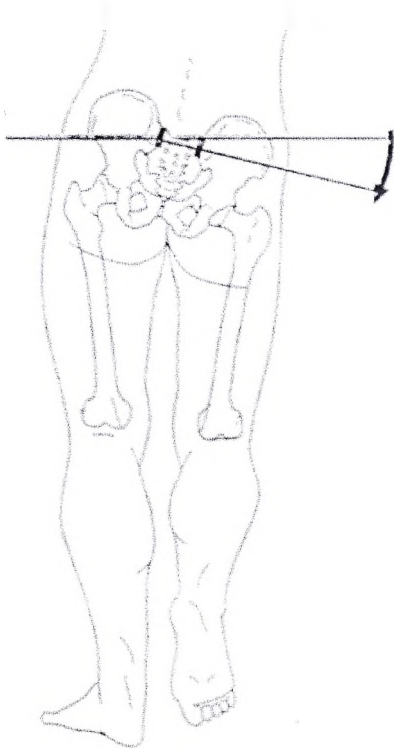


Figure 9: Compensated Trendelenberg

Diagrams according to Lee (1996), reproduced with permission.

Therefore, it is suggested that failure of hip extension may produce both ITBFS and BAOPTP at either the same or at different times. Failure of hip extension may lead to increased fatigue as well as an increased incidence of overuse injuries. It is suggested that unless hip extension is restored and the pelvis enabled to regain the ability to be stable in the weight bearing position, symptomatic treatment of any one of these pain patterns would be palliative only. While the injury may recover, the dysfunction may reproduce symptoms elsewhere in the kinetic chain. This has not been proven, however, the evidence suggests that this may be the case.

Don Tigny (1993 p4) also states that the gluteus medius and other hip abductors function in "a harmonious sequence with the gluteus maximus" to stabilise the pelvis horizontally. For this to occur, there must be adequate force closure of the SIJ's as well as adequate form closure, and the timing as well as patterning of muscle contraction in the area must be normal.

2.6 THE ANATOMY OF THE ILIOTIBIAL BAND

Renne (1975) was the first author to document findings on ITBFS. His simple explanation of his findings in military conscripts was the basis of the modern understanding of the condition. The ITB is a thickened strip of fascia latae that runs from above the hip to below the knee. It receives the insertion of the TFL and gluteus maximus. It passes distally down the lateral aspect of the thigh in continuity with the lateral intermuscular septum and inserts into Gerdy's tubercle on the lateral tibial condyle, having passed over the lateral epicondyle of the femur (Schwellnus et al, 1992). With the knee in extension the IT tract lies anterior to the axis of knee flexion, and in flexion it passes posterior to this axis. It moves forward and backward with flexion and extension of the knee (Renne, 1975).

Terry et al (1986) describe the anatomy of the ITB more finely. They state that it is divided into two functional components: the iliopatellar band and the iliotibial tract. The iliotibial tract functions as an anterolateral ligament of the knee, and the iliopatellar band functions as the lateral stabiliser of the patellar and influences decelaration.

Evans (1979) maintains that of the vertical fibres, most attach to the lateral tibial tubercle, some blend anteriorly with the patellar retinaculum, some go deeply to attach to the lateral femoral condyle, and some continue to the tibial tuberosity. He describes his findings from dissections, but does not document the methodology of dissection, nor state how many specimens he has examined. As has been discussed, he maintains that the gluteus maximus muscle has no effect on the tract since it attaches into the horizontal fibres of the fascia lata. His opinion is considered, although the lack of scientific documentation makes this controversial opinion less valuable than it could be.

2.7 THE ANATOMY OF THE HAMSTRING MUSCLES

In 1995, Brandser et al wrote up the findings they made from imaging the hamstrings of 22 patients. They included a thorough explanation of the anatomy of the muscle group in their discussion. The hamstring muscles are the semimembranosis, semitendinosis and biceps femoris muscles and that portion of adductor magnus, which is innervated by the tibial nerve.

The hamstring muscles originate in a conjoined tendon at the postero-lateral aspect of the ischial tuberosity, except for the short head of biceps femoris which, originates from the lateral lip of the linea aspera on the femur, along its middle and upper portion (Brownstein and Mangine, 1995). The long head of biceps femoris and semitendinosus originate from the upper portion of the ischial tuberosity (van Wingerden et al, 1993), and the semimembranosis originates just superior to this, although their fibres blend.

Distally the hamstrings cross the knee joint. Semitendinosus crosses anteromedially to become part of the pes anserinus which inserts into the medial aspect of the proximal tibia, just below the plateau. The tendon passes over the medial collateral ligament and is separated from it by a bursa (Brownstein and Mangine, 1995). Semimembranosis has five arms inserting around the knee joint. The primary portion inserts below on the medial tibial plateau. The remaining four portions include: one into the medial meniscus, one into the posterior capsule, one forming the oblique popliteal ligament which also blends into the pes anserine complex, and the fourth reinforces the posterior medial capsule, inserting into the medial collateral ligament. There is some controversy as to whether this arm exerts tension on this ligament when the muscle is contracted (Brownstein and Mangine, 1995).

Garrett et al (1989) did a study on computed tomography of hamstring strains, which they preceded by a dissection study of five cadavers. They made detailed observations from their cadaveric study, which enabled them to interpret their scan findings more accurately. They describe the hamstring origin from the ischial tuberosity as an incompletely separated common mass. They noted that the semimembranosis muscle split from the remaining two muscles approximately five centimetres from the tuberosity, whereas the biceps femoris and semitendinosus occurred further distally approximately ten centimetres from the tuberosity.

Garrett et al (1989) did not describe the cadavers they dissected with respect to gender, size or any other features, which would make these findings easier to interpret. They recorded their findings regarding biceps femoris in detail. Muscle fibres originated approximately six-cm from the tuberosity. The proximal tendon and muscle-tendon junction extended approximately 60% of the total length of the

muscle, and the distal muscle–tendon junction extended 66% of the length of the muscle. The regions of muscle tendon junction extended the full length of the muscle belly on either the proximal or the distal portions. The specific part of the proximal region, which was most commonly found to be the site of injury, occurred near the common origin of biceps and semitendinosus. Semimembranosus contained a similar arrangement where the entire muscle belly contained either proximal or distal muscle-tendon junction. Semitendinosus muscle had a different configuration. Proximal muscle fibres took direct origin from the tuberosity and muscle-tendon junction. It had a midline raphe of connective tissue near the middle of the muscle belly, into which proximal muscle fibres insert and from which distal fibres originate.

Marshall et al (1972) did a cadaveric dissection of 31 knees, which led them to make several valuable observations about the common tendon of the heads of biceps femoris muscle, its anatomy and its function. The fleshy fibres of the long head of biceps formed a broad, flat tendon, which was joined by the short head on its under surface, forming a broad, short common tendon. This common tendon split into three layers: superficial, middle and deep.

The superficial was lateral to the lateral collateral ligament, the middle, surrounded it and the deep was medial and deep to it. They found the superficial layer formed three expansions. The anterior thin, although strong expansion, which fanned out to blend with the anterior crural fascia, and sent some fibres deep and anteriorly to reach the tubercle of Gerdy. The middle expansion spread on the surface of the collateral ligament and blended with the peroneal muscle fascia, some fibres inserting into the head of the fibula. The posterior expansion extended inferiorly blending with the calf muscle fascia. The middle layer of the tendon was thin and poorly defined and surrounded the collateral ligament like a sling, being separated from it on three sides by a bursa. The deep layer bifurcated and had a fibular and a tibial attachment, the latter being to the tubercle of Gerdy. Some extensions passed into the posterior lateral aspect of the knee joint capsule, some into the posterior aspect of the tibia.

Marshall et al (1972) also made the interesting fibrous attachment between the ITB and the distal part of the biceps tendon, known. These anatomical findings led to a better understanding of the function of the biceps femoris muscle:

1. The superficial expansion acts as a flexion lever, and an external rotator of the leg.
2. The strong fascial connections to the lower ITB may keep the tract taut in various degrees of flexion. It had previously been found to be able to be ruptured in 10-15 degrees of flexion and internal rotation, and these researchers plausibly suggest that, based on their findings, the biceps femoris muscle may furnish support via its connections to the tract.

3. The connection of the middle layer to the lateral collateral ligament may keep the ligament tight as the knee progresses into flexion, thereby contributing to knee stability.

4. The capsular insertion of the deep layer pulls the posterior capsule posteriorly as the knee progresses into flexion, preventing impingement and enhancing stability.

In addition to flexing the knee, the hamstrings also produce tibial rotation, according to the in-depth look at the anatomy and biomechanics of the knee, taken by Brownstein and Mangine (1995). Their article is well researched. The biceps femoris rotates the tibia externally and the semimembranosis and semitendinosis rotate it internally, together with the rest of the pes anserine group. The hamstrings can not rotate the tibia in full extension, due to the bony block. As the angle of flexion increases so the rotatory movement increases.

2.8 REVIEW OF THE LITERATURE ON ILIOTIBIAL BAND FRICTION SYNDROME

Many authors have described ITBFS (Lindenburg et al, 1984; Noble, 1979, 1980; Bates et al, 1982; Orava, 1978; Renne, 1975; Sutker et al, 1981, 1985). The syndrome is the result of inflammation, secondary to overuse (Barber et al, 1992). The postulated mechanism of injury is that the band is repetitively frictioned against the femoral epicondyle as the runner flexes and extends the knee through the 30 degree arc required for running (Schwellnus, 1992).

Ober (1936) as early as 1936, overviewed the effects of ITB tightness on the lower back as a source of pain in this area, and concluded that contracture of the gluteus maximus and TFL fascia caused increased stress on the sciatic nerve by altering the pelvic levels.

Gose and Schweizer (1989) produced a thorough article, which attempted to present an historical review of the literature on ITB. The article discusses much of the literature written on the mechanical effects of lateral hip muscle weakness, commencing with Trendelenberg's description of the contraletral hip drop that occurs with weight-bearing with ipsilateral gluteus medius weakness (see Figures 8, 9). They attempted to present the evaluation and treatment regimens that have been successfully used to manage tightness of the band. One of the treatments they discussed was the need to stretch the hip flexors and strengthen the hip musculature although they do not cite any research to support this suggestion, nor give any explanation of how it could be effective in the long-term management of the condition. However, they do cite articles that explain the negative effects of weakness.

Gose and Shweizer's (1989) literature review ascertained that there are four prime causes of ITBFS. They are: running on crested roads with the down hill leg in more genu varus, running in worn shoes especially if worn on the lateral surface, altering the training regime too dramatically with hill and speed workouts, and increasing distances too quickly. They also cite not maintaining adequate strength in the musculature around the hip and knee as a possible cause.

Anderson (1991), found that strength and flexibility exercises to maintain abductor, quadriceps, and hamstring strength, together with stretching of the band, was an effective form of treatment. This would indicate that muscle strength and inflexibility are causes of the condition. Linenger and Christensen (1992) gave an earlier more thorough overview of the factors suggested in the literature as being causative. They included over-striding on the downhills, which pulls the band taut over the lateral femoral epicondyle, and a leg length discrepancy, which creates a pelvic tilt and stretches the band on the longer leg side. This was confirmation of Noble's

findings in 1979 (Noble, 1979; 1980), and was in support of other authors on the subject (Renne ,1975; Sutker et al, 1985).

Linenger and Christensen (1992), also suggested that excessive pronation and intoeing, during the support phase of running, may predispose to it, apparently by increasing internal tibial rotation, thereby stretching and frictioning the band. They concluded from their very simple study that the incidence of ITBFS among military recruits was higher than previous studies had reported. However, their inclusion criteria and method of diagnosis were vague and may have led to inaccuracies.

Aronen et al (1993) explain that the ITB is involved in four actions of the lower extremity. It acts as a primary hip abductor, a hip internal rotator when the hip is flexed to 30 degrees, an accessory leg flexor when the leg is in more than 30 degrees of flexion and an accessory extensor when the knee is in less than 30 degrees of flexion. This information is of interest, but it has not been substantiated with references. The authors do not describe the inclusion or exclusion criteria for the recruits or athletes that they used to form the basis for their observations. Their observations are therefore viewed with a degree of reservation.

The ITB crosses two joints and therefore its effect on the knee varies according to the position of the hip (Evans, 1979; Sutker et al, 1985). At the knee joint the band has been found to act as a stabilising ligament between the lateral femoral condyle and the tibia, according to Sutker et al's introduction (Sutker et al, 1985). This statement is unsubstantiated.

According to Evans (1979), the ITB contributes to the "pelvic slouch" (one leg stance position, see Figure 10), by its action on the hip, enabling people to rest while standing. Although he has no evidence to prove this, he believes that the ITB developed phylogenetically with the development of the upright posture.

Anderson (1991) stated that training errors and mechanical and / or anatomical alignment errors could not alone be responsible for ITBFS development. This is because the onset of the pain is so sudden and so seemingly distance specific. He uses McNichol et al's (1981) explanation of the loss of stress transference capabilities that occur in the musculoskeletal system in times of fatigue to explain

what happens when the pathology sets in. The gluteus medius muscle on the supporting leg contracts to prevent the pelvis from falling to the unsupported side. This action is supplemented by a contraction of the muscles inserting into the ITB:TFL and gluteus maximus. Tension in the ITB on the support side will help alleviate dipping of the pelvis to the unsupported side. He therefore hypothesised that fatigue to this musculature will result in a pelvic tilt during the support phase of running, causing increased tension in the band on the supporting leg side. Pelvic tilt and increased tension in the band would create a greater friction between the band and the lateral femoral epicondyle. This would lead to an inflammatory reaction of sudden onset, with its associated pain. His paper does not involve a method section and it is therefore assumed that he used his exploration of the literature to come to this conclusion. His ideas are of great interest to this study.

Sutker et al (1985) found that 48 runners out of 1030 seeking medical intervention for lower extremity pain had ITBFS as diagnosed by clinical data and physical findings. These findings included tenderness on palpation of the lateral femoral epicondyle. They did not consider cases that had concurrent patellar-femoral pain, nor did they use any other test to confirm their diagnosis. No mention was made of one tester making all the diagnoses, or of what the inter-tester reliability was for the palpation test.

Noble (1979) reported on 221 cases of ITB, nine of which failed to respond to conservative treatment. These nine were therefore treated surgically, this amounted to four per cent. Martens et al (1989), performed surgery on 23 patients with ITBFS, and followed up 19 of them for a period of 45 months. They found satisfactory results in this entire relatively large sample. The surgery had been performed as a last resort. This was a well controlled study, which indicates that this an effective treatment in cases that remain resistant to treatment. No mention was made however, as to whether the runners developed any other injuries in this time, which would have been interesting. Noble (1979), reported that of the nine cases operated on, one had not been able to return to running due to persistent pain, one patient developed the condition in the other leg, which did, however, respond to conservative treatment and eight of the nine had returned to running (Noble, 1979).

Ekman et al (1994) Magnetic Resonance Insonating (MRI) scanned seven ITBFS positive knees. They compared these to ten normal controls, and found that the average ITB thickness was significantly greater in the disesased knees (5,49nanometers (nm) ± 2,12 as compared with 2,52 ± 1,56 nm in the controls). This statistic sounds more conclusive than it is as only four of the seven knees had an increased thickness. The small sample size precludes any conclusions being drawn from this evidence.

Ekman et al (1994) also found fluid deep to the band in five of the seven knees, and in only one of the controls. This would seem to indicate the presence of a bursa beneath the band, which becomes inflamed in the face of the syndrome. The finding of a potential space on cadaveric dissection in all of the disease free legs they dissected would confirm this suggestion. This is in contrast to Noble (1980), who found that there was no bursal fluid found in the histologic study of the tissue removed from the five knees that he took to surgery of his sample of 100 knees. He reported a finding of fibrous tissue containing inflammatory cells found on histologic study. Two of the five knees had a fibrinous exudate.

Ekman et al (1994) followed up one patient for a year post injury, re-scanned the then symptom free leg, and found that the fluid collection seen previously had gone. This study by Ekman et al (1994) had the potential to answer many questions about the syndrome. The small sample size and the myriad of sections to the study make the results less valuable than they may have been for example, had more of the diseased knees been re-scanned when symptom free, and more diseased knees been scanned in the first place. Noble's (1980) results found at surgery are also of limited value, due to the small sample size. It would have been very beneficial if he could have reported on many more surgical cases.

Evans (1979) states that the people who most often use the one leg stance or "pelvic slouch" position (see Glossary) are people who are bored or waiting. He does not substantiate this, however, and it is assumed here that it is a habitual, lazy posture. Evans looks back through the fossil record to establish his opinion that the ITB developed to help the species attain the bipedal gait, and that its mark seen on the femur started to appear around the time that the upright posture was first assumed. He calls it the "Ligament of Boredom" (Evans, 1979 p276). There does

not seem to be any evidence in the fossil history to contest this opinion. The evidence discussed by Evans is that bony thickenings occur along lines of transmitted force, and these have been evident in the form of the acetabulocristal buttress, since the time of the species Homo Erectus. Whether this can be attributed entirely to the force of the ITB is not evident.

Lee (1996) explains what occurs in the SIJ's during the gait cycle as has already been discussed. She states that in the presence of instability, the displacement of the centre of gravity is exaggerated. An attempt is made to reduce the shear forces through the SIJ's by: either transferring the weight laterally over the involved limb, or by excessively adducting the pelvic girdle on the weight bearing limb (see Figures 8 and 9). Evan's (1979) description of the "pelvic slouch" (see Glossary), and its effect on the ITB may lead to the deduction that when this position is repetitively assumed several thousand times on a particular run, that the pelvis is repetitively hanging on the ITB. Since the knee can not be locked into hyperextension if running is to continue, this may lead to frictioning on the lateral side of the knee joint, underneath the band, due to the upward pull on the lower attachment of the band. Therefore, if a form of diminished stability should be present, be it in the passive or the dynamic components of stability, the ITB may be affected as part of the compensatory strategy, which would enable running to continue.

2.9 REVIEW OF THE LITERATURE ON HAMSTRING INJURIES

Most hamstring injuries occur at the proximal end to the tendon or to the musculotendinous junction (Brandser et al, 1995). Muscles which cross two joints function eccentrically and have more fast twitch (type II) than slow twitch (type I) fibres and are at greater risk of strain (Brandser et al, 1995). They are described as postural muscles (Sahrmann, 1991).

Clarkson et al (1988) set out in their study to examine the phenomena of exercise induced muscle damage, repair and rapid adaptation in humans. They did not comment on the inter-tester reliability, or on who had done the testing, and whether this may have affected the results. They did, however have interesting results. They found that muscles adapt to exercise by becoming resistant to the damage produced by exercise and by repairing damage that is produced faster.

Heiser et al (1984) discuss the fact that the short head of biceps femoris is the most commonly injured part of the hamstring group. They explain that it has two motor points, one, which is innervated by the tibial part of the sciatic nerve, and one, which is innervated by the peroneal division of this nerve. Burkett (1976) suggested that the dual innervation may cause the short head of biceps to contract at the same time as the quadriceps, which he suggests would result in a hamstring strain.
Garrett et al (1989) confirmed the finding that most injuries to the hamstring muscle group are to the biceps femoris, either to the proximal or the lateral portion of the muscle. They suggest, however that it is more commonly the long head and not the short head of biceps that is injured. Since they used imaging to make their deductions, their results are considered to be more credible. They used computed tomography studies of ten known hamstring strains, and concluded that it was inflammation and oedema that were the main components of injury in acute muscle strains and not bleeding as is commonly assumed.

Garrett et al (1989) also found areas of calcification on follow-up scan of two of the ten subjects in their study, and in three of them who had suffered a previous hamstring strain. They could not comment on the significance of this calcification, however. They do suggest that it may be the hamstring muscles, which develop calcification that are prone to develop injuries, which recur.

In an article on the factors associated with recurrent hamstring injuries, Muckle (1982) briefly discusses the fact that recurrence or chronicity of hamstring injury may be due to spasm produced in the hamstrings by a lumbo-sacral problem. He cites a mild disc bulge at L4-L5, or L5-S1, facet joint arthrosis, or spondylolysis as possible causes for the spasm.

Hughston et al (1976) wrote a paper on the role of the posterior oblique ligament in repairs of acute medial ligament tears of the knee, in which they describe the function of the attachment of the posterior oblique ligament to the upper edge of the semimembranosus tendon. The ligament, which is less taut in flexion, provides a dynamic stabilising role for the knee due to the fact that contraction of semimembranosus muscle pulls the ligament tight as the knee is actively flexed. This function of semimembranosus is discussed, but neither a reference nor a study is provided to prove its validity.

Heiser et al (1984) did a study on hamstring muscle injuries in intercollegiate football players published in 1984 but which spanned a period of nine years. They studied the recovery and recurrence rate when rehabilitating players post injury with isokinetic testing as opposed to without it. They also assessed players who were not symptomatic for imbalances and rehabilitated these preventatively. They based their study on the finding in the literature that hamstring strains are associated with lumbar spine abnormalities, meniscal problems and unbalanced quadriceps action. The number of hamstring strains dramatically diminished when they commenced this testing, suggesting that the hypothesis that imbalance is a major causative factor is correct. They used a ratio of 0.60 hamstrings: quadriceps as optimal. This is in agreement with the findings of Paton et al (1989). They also reported from the results of their pilot study that moderate-major hamstring tears respond to conventional Physiotherapy and do not involve permanent functional damage of the muscle complex, provided they are adequately rehabilitated and imbalances corrected.

2.9 POSTURE AND MUSCLE IMBALANCE

Norris wrote an article in *Physiotherapy* in 1995, in which he summarised many of the ideas of Janda, Jull and Sahrmann among other authors, which had been included in textbooks and presented at congresses, but which had never been published in journals. He discusses the concept of the division of muscles into postural and phasic types. He explains how the postural muscles have a tendency to tighten as opposed to their phasic counterparts, which are usually antagonists in function to the postural muscles, and which tend to lengthen and develop stretch weakness. This is described as an inability of the lengthened muscle to produce a peak torque in mid range: there is no real loss of strength. The classification according to Jull and Janda (1987), follows in Table 1.

Table 1: **Postural and phasic muscle classification** (Jull and Janda, 1987)

MUSCLES	CHARACTERISTICS
Postural	
Example	Tend to tighten
Quadratus lumborum	Biarticular
Erector spinae	One third_stronger
Iliopsoas	Trigger points
Tensor fascia latae	Lower Irritability Threshold
Rectus femoris	
Piriformis	
Pectineus	
Adductors	
Hamstrings	
Gastrocnemius	
Soleus	
Tibialis posterior	
Phasic	
Example	
Rectus abdominis	Tend to weaken
Internal and external obliques	Weak
Gluteals	Uniarticular
Quadriceps	
Tibialis anterior	
Peronei	

Stabiliser muscles tend to have a postural holding role, associated with eccentrically decelerating or resisting momentum and are mechanically able to control excessive range of motion. Even the spinal stabiliser muscles, although they cross many segments, are effectively one joint muscles, as they attach to every segment individually between their origin and insertion (Janda, 1985; Sahrmann, 2000; Comerford and Mottram, 2001).

The disposition to muscle weakness or tightness is not random, but can occur in specific muscle imbalance patterns, focused around the pelvic and shoulder girdles. One important pattern being the pelvic crossed syndrome as explained by Janda and Schmid at the Fourth "International Federation of Manual Therapists Conference" in New Zealand in 1980, and quoted by Norris in 1995. This involves a combination of tightness in short hip flexors and ES and weakness in the abdominal and gluteal muscles. This often leads to an increased pelvic tilt, which is resisted by tightening of the hamstrings.

Richardson took the classification of muscles one step further, in 1992, when she described muscles as fitting into one of two categories: movement synergists and stability synergists. She presented her theory at a physiotherapy conference in New Zealand, and her ideas are also quoted in Norris' article (1995). This classification considers the anatomical site of the muscle and its biomechanics, as well as the overall motor programming of a movement in which the muscle is involved. The stability synergist, is usually a single joint muscle, aligned to oppose gravity and approximate a joint. They are usually slow twitch muscles, which are able to control low-level forces for long periods of time.

Postures such as sway back and hyper-lordosis tend to rely on ligamentous support leading to disuse in the postural muscles. The slow twitch fibre muscles tend to waste more quickly than the fast twitch types, according to the description of Richardson's findings by Norris (1995). This leads to diminished endurance of the stability synergist, which tends to lengthen.

Table 2: Examples of stability and movement synergists
(Richardson, 1992 as reproduced by Norris, 1995)

Stability Synergist
Iliopsoas
Gluteus maximus
Gluteus medius
Vastus medialis obliqus
Soleus
Deep neck flexors
Transversus abdominis
External oblique
Movement Synergist
Tensor fascia lata
Rectus femoris
Hamstrings
Gastrocnemius
Superficial neck flexors
Rectus abdominis

This concept has recently been even further developed by Comerford and Mottram (2001). They built on the work of authors such as Rood, Goff, and Bergmark. Muscles are now divided into the global muscles, which control range of movement and alignment, and the local muscles, which maintain the mechanical stiffness of the spine and control inter-segmental motion. The global muscles may have a prime mobility or stability role.

2.9.1 Local and Global Characteristics

Table 3: Local and global muscles (Comerford and Mottram, 2001)

Local Muscles
Deepest layer muscles.
Originate and insert segmentally.
Control and maintain the neutral spinal curvature.
Respond to changes in posture and changes in low extrinsic load.
Independent of the direction of load or movement.
Appear to be biased for low load activity.
Global Muscles
Superficial or outer layer of muscles.
Lack segmental vertebral insertions.
Insert or originate on the thorax or pelvis (non-segmentally).
Respond to changes in the line of action.
Respond to magnitude of high extrinsic load.
Large torque producing muscles.
Biased for range of movement.

2.11 POSTURE AND LONG DISTANCE RUNNING INJURY DEVELOPMENT

Poor posture assumed for extended periods of time may lead to general muscle imbalance and weakness in a specific pattern, e.g. the upper and lower crossed syndromes as described by Jull and Janda (1987). These syndromes involve an alteration in the basic positions of the head, neck and shoulders in the following pattern:

The occiput and C1/C2 will hyperextend, with the head being pushed forward.

The lower cervical to 4th thoracic vertebrae will be posturally stressed as a result.

The scapulae will lie in rotation and abduction.

An altered direction of the axis of the glenoid fossa results in the humerus needing additional stabilisation by increased levator scapulae, supraspinatus and upper trapezius activity.

This pattern of weakness, called the "upper crossed syndrome," commonly leads onto or exists in conjunction with the "lower crossed syndrome". Here the pelvis tips forward on the frontal plane, flexing the hip joints and producing an increased lumbar lordosis and stress at L5-S1, with pain and irritation. This is a common

posture seen in all walks of life not necessarily in the long distance running community. When it is habitually assumed for extended periods of time, soft tissue changes will occur.

In this posture, the anterior shoulder muscles are held in the shortened position and respond by losing sarcomeres, becoming infiltrated with connective tissue, weakening and having their length tension curve shifted to the left. This is according to Sahrmann's course notes, which were based on the work of Williams and Goldspink (1990). They did an animal study in which they casted ankles of animals for 4-6 weeks, so that extensor digitorum was maximally shortened or stretched. Sahrmann used their findings to explain what she saw occurring in humans whose muscles were posturally held in either a shortened or a lengthened position.

It can be deduced that if these postures are habitually assumed, it is either because of, or the result of, a weakness in certain muscle groups. It is not the severity of the elongation beyond the muscle's normal resting length, but rather the duration of it that is responsible for the stretch weakness produced (Kendall et al, 1993).

A very complex and detailed study was performed on the trunks of ten normal males by Thorstensson et al (1984) According to their findings, the trunk functions in locomotion to balance the head and act as a shock absorber. The trunk was described as having the role of minimising the accelarations of the head and optimising the conditions for the visual, and perhaps the vestibular systems. They found that the amplitudes of movements at C7 were markedly smaller than those at L3. The vertical movements did not vary with differing speed (walking or running), however the lateral displacements at L3 increased significantly with increasing speed. The amplitude at C7 remained the same or even diminished with increasing speed, indicating a damping of movements up the spine. Despite their small sample size they were able to conclude that the demands on equilibrium control are markedly different between walking and running. There is internal bending of the trunk mostly during the airborne phase of running. According to their results, during the main part of the stride cycle in running, the upper region of the trunk is on one side and the lower region on the other side of the mid-line. These findings indicate the vast need for stabiliser control in the postural muscles during locomotion most

especially ultra- distance running. Absence of adequate stabiliser control would lead to excessive displacement, and injury due to strain.

Gracovetsky and Farfan (1984) had a somewhat conflicting opinion, which was based on a mathematical model and the study of the evolution of the human spine. They maintain that the motion of the spine in walking and running is the same. The only difference is the power requirement and, according to their theory, this requirement exceeds the resources of the trunk musculature. The increased demand is provided for by the hip extensors. The interaction of the musculoskeletal system with the gravitational field is ever more essential as speed increases, since the runner is airborne between one ground contact and the next. Gracovetsky and Farfan (1984) describe the coupled motion of the spine which forces the trunk and upper extremities to move in balanced opposite motion to the pelvis and lower extremities. This oscillating mechanism conserves energy. Energy is stored in the viscolelastic structures of the spine, which are stretched. This is in accordance with Gracovetsky and Farfan's description of the spine as an engine, where the engine is fuelled by the hip extensors.

Also resulting from poor postural habits as recognised by Kendall (1993), Sahrmann (2000), Janda (1985), and Comerford and Mottram (2001), are altered patterns of recruitment and sequencing of muscle activity.

Examples include:

1. Hip Extension, which is performed in the normal subject by hamstrings, followed by gluteals, followed by contralateral erector spinae. This is compared with the low back pain patient who performs the action, with hamstrings followed by a delayed gluteal contraction, ipsilateral ES contraction. They may alternatively use thoraco-lumbar ES, lumbar ES, followed by hamstrings and variable gluteals. This means that gluteals do not necessarily have to be weak, they may just be incorrectly recruited to produce faulty movement patterns.
2. Hip abduction, which is performed in the normal subject by gluteus medius followed by TFL, and lastly contraction of ipsilateral QL. In the low back pain patient, TFL initiates the movement, followed by gluteus medius, and ipsilateral QL. They may alternatively use QL, to initiate the movement

followed by contraction of TFL, and only use gluteus medius as a last addition to the movement.

2.12 CONCULSION

In conclusion, muscle balance is essential for normal locomotion to occur, especially the locomotion, which culminates in long distance running. Dysfunction may result in increased fatigue. Muscle patterning is another critical component of normal locomotion (Jull and Janda, 1987). The reciprocal action of the biceps femoris and gluteus maximus muscles in normal gait is an example (Dananberg, 1995). As the biceps femoris relaxes, the gluteus maximus contracts to take over the function of extending the hip. If the gluteus maximus is weak, inhibited or its firing is delayed, the stride length will decrease, and the hamstrings will be overworked (Lee, 1996). Also if the gluteus maximus is not functioning the force closure of the SIJ will be diminished and the hamstring group will be overworked in an attempt to stabilise the SIJ's (through the sacrotuberous ligaments) (Vleeming et al, 1997).

A weak gluteus maximus will also produce an unbalanced pull on the ITB into which it inserts. The TFL muscle will exert a stronger anterior pull on the band. This effect may be exaggerated by the production of increased side bending (Lee, 1996) to compensate for the lack of hip extension in the gait, which would load the gluteus maximus / ITB complex, leading to thickening of the band (Gose and Schweizer, 1989).

This author has used the findings in the literature to explain the changes that have been seen to occur in the presence of these injuries and to explain the evident connection between the two seemingly unrelated injuries of ITBFS and BAOPTP.

CHAPTER 3

Process of Questionnaire Development for a Survey Determining The Relationship Between Iliotibial Band Friction Syndrome and BAOPTP

3.1 INTRODUCTION

It was decided that a questionnaire would be the most effective means of accessing a very large sample of Comrades runners. The term "Comrades runners", refers to the group of runners who entered and participated in the 1999 Comrades Marathon. A large sample was required, because the aim of the study was to evaluate the prevalence of each one of the injuries, the prevalence of the concurrent existence of both injuries, as well as the numbers of runners who exhibit signs of lumbar dysfunction, or who demonstrate poor postural habits. In order to be able to make relevant conclusions about the relationship between these injuries and the risk factors associated with them, it was necessary to assess as large a sample as possible.

Data obtained from self-reported questionnaires is open to criticism, because the responses are difficult to validate. A questionnaire has the disadvantage of accessing only subjective information. Long distance runners out of necessity are well informed about their bodies, and know a lot about injuries, making their opinions valuable (Cottrell, 2002). Cottrell is not a medical expert, however he has written extensively on the subject of long distance running and has designed many successful training programmes. Tim Noakes' book *The Lore of Running*, has been called the "Bible" of running (Noakes, 1992 preface to the Second Edition). It is a very technical reference book. The fact that the book has been a best seller, is strong evidence that many runners are well read and have a strong desire to understand the function of their bodies. Comrades runners are experienced athletes (Noakes, 1992). It is necessary to run at least one qualifying marathon in order to enter the race. In 1999, that qualifying marathon had to be run in four and half-hours (Cottrell, 2002). In order to accomplish this a runner must be experienced and know what he or she is doing (Cottrell, 2002; Noakes, 1992; Fordyce, 1996). The training required for the event is very time and energy consuming and runners will do anything to avoid the risk of being unable to participate and excel on race day.

This meant that they were a good choice of subjects for a questionnaire-based study, and that their opinions could be relied upon to provide valuable data.

A covering letter which contained a detailed description of the symptoms of ITBFS, and BAOPTP, as well as a body chart, with the areas of pain referral carefully depicted, was prepared to precede the questionnaire.

A pilot study was conducted to list the responses of runners who were known to suffer from each condition. Based on the results of this pilot study, it was concluded that a questionnaire that would be used as the only measuring tool was a feasible means of eliciting the desired information from the running community. The questionnaire was developed. Three further pilot studies led to the altering of the questionnaire. The results of these pilot studies confirmed that the final questionnaire was a reliable measuring tool. There has been no previous study of this nature and therefore the designed questionnaire had to cover a wide range of subjects.

Prior to the description of the subject selection and method, the development of the questionnaire will be discussed.

3.2 THE QUESTIONNAIRE WAS DESIGNED IN THE FOLLOWING WAY

Questions were taken from the literature.
Brainstorming sessions were held with colleagues and runners with experience of the injuries in question, and the training required for the Comrades marathon.
Expert advice was sought.
Four pilot studies were undertaken in order to ensure that the questionnaire could elicit the necessary information.

3.2.1 Questions From the Literature

When reviewing the literature on the subjects of long-distance running, Comrades training, running injuries, and specifically BAOPTP and ITBFS, questions were identified that were essential to include. The motivation for including each question will be provided in the section on Questionnaire development. The questions will be identified by section and then by number (S1; Q1).

3.2.2 Expert Advice

Professor Mike Lambert of the Sports Science Institute was consulted prior to the commencement of the questionnaire, and was asked to assess questionnaire 1 and offer suggestions for its improvement, based on his expertise. Professor Lambert is a scientist and has done many studies with a similar format, as well as having supervised many students in similar projects.

Adjustments were made according to his recommendations, which led to the use of less ambiguous questions, and the dividing of the questionnaire into four sections for ease of interpretation. He also recommended that the questionnaires be handed out at the Comrades Exposition as opposed to being posted from the Comrades Association's mailing list to all runners. The Comrades Exposition is held in both Durban and Pietermaritzburg for three days prior to the race. All runners are required to go to the exposition in order to register for the race. This suggestion led to the very effective dissemination of the questionnaire and the large number of respondents.

3.3 THE FIRST QUESTIONNAIRE

Questionnaire 1 was used to assess the ability of runners to recognise whether they suffered from any or both of the injuries in question (Questionnaire 1 in Appendix I).

3.4 THE SECOND QUESTIONNAIRE

Questionnaire 2 (Questionnaire 2 in Appendix I), was put through a series of Pilot Studies, which led to the development of the final questionnaire (Questionnaire 4 in Appendix I).

3.5 THE FINAL QUESTIONNAIRE

Questionnaire 4, which was the final questionnaire will be named "the questionnaire" for the remainder of this study. The questionnaire comprised 45 questions. It was divided into four sections for ease of interpretation. All runners were required to complete Sections 1 and 4 and only runners who had, or who in the past had had, either ITBFS or BAOPTP were required to complete Sections 2 and 3 respectively. Runners who had, or who in the past had had both pains, were required to complete all sections of the questionnaire.

The questionnaire was designed to elicit much information regarding each runner's running "portfolio", somatype, training schedule and techniques, their use of cross training, gym and stretching. Further information was elicited based on the presence or absence of signs of lumbar-pelvic dysfunction, and poor muscular control of the region (Questionnaire 4 in Appendix 1).

3.6 REPORT ON FOUR PILOT STUDIES

Once the design of the original questionnaire had been completed it was tested for reliability in four separate pilot studies. As flaws emerged in the design of the questionnaires they were corrected. These pilot studies were conducted between February and May of 1999.

3.6.1 Pilot Study 1

The first pilot study was undertaken in February 1999.

3.6.1.1 Objectives

Prior to developing the questionnaire it was necessary to establish that a questionnaire would be a feasible means of eliciting the information desired from the runners. If they could not be relied on to recognise their symptoms on a body chart, then it would not be possible to use their opinions to answer the research questions.

Pilot study 1 was designed for the following purpose:

1. To establish whether the ITBFS runners would recognise their symptoms on the chart and in the covering explanation, and answer the questionnaire accordingly.

2. To establish whether the BAOPTP runners would recognise their symptoms and answer the questionnaire accordingly.

3.6.1.2 Method

Twenty patients were identified for inclusion in the pilot study.

Ten of the patients had classic ITBFS, as diagnosed by the author. The remaining ten patients had BAOPTP, also diagnosed by the author. These patients had BAOPTP of varying cause, as detailed in the Glossary.

Five had SIJ dysfunctions, which produced referred pain into the area.
Three had chronic hamstring origin strains.
Two had L5-S1 facet joint sprains that had produced buttock and posterior thigh pain, in the S1 dermatome.

They were all patients seen in the author's physiotherapy clinic. All were diagnosed, but no one was told their diagnosis, until after they had completed their questionnaire.

The body chart and covering explanation of each of the two injuries in question were given to each patient. A covering letter and a short questionnaire (Questionnaire 1 in Appendix 1) accompanied this chart. The covering letter explained the purpose of the questionnaire, the voluntary and anonymous nature of participation, as well as the requirements of participation. Patients were asked to study the body charts with the pain patterns marked on them, and answer the accompanying questions.

3.6.1.3 **Development of the Questionnaire**

The questionnaire contained only four questions.

1. The first question referred to the body chart, and asked the patient whether they suffered from either of the two descriptions of ITBFS.

2. The second question asked the patient whether they would answer a section of a questionnaire marked "only answer this section if you have ever had ITBFS as explained on the body chart".

3. The third question asked the patient whether they suffered from BAOPTP as described on the body chart.

4. The fourth question asked whether they would answer a section of a questionnaire marked "only answer this section if you have ever had buttock and /or posterior thigh pain as explained on the body chart".

3.6.1.4 **Results**

Of the known ITBFS patients ten out of the ten answered that they did suffer from ITBFS as described on the body chart, and that they would answer a questionnaire accordingly.

Of the known BAOPTP patients ten out of the ten answered that they did suffer from BAOPTP as described on the body chart, and that they would answer a questionnaire accordingly. These results are summarised in Table 3.

Table 4: Tabulation of responses to Questionnaire 1, Pilot Study 1

Question	Percent "yes"
Do you suffer from ITBFS?	50%
Would you answer a questionnaire on ITBFS?	50%
Do you suffer from BAOPTP?	50%
Would you answer a questionnaire on BAOPTP?	50%

3.6.1.5 **Conclusion**

All of the known ITBFS and BAOPTP patients answered such that they had clearly recognised their injuries to resemble those in question. The combination of the body chart and the accompanying explanation clearly explained the pain pattern of the conditions in the study. They could be used in the final questionnaire. A questionnaire was a feasible measuring tool to use to answer the research question. The runners could be relied upon to answer the correct sections accurately and to identify themselves as suffering from the injuries in question if they had ever had the symptoms described.

3.6.2 **Pilot Study 2**

The second pilot study was undertaken in March 1999.

3.6.2.1 **Objectives**

Pilot study 2 was used to establish whether runners who were injured, but not with the injuries in question, would recognise from the explanation and the body charts provided that their symptoms were not those being asked about in this study.

3.6.2.2 Method

Twenty patients were identified for inclusion in the pilot study. They were all patients seen in the author's physiotherapy clinic. All were diagnosed, but no one was told their diagnosis, until after they had completed their questionnaire.

All twenty had been diagnosed to be suffering from pain emanating from pathology other than ITBFS and BAOPTP. The author made all of these diagnoses. No patient was told their diagnosis until they had completed the questionnaire.

Seven were runners who had "runner's knee" (patellar-femoral pain syndrome) (PFP).

Three patients had soft tissue sprains: a medial collateral ligament sprain, a lax anterior cruciate ligament, and a popliteal tendinitis respectively (lig. sprain).

Two patients had hip joint capsulitis (hip caps).

Three had L1 or L2 referred pain down their upper legs (RP).

One had a medial head of gastrocnemius strain (MHGS).

Two had thoracic pain (ThP).

One had an adductor strain (Add. strain).

One had a rectus femoris strain (RF strain).

The body chart and covering explanation of each of the two injuries in question were given to each patient. A covering letter and a short questionnaire (Questionnaire 1 in the Appendix I) accompanied this chart. The covering letter explained the purpose of the questionnaire, the voluntary and anonymous nature of participation, as well as the requirements of participation. Patients were asked to study the body charts with the pain patterns marked on them, and answer the accompanying questions, while still in the physiotherapy rooms.

3.6.2.3 Development of the Questionnaire

The same questionnaire as the one used in Pilot Study 1, was used for Pilot Study 2

3.6.2.4 Results

Of the known knee injured patients ten out of the ten answered that they did not suffer from ITBFS as described on the body chart, and that they would answer a questionnaire accordingly (that is they would not answer a section of a

questionnaire marked "Only answer this section if you have ever suffered from ITBFS as described by the accompanying body chart".

Of the remaining patients ten out of the ten answered that they did not suffer from BAOPTP or ITBFS as described on the body chart, and that they would answer a questionnaire accordingly. These results are summarised in Table 5.

Table 5: Tabulation of results from Questionnaire 1, Pilot Study 2

Question	PFP	Lig. sprain	Hip caps.	RP	MHGS	ThP	Add. strain	R F strain
Do you suffer from ITBFS?	0%	0%	0%	0%	0%	0%	0%	0%
Would you answer a questionnaire on ITBFS?	0%	0%	0%	0%	0%	0%	0%	0%
Do you suffer from BAOPTP?	0%	0%	0%	0%	0%	0%	0%	0%
Would you answer a questionnaire on BAOPTP?	0%	0%	0%	0%	0%	0%	0%	0%
	35%	15%	10%	15%	5%	10%	5%	5%

3.6.2.5 **Conclusion**

From the results of this pilot study it can be assumed that the body chart and covering explanation are a reliable means of communicating to runners what injuries were being studied and who should complete the sections on ITBFS and BAOPTP. It can be concluded that runners could be relied upon to accurately identify themselves as non-sufferers of either or one of the injuries in question, should the symptoms that they suffered from not match the description provided or the body chart drawing which accompanied the questionnaire. The questionnaire was a viable tool to be used to answer the research questions.

3.6.3 Pilot Study 3

The third pilot study was undertaken in April 1999.

3.6.3.1 Objectives

Questionnaire 2 was drawn up as has been explained in the next section. This pilot study aimed to establish the effectiveness of Questionnaire 2 (see Questionnaire 2 Appendix 1), as well as the ease with which it could be completed and understood. It was also the aim of the pilot study to establish the length of time that would be required to complete it.

3.6.3.2 Method

Ten respondents were arbitrarily selected from among the researcher's 1998 Comrades training group. They were asked to complete Questionnaire 2, time themselves doing so and to report back on any difficulties they had encountered, the time they had required to complete the questionnaire, and to offer any suggestions for the questionnaire's improvement.

Their feedback was requested and carefully noted. This feedback was elicited in an interview conducted by the researcher immediately after they had completed the questionnaire.

The ten questionnaires were analysed. Problems with interpretation and ease of answering of the questionnaire that had been identified led to the appropriate modification of the questionnaire, which was then utilised in a further test of reliability. Questionnaire 3 was thus created (see Questionnaire 3 Appendix 1).

The responses of the respondents of Pilot Study 3 to the question regarding posture-type (S1 Q13) were compared to an objective assessment made by the researcher. This was in order to establish that respondents were able to make an accurate assessment of their posture. This would ensure that this was a reasonable way to ascertain what type of posture runners had.

3.6.3.3 Results

Some valuable suggestions were made, that led to minor modifications in the questionnaire's layout.

The questionnaire was found to require a mean of ten minutes for its completion. As this was felt to be an appropriate amount of time, it was not shortened.

The wording in two questions (S1 Q16 and S1 Q22) was altered to remove the ambiguity, which had been found by one of the respondents.

Weight was asked for in kilograms when two respondents had given their weight in stones and pounds respectively. It was decided to ask for height in metres. Slightly

more space was left for the "other" option, wherever it appeared, as it was apparent that insufficient space had been left in Questionnaire 2.

The wording in S1 Q5 was altered, because one of the respondents recommended that it would be easier to compute the results if there were simply a yes or no value for each of the categories "ball sport" participation and "no-ball" participation.

All ten respondents had assessed their posture type exactly as the researcher had.

3.6.3.4 **Conclusion**

The valuable input of 10 runners who were not involved in the study was used. The result was a more easily answered questionnaire, Questionnaire 3 (see Questionnaire 3 Appendix I). The question regarding posture type (S1 Q13) was a feasible question, which was a reliable means of assessing posture.

3.6.4 **Pilot Study 4: Test of Reliability of Questionnaire 3**

The fourth pilot study was undertaken in May 1999.

3.6.4.1 **Objectives**

The aim of this pilot study was to establish whether questionnaire 3 was a reliable measuring tool. If it was not found to be reliable as a means of accessing the desired information then the study could not be undertaken. The pilot study would establish what questions needed to be changed in order to render the final questionnaire reliable.

It was the aim of this pilot study to ascertain whether the questionnaire would be answered the same whenever it was completed and no matter whom handed it to the respondent.

3.6.4.2 **Method**

A further twenty, 1998 Comrades runners were arbitrarily chosen to complete Questionnaire 3. Two independent people were selected to assist in the pilot study. They were running club chairmen and not medical professionals. They were required to hand out the questionnaires to a group of runners who had been identified by the author.

The questionnaires were handed out one week apart, one in the morning, after a training session, and one in the evening over a post-training drink. The questionnaires were received from a different interviewer and in a different setting each time.

These twenty people were required to complete the form immediately, each time they received it. Thus the forms were completed one week apart. The responses to each of the 57 questions were compared to those given the previous week for each of the respondents. This was in order to ascertain whether the same responses were elicited irrespective of the interviewer, and whether the respondent's responses would remain unchanged despite time of day, mood, and place of questionnaire completion.

3.6.4.3 **Result**

Answers were consistent except in the case of three questions.

Question 12 regarding flexibility was answered differently by one respondent:
Respondent 6 answered the first time that she was "very flexible" and the second time that she was "average".

Question 13 regarding fitness level variance between the running and the "off season" also received a different answer by one respondent:
Respondent 9 answered that "yes" his fitness level did vary and then the second time answered that "no" it did not vary.

Question 23, asked about the number of injuries sustained in order of severity, was inconsistently answered by one runner, and it was decided to eliminate it from the final questionnaire draft:
Respondent 14 answered the question such that the order of her injuries was different each time, and one injury, a calf tear, had been left out completely in the second questionnaire she completed.

It was not essential that any of these questions were included, and therefore, since they could not be relied upon to elicit accurate information, it was decided to eliminate them altogether.

Two questions were the source of controversy and were thus also eliminated:

Question 15, regarding the runner's assessment of whether they had good posture or not, created much discussion and was thus not used. It was not critical to the answering of the research question.

Question 17 regarding the runner's perceptions of the strength of their abdominal, back and buttock muscles, was considered to be too subjective and to provide less than valuable information. It was also not used.

Question 18, regarding standing with all the weight on one leg, was a source of confusion, as two runners were unsure what was meant by the term "stand with all your weight on one leg". Therefore it was decided to include a picture of the position being described (see Figure 10).

A further three questions were not used (S1 Q25, S1 Q26 and S1 Q27), because it was decided that the information they provided was irrelevant to the answering of the research question. It was not the aim of the study to establish the footwear history of the runners.

It was of no use to ask whether respondents who were answering Section 3, had ever had pain in their buttock and/or hamstring (S3 Q40). They would not have completed the section if they had not. It was decided that information regarding previous best Comrades times was of no value and thus the question was also not included (S4 Q52).

Questionnaire 4 was the result (see Questionnaire 4 Appendix 1).

3.6.4.4 **Discussion**

Six questions had proved to be unable to elicit reliable data, and they were therefore of no use in the survey. All the other questions were easy to interpret, unambiguous, and were objective enough to elicit the same data, no matter who asked for it and at what time of the day they asked for it. These six questions were thus eliminated, as were the other five, which were considered to be irrelevant. There were 45 questions in Questionnaire 4.

3.6.4.5 **Conclusion**

Questionnaire 4 was the final product of the four pilot studies and it had been proven to be a reliable measuring tool. It would elicit the same information despite the time of day that it was completed, no matter who distributed it, and no matter what the mood of the runner when they completed it. It could therefore be used to answer the research question accurately.

3.7 CONTENT OF THE QUESTIONNAIRE

According to Subotnick (1978), ITBFS is the cause of many problems occurring about the lateral aspect of the hip, as well as the knee. This led to the inclusion of the lateral hip pain in the explanation and the diagram explaining to the respondents what was meant by ITB. The chart and explanation describing BAOPTP included the area of possible pain referral of each of the three proposed causes of buttock and posterior thigh pain. This was in accordance with the explanation of the term provided in the Glossary.

3.7.1 Section One: Development

Section 1 was to gather information about each runner and their running career. It was to be completed by all respondents.

The initial part of Section 1 of the questionnaire gathers demographic data.

Sex and Age

The sex and age of the respondents was considered relevant, as previous studies had reported their relevance to ITBFS (Barber and Sutker, 1992; Sutker et al, 1985; Orava, 1978) and to the lumbar spine, SIJ (Twomey and Taylor, 1995; Bellamy et al, 1983) and the hamstring muscle group. Suggested reasoning for the relevance of gender was the higher prevalence of genu valgum and ligament laxity in women (Wen et al, 1997; Noble, 1979). Also suggested to be relevant is the fact that as many more long-distance athletes are men, they must therefore sustain a higher prevalence of injuries (Satterthwaite et al, 1999; Stanley et al, 1978).

Suggested reasoning for the relevance of age was mostly the water content and elasticity loss from the soft tissues of the musculoskeletal system, associated with ageing. There is a decline in muscle strength, cross sectional area, fibre number,

spinal motor neurone number and motor unit number with increasing age (Hughes, 1999).

Weight and Height

Information about weight and height was requested, because ITBFS was found to be less prevalent in endomorphs, due to the lubricating function of the fat around the knee (Barber and Sutker, 1992). Excess weight overloads the lumbar spine and pelvic structures (Tancred et al, 1996). It was decided to ask the athletes their weight and height and to use these values to calculate each runner's Body Mass Index (BMI).

The Number of Marathons, Ultramarathons, Comrades Marathons and Years of Running Experience

Questions were included to create a running profile for each runner, i.e. how many years have they been running, and how much ultra and long distance racing have they packed into this time (S1 Q1-4). This was thought to be relevant, partly based on the opinion of Subotnick (1978), that it takes approximately a full month for people to recover from a marathon run at a fairly sustained effort, and 6 to 8 weeks to recover from a marathon run at all out effort. This statement is based on his experience only, and is not backed by any scientific experimental evidence. However, It would indicate that there could be an association between the number of marathons or ultra-marathons run in a year and over-training.

"Runs over 42 kilometres are severely damaging to the leg muscles, especially on South Africa's hilly courses, and damage takes weeks or months to heal", according to Fordyce (1996 p33). He is considered to be an expert on the subject, due to his successful participation in ultra-distance running over an extensive time period. He suggests that running too many long runs results in muscle tissue break down.
Over-doing the very long runs, as well as doing too many ultra-marathons and marathons per annum, was considered to be a training error. Training errors are one of the most widely accepted causes of ITBFS (Anderson, 1991; Noble, 1980; Barber and Sutker, 1992).

The Total Number of Kilometres of Training, the "Peak" Weekly Mileage, and the Number of "Quality" Sessions of Training per Week

These questions were included in order to establish whether training errors had occurred in the Comrades preparation. The "peak week mileage" (S1; Q9) was asked for as training is escalated up to a peak and then diminished again in order for recovery to occur (Fordyce, 1996). It was decided that the "peak" week would be a good indicator of whether excessive training distances had been run during the training period. Fordyce peaked at 175 kilometres in his "peak" week.

Errors may occur in the quantity or the "quality" (intensity) of training (Linegar and Christensen, 1992). Fordyce (1996) warns his readers of the need to exercise caution when doing hill training. However, he makes no recommendation regarding what should be done (S1; Q10).

The information elicited from these questions was to be assessed in relation to the number of years of running. Distance must be seen in the context of a runner's experience, before it can be classed as excessive (Sutker et al, 1985; Miesser, 1988). Excessive distance training is, however, a common training error (Fordyce, 1996; Noakes, 1992) (S1; Q8).

Muscles have the ability to adapt to exercise-induced damage, and to become resistant to damage induced by excessive exercise. They also "learn" to repair at a faster rate when they adapt to excessive training. It was important to be careful with the assessment of training for this reason. Many questions were used to ascertain whether a runner was training erroneously (Satterthwaite et al, 1999). Training distances and intensity needed to be viewed in the perspective of the number of years of running and the number and quality of Comrades runs completed.

Participation in Other Sports

Many authors on the subject of ITBFS found that participation in other sports was relevant to the development of ITB, especially if they involved repetitive knee flexion (Noble, 1979; Martens et al, 1989; Orava, 1978). This was therefore important to establish in this study sample (S1; Q5).

It was assumed that since cross training, especially with ball sports, would help to develop the stabiliser system of the body, it would do this by continually moving it out of its base of support, requiring correction, co-ordination, proprioception and balance. Developing these functions was expected to provide protection against injury (Comerford and Mottram, 2001; Norris, 1995).

The use of Gym or Strength Training, and the Weekly Frequency of Participation

Fordyce (1996) is of the opinion that use of muscles through their full range of movement improves flexibility, and upper body weight training improves carriage and posture. He also believes that strong abdominal muscles allow runners to bring their knees up higher and for longer, enhancing efficiency. He states that gym training protects athletes against muscle imbalances in the body. His statements are not substantiated by anything except his own personal knowledge and experience in the field. He completed three weight sessions per week, when he was in full training (S1; Q6, 7). Exercise should ideally be performed three times per week if lasting value is to be achieved from it (Tancred et al, 1996), therefore strength training performed only once per week was considered to be the same as not participating in strength training at all.

The Use of Stretching in the Training Programme

Many researchers believe that stretching is valuable (Subotnick, 1978; Bates et al, 1982; Schwellnus et al, 1992; Barber and Sutker, 1992), however Fordyce does not agree (Fordyce, 1996).

Stretching, it was assumed, would help to prevent BAOPTP, as shortened hamstrings have often been cited as a cause of low back problems, and altered lumbar-pelvic rhythm (Norris, 1995; van Wingerden et al, 1993), as has a tight piriformis muscle (Benson and Schutzer, 1999), and immobile neuromeningeal structures (Elvey, 1995). Also it is recognised that muscles undergo adaptive shortening and remodelling if maintained in a shortened position, therefore it would seem logical to assume that stretching would be a protective factor (Sahrmann, 1991) (S1; Q11).

Resting for a Month or More after Comrades

It has been postulated that the intensity of training should vary during the course of the year, allowing for peaking and then recovery (Fordyce, 1996). This training tactic averts injury in Fordyce's opinion. It was thus decided to ascertain whether runners who stopped training completely after Comrades were more or less likely to suffer one of the injuries being studied here (S1; Q12).

The Self Assessed Posture of Each Runner

It was necessary to establish whether these injuries are more common in any particular type of posture. Runners were assumed to have one or the other posture type, no provision was made for the assessment of a posture as neutral, as it would make self assessment inaccurate. The **"hollow back posture"** (lordotic, or kypholordotic posture type (Norris, 1995)), leads to weakness in the abdominal muscles, gluteals and stress in the L5- S1 joints (Chaitow, 1996; Janda, 1986). The **"flat backed posture"**, (sway back or flat back posture type (Norris, 1995)) with its associated loss of normal lumbar curves, leads to a diminished dampening of the rhythmic sacrocranial vertebral oscillation which occurs with locomotion. It also leads to reduced elastic energy storage and release (Don Tigny, 1993).

Both of these postures lead to muscle imbalance, and loss of the fine balance around the pelvis, it was necessary to establish whether this was relevant to the onset of one or both of these injuries (S1; Q13). The **"hollow back posture",** which correlates to the pelvic crossed syndrome, previously described (Janda, 1986). This posture type results in a combination of tightness in the short hip flexors and ES and weakness in the gluteals, which is often resisted by shortening of the hamstrings (Norris, 1995). The **"flat backed posture"**, results in the one joint hip flexors becoming lengthened and weak, and the hamstrings, becoming short and strong, while the back extensors become elongated and weakened as does external oblique.

The Regular Use of the "Pelvic Slouch" Position when Standing

"Pelvic slouch" was the term used by Evans (1979) to describe a commonly assumed posture (see Glossary; see Figure 10). According to Evans (1979), there was absent electromyographic activity in the gluteal abductors in this posture. He

did not explain how he applied the electrodes, making this statement difficult to assess for value. Data obtained from surface electrodes is of little scientific value.

Figure 10: **Illustrates position of "pelvic slouch"**

This asymmetrical posture, if habitually assumed, would result in shortening with increased tone in the TFL. According to Norris (1995) this tightness would be transmitted down the ITB. This posture would result in stretch weakness in gluteus medius. It seemed relevant to establishing whether a relationship existed between the two injuries in question. Also relevant was which leg the respondent rested upon, if there was one most commonly used. This would establish whether a correlation existed between the leg "slouched" on and the injured side (S1; Q14 a, b).

Information Regarding the Function of the Stabiliser Muscles of the Lumbar-Pelvic Region

Questions were required to establish whether any signs of lumbar or SIJ dysfunction or loss of stabiliser muscle control of the region were present. Questions (S1; Q15-18) were chosen to be easily recognised, relatively objective signs. Answers relied on the runners' opinions. These were not necessarily the obvious signs or symptoms of choice to establish the presence of dysfunction, but within the context of the questionnaire were chosen. These questions assessed for lumbar-pelvic dysfunction and precluded the need for objective assessment, which would have been impossible with the large sample size. No scientific evidence has been found to ascertain that these are valid causes or signs of "poor stabiliser control", however it is speculated that based on the available evidence that they would provide valid signs, that "poor stabiliser control" existed. Conversely, if such postures were habitually assumed then "poor stabiliser control" would ensue.

Lumbar-pelvic dysfunction, it was decided, would exist when three of these four factors were reported to be present.

Discomfort with Sitting, the Length of Time it Took to Come on and the Need to Shift and Move a Lot when Sitting

According to Hartley (1996) SIJ pain increases with prolonged postures, specifically sitting. This is in agreement with Broadhurst (1997) who states that a regular symptom of SI dysfunction is an inability to sit evenly on both buttocks for one hour or more. More evidence for its relevance was found in Nachemson's work (1963). Sitting raises intradiscal pressure. In the presence of disc pathology, sitting causes pain, or the need to constantly shift and move when sitting (Nachemson, 1963). Most sitting postures cause a loss of lordosis and place the sacrum in a position of counternutation, which has been found to be an unstable position (Vleeming et al, 1990, Snijders et al, 1989).

Don Tigny (1979 p29) explained how if wedging has already slightly spread the innominate bones, then sitting would increase the "spreading". This would result in

ligamentous stretch, which would be painful, or at least uncomfortable. His article is well researched although it contains some unsubstantiated statements.

The presence of discomfort with sitting may therefore be seen as a sensitive measure of lumbar-pelvic dysfunction (S1; Q15). Shifting and moving with sitting may be seen as a sign of the body needing to adapt to cope with the forces produced during sitting (S1; Q17). There are other reasons that a person may shift and move and be uncomfortable when sitting, however lumbar or lumbar-pelvic dysfunction is a very common cause, and it was considered to be relevant when present in conjunction with the other factors.

Crossing the Legs when Sitting

Snijders et al (1997) wrote a well-researched article on the "Biomechanics of the interface between the spine and pelvis in different postures." Their paper describes a biomechanical model. They found that crossing legs with sitting produced a significant decrease in activity in the internal oblique muscles (Snijders et al, 1995). They measured the surface electromyographic activity in various unconstrained postures. Although this is not a very scientifically reliable test, it can be extrapolated from their finding that if the muscle groups, which function to produce pelvic compression with sitting are lacking in endurance, then habitual leg crossing would be a functional adaptation. It would be adopted to provide the compression required to resist the shearing produced by the prolonged load of sustained sitting.

Crossing of the legs also causes the trunk to rotate slightly (Snijders et al, 1995). This would produce slight tension in the fascial tube of the body. This would provide compression of the pelvis, if the muscles are unable to adequately provide this. It accordingly has been used in this study as a sign of inadequate ability of the abdominal muscles to stabilise the pelvis in the sitting position (S1; Q16). Again, weakness in the stabiliser system is not the only reason for a person to cross their legs when they sit, however in conjunction with the other signs it was considered to be a relevant sign. The test has not been shown to be a valid one, the evidence is empirical.

Supporting the Arms or Hands in the Standing Position

The author has extrapolated from the work of Sahrmann (1991) and Kendall (1993) that standing with arms folded or hands in pockets is a sign of the need to adapt to diminished endurance in the antigravity and postural muscles. This posture provides support for the shoulder girdle. This reduces the load on the rhomboids and middle and lower fibres of the trapezius muscles. It also reduces the load on serratus anterior, whose function it is to hold the shoulder blades back and against the rib cage, in the upright posture. If it is a regularly assumed posture it may also be the cause of diminished strength and endurance in these muscles. The scapular stabiliser muscles are maintained in a lengthened position in this posture. If this posture is habitually assumed, these muscles will undergo length-associated changes, according to Sahrmann (1991) (S1; Q18). This empirical observation has also been used as a test, the test has not been scientifically tested.

Stabiliser control has been shown to be relevant to the function of the lumbar-pelvic region (Sahrmann, 1991; Kendall, 1993; Richardson and Jull, 1995). The trunk is required to support the head, and to provide a stable base from which the legs can work in locomotion (Thorstensson et al, 1984).

Gracovetsky and Farfan (1984) describe the human spine as an engine driven by the power of the hip extensors. The degree of lordosis is a main factor in the conversion of unilateral extensor power to axial torsion, according to this engine model. Spine geometry must be continually modified to keep stress minimal and equal. This dynamic function is provided for by each intervertebral joint's muscles, as well as by the larger spinal muscles. (Gracovetsky and Farfan,1984). Proper control of the spine is essential if injury is to be avoided.

Joint failure occurs when muscle response is uncoordinated, or unable to respond to changing stress levels (Comerford and Motram, 2001). The crucial importance of the trunk musculature is also well illustrated by Panjabi's observation (1992) that the spinal column, devoid of its musculature, buckles and collapses under an axial load of as little as 2,5 Kg. Also recognised by Kendall (1993), Sahrmann (2000), Janda (1985), and Comerford and Mottram (2001), are the altered patterns of recruitment and sequencing of muscle activity that occur in the face of dysfunction. Therefore,

muscles do not have to be weak to allow loss of stabiliser control to exist: they may merely be poorly or incorrectly recruited.

Questions pertaining to habits and postures search for the causes and signs of this altered patterning of contraction and recruitment (S1; Q14-18).

3.7.2 Section Two: Development

This section was to be completed by ITBFS sufferers only.

The Time Span for the Last Incidence of ITBFS

Was the ITBFS being discussed an old or relatively new problem? (S2; Q19).

Which Leg was Symptomatic

It was necessary to establish whether the leg used for "pelvic slouching" (S1; Q14), or the one that had BAOPTP (S3) in runners with both injuries, was the same as the one with ITBFS. Most authors found the symptom to be present in an equal spread of left and right legs (Barber and Sutker, 1992; Orava, 1978), or some found it occurred more frequently in the right leg (Firer, 1989)(S2; Q20).

Treatment Used for ITBFS

It was interesting to know what treatment had been tried (S2; Q21). Ice, stretching, orthotic use and anti-inflammatories are the most common form of treatment, suggested in the literature for ITBFS (Noble, 1980). Physiotherapy modalities have been found by some to be effective (Scwellnus, 1992). Cortisone injections are discussed by some authors (Noble, 1980; Firer, 1989).

The Use of Surgery to "Snip" the Distal End of the Band

Surgery is sometimes used in rare cases (Noble, 1980), this was confirmed by Martens et al (1989). It was considered necessary to determine if any of the runners had surgery prior to the event (S2; Q22).

The Duration of the Symptoms

ITBFS is very resistant to treatment, and tends to become a chronic problem (Noble, 1980; Sutker et al, 1985; Lindenburg et al, 1984; Martens et al, 1989). This fact was

a contributing motivating factor behind the study. It was necessary to know how long runners had suffered from their symptoms and how many were complaining of chronic ITBFS (S2; Q23)

Whether the ITBFS Had Completely Healed, Whether the Runner Still Needed to Protect the Knee, and What the Runner Did to Prevent a Recurrence

Information was sought as to whether persistent problems were common, and if total resolution did in fact occur in some cases (S2; Q26). Some authors suggest that most remain relatively symptom free provided the runner manages their training properly (Sutker et al, 1985) (S2; Q29). Many researchers, however, report the need for ongoing management and stretching in order to keep symptoms at bay (Firer, 1989; Aronen et al, 1993) (S2; Q30).

Causes of the Injury

It was considered important to include a question to confirm the findings in the literature that training errors (Noble, 1980), genu varus, cavus foot, leg length discrepancy, road camber, and hard running shoes exacerbate the condition (Schwellnus, 1992; Firer, 1989) (S2; Q24).

The questionnaire was designed to ascertain what the risk factors were for each of the injuries in question. It was necessary to establish whether training errors and biomechanical abnormalities are in fact the only etiological factors for ITBFS development, or whether some other previously untested factor was involved. The factor being tested was diminished muscular control, caused by poor postural habits.

The Length of Time Symptoms of ITBFS Halted Running

It was necessary to establish the severity of the symptom, as well as to confirm the diagnosis. Runners are always very reticent to rest, and only debilitating pain will halt their training. Noakes (1992 p449) defines the pain of ITBFS as pain which comes on fairly rapidly, possibly even immediately running commences and "completely stops further running". This description was confirmed by Lindenberg et al (1984). It was assumed that true ITBFS would have stopped running for at least three days (S2; Q25).

The Use of Ongoing Stretching of the Band

According to Bates et al (1982), stretching the band and the TFL is an active means of alleviating symptoms and preventing their recurrence. The fact that stretching does relieve symptoms has been found by virtually all the researchers on the subject (Noble, 1979; Schwellnus et al, 1992; Lindenberg et al, 1984; Bates et al, 1982). The questionnaire aims to establish whether stretching is done prophylactically, or only when symptoms present, as well as to ascertain whether it is in fact an effective method of management of the condition (S2; Q27).

3.7.3 Section Three: Development

This section was to be completed by all BAOPTP sufferers.

The Symptomatic Leg

It was again necessary to establish which leg had been the one affected by the BAOPTP (S3; Q31). Also relevant was the question of whether this limb correlated to the side affected by ITBFS (S2; Q20), and if it was the one used for the "pelvic slouch" (S1; Q14). Pain may have been present in both legs.

The Time of First Symptom and the Duration of Symptoms, the Method of Alleviating or Treating the Symptoms, The Intensity of the Symptom, and the Need to Stop Training for Longer Than Three Days

The questionnaire asked about the intensity of the symptom (S3; 36), the need to halt training for more than three days (S3; Q37), and the duration of the symptoms (S3; Q32). An acute muscle tear causes agonising pain and loss of function, with associated bruising and swelling (Noakes, 1992). Rest may be required for up to six weeks. A more chronic muscle injury could result in much milder pain and less, if any, loss of function. This is a more common type of injury in long-distance runners. Many runners can continue to run almost indefinitely with a chronic muscle tear (Noakes, 1992)(S3; Q37). Referred pain from the SIJ, the lumbar-sacral junction, or the neuromeningeal structures, would most probably produce moderate or mild pain or at worst "bad" pain (S3; Q36). These pathologies would be less likely to stop the

athlete from training, but would require modification of training (S3; Q35), as well as some other means of "alleviating" the symptoms (S3; Q33).

Aetiological Factors

It was important to know whether the aetiological factors were similar for the ITBFS group and the BAOPTP group, in order to establish what was the relationship between the two injuries. Were there common causative factors, which were relevant?

Noakes (1992) postulates that the back is one of the areas of the body that is least well designed to cope with the stresses of running. He suggests this be as a result of the strength imbalances between the abdominals and back muscles, and the inflexibility in the hamstring muscles caused by running.

Intrinsic injuries occur at "breakdown point", and each runner has their own point of breakdown (Satterthwite et al, 1999 p25). Exceeding this point leads to injury due to breakdown being greater than regeneration (Noakes, 1992; Fordyce, 1996). A common situation may exist in which the runner, reticent to stop, continues to run despite having pain from an injury. The injury leads to altered biomechanics, adaptation, altered running style and overload of structures which have not adapted to the load they are then placed under (Noakes, 1992). A secondary injury then sets in.

Footwear may have worn out, be providing inadequate support, or be enhancing rather than compensating for biomechanical abnormalities. (Noakes, 1992; Fordyce, 1996; Lehman, 1984). Incorrect footwear is a common cause of running injuries (S3; Q38).

3.7.4 **Section Four: Development**

This section was to be completed by all participants.

In order to assess each runner within the context of his/her running portfolio, further information was obtained through Section 4. Section 4 also provided a forum for establishing some answers that were of interest value only.

Expected time for the 1999 Comrades was asked for (S4; Q40). This was necessary, because a faster runner is usually more experienced and better trained. This information also provided assurance that a good cross section of experience and abilities had been assessed in the study.

It was of interest to know what runners' perceptions were of physiotherapy (S4; Q41 and 42). The inclusion of these questions was incidental to the main study.

Stability of the pelvis can be enhanced when exercise programmes address the force closure mechanism. Runners were asked whether they had tried or would be prepared to try a strengthening programme (S4, Q43), and whether they could see the logic in doing such a programme (S4; Q 44).

Programmes must include muscle patterning and timing as well as specific strengthening during functional activities (Lee, 1996). Based on this, it was felt that a series of specialised exercises which would enhance force closure would benefit respondents and render them more stable, better biomechanically and therefore more able to run efficiently. In view of this runners were offered a programme as a token of appreciation for their participation in the study.

CHAPTER 4

MATERIALS AND METHODS

4.1 INTRODUCTION

The objectives of this study were to determine whether a relationship existed between ITBFS and BAOPTP in ultra-distance runners. If such a relationship could be found to exist, then this relationship was to be explored, and the risk factors for the development of one or both injuries were to be identified and quantified.

This chapter presents the methods used to:

1. Distribute the questionnaire for completion by a large a sample of Comrades runners.

2. Assess the information obtained from these completed questionnaires, and statistically analyse it.

Ethical clearance was granted for this study to be undertaken (see Certificate, Appendix 2). As has been discussed in Chapter 3 a questionnaire was designed. The completed questionnaire was tested by a series of four pilot studies and adjusted accordingly. After this process it was found to be a reliable measuring tool, which was able to answer the research question. It was used in the final study.

4.2 PROPOSAL

A proposal was prepared (see Appendix 3). It was submitted to the department of Health Sciences of the University of the Witwatersrand.

4.3 PERMISSION TO CARRY OUT THE STUDY

An application was made to the Human and Animal Ethics Committee of the University of the Witwatersrand, Johannesburg, for permission to carry out the study. This application was approved and permission to carry out the study was granted. The clearance certificate protocol number is M990438 (Certificate: Appendix 2).

4.4 RESEARCH PARTICIPANTS

Runners who had entered the 1999 Comrades Marathon were all potential participants. A sample of these runners was chosen by convenience. Runners were approached either by the researcher or one of two Physiotherapy students from the University of the Witwatersrand.

The only inclusion criteria were that they could speak, read and write English, were sufficiently educated to enable them to understand the questions and answer them, and that they were entrants for the 1999 Comrades Marathon. No attempt was made to evaluate a runner's ability to fulfil the inclusion criteria, but a small percentage of runners, answered the request in another language, indicating that they would be unsuitable participants and would be unable to complete the questionnaire. A total of 93 forms were discarded, because they had been inadequately completed, indicating that the runner had had difficulty interpreting the questions for whatever reason. Any runner who fitted the description of the inclusion criteria, and who was willing to complete a form, who could be accessed among the crowds of runners, was approached. A very small percentage of runners opted not to complete the form, citing reasons such as lack of time, most runners were enthusiastic about participating and some even asked to be allowed to complete a form. Runners were requested to complete the questionnaire right then and there and to give it back to the researcher or one of the students. No attempt was made to obtain equal proportions of male and female runners compared to the percentages of those entering the race, as this would have made the selection not entirely arbitrary.

4.5 RESEARCH TOOLS

This retrospective study was carried out by means of a questionnaire. A letter informing all potential respondents of the purpose of the study preceded the Questionnaire (Appendix I). The letter explained the following:

1. Completion of the questionnaire and therefore participation in the study was completely voluntary.

2. Confidentiality was ensured and participants would not be identified.

3. Volunteers, who wished to receive it, would be sent a summary of the findings of the study, as well as some recommended strengthening exercises, based on the findings of the study.

4.6 SAMPLE SIZE

The sample amounted to 978 fully completed and unspoilt questionnaires. Any questionnaires that were not completely answered were considered to be spoiled, and were not used in the final analysis.

4.7 RELIABILITY ESTABLISHED

Questionnaire 4 was proven to be reliable by means of a series of four pilot studies. It could be trusted to provide reliable data about the opinions of the runners who completed it, and to provide information about the Comrades running community in general, since a large cross section participated in the study.

The Comrades running community is an experienced group of runners (Noakes, 1996). As such, their opinions are valued, and could be relied on to provide useful information. Also of value, was the size of the 1999 Comrades community. This enabled a large group to be accessed to answer the questionnaire. This made it possible to survey the group thoroughly.

4.8 REPEATABILITY ESTABLISHED

The questionnaire was designed for reliability. Most answers were simply a "yes" or "no", or a statement of fact. The data was not therefore subjected to statistical analysis for reliability.

4.9 DISTRIBUTION OF THE QUESTIONNAIRE

The questionnaire was handed out, at the Comrade's Exposition, with permission of the Comrade's Association. This was held in the three days preceding the race. The exposition was held in Durban and in Pietermaritsburg, the Durban one being the bigger of the two. Only the Durban exposition was used, as other researchers were using the Pietermaritsburg venue. Runners were approached as they queued to register for the race, or as they sat down to eat in the dining area of the exposition.

Two University of the Witwatersrand physiotherapy students assisted the author in this task. They were asked to approach every runner who fitted the inclusion criteria and who agreed to complete a form. (The inclusion criteria included literacy in English and the presence of sufficient education to enable them to understand the questionnaire).

4.10 ANALYSIS OF THE QUESTIONNAIRE

Responses were computed and were statistically analysed.

Results, after analysis, were summarised and mailed or emailed to the respondents, together with some exercises which facilitate the use of the stabiliser muscles of the pelvis and enhance force closure of the SIJ (see Appendix 4).

The questionnaire was divided into sections that could provide answers to questions which had been identified as risk factors. For ease of data insertion into the computer, categorical variables were given values of either 1 or 2, for example male being 1 and female being 2.

4.12 CATEGORICAL VARIABLES

The categorical variables included: age categories, BMI categories, gender, participation in other sports, use of strength training, the presence of strain in the training programme, stretching, taking a break of a month after Comrades in order to rest before recommencing training (stopping training). Also, the subjective assessment of the presence of a lordosis, or a flat back ("posture-type-hollow" or "flat"), habitual "pelvic slouching" ("pelvic slouch use") (Evans, 1979), and the presence of "poor stabiliser control" as previously defined. The responses to these variables were either "yes" or "no". The data was summarised using frequencies and percentage.

4.13 CONTINUOUS VARIABLES

The continuous variables, included BMI, and the number of standard marathon equivalents, divided by the number of years the runner had been running (load per year). This value was expressed in increments of five (load per year/5), and the number of years of running was expressed in five year increments (years run/5).

The continuous variables were analysed using means, standard deviations, minimum and maximum values.

Age:

Age was divided into categories:

- Below 25 years.
- 26 to 35 years.
- 36 to 50 years.
- 51-60 years.
- Over 60 years.

A new variable was created, " age group 2" which divided those below 50 from those over 50. The fact that Cohen at al (1967) found that a significantly higher percentage of people over the age of 50 had signs of erosion of the SIJ, and/or subarticular sclerosis partly motivated the use of this second age category. According to Hughes (1999), the decline seen in muscle tissue is accelerated at about 50 years of age.

Bellamy (1983) explains from his thorough literature search that SIJ mobility decreases until puberty, and then in females it increases until a peak at age 25. In males, however, it remains at a low level until middle age, when in some cases it completely ceases, but in others remains very minimal. With increasing age, which is not precisely defined, the changes of chondramalacia and subchondral sclerosis and cyst formation, shearing off of articular cartilage flaps, osteoarthrosis, and osteophytic lipping, have been found to occur. Changes also occur in the bone of the spine which are associated with "old age", although these changes are less relevant in the active population being studied here (Twomey and Taylor, 1994). McKenzie (1994) states in his poorly substantiated article on disorders of the low back, that derangement syndrome which, in his opinion, is by far the most common cause of low back and referred pain from the area, occurs between 20 and 55 years of age.

When all these findings from the literature were considered, It became relevant to assess age in five categories as well as simply above and below 50.

Body Mass Index

BMI was calculated from the weight and the height for each athlete and was analysed in increments of three, in order to use the data as categorical data. This increment was chosen for convenience, and because it was assumed that this would be a fine enough means of determining a trend, should one exist.

The Number of Marathons Run Over the Period of Years Through Which the Runner Had Been Running

The answers to the first three questions were summed to calculate the number of equivalent-to-marathon-distance-runs that had been run and this value was divided by the number of years that the runner had been running. This information was used to create the variable named: "load per year".

This value was then grouped in increments of five, giving the variable: "load per year/ 5". Five was an arbitrarily chosen figure. Five was a sufficiently small increment to be sensitive to changes produced by differing loads. This variable was used to facilitate the analysis, by converting this data into categorical data.

The number of years of running was also grouped in increments of five years for ease of analysis, giving the value: "years run/5".

The Use of Strength Training in the Training Programme

A "yes" or "no" was obtained for the use of strengthening in the training programme. Strengthening exercises had to be done more than once a week for the variable to be awarded a "yes" value. This produced the "gym" variable.

The Number of Kilometres in Total Training, the "Peak" Week, and the Number of "Quality" Training Sessions Per Week

The variable "strain" came from the answers to three questions (S1 Q8, 9 and 10). The "strain" variable was judged to be positive when:

- The value for the "peak" week contained more than eight per cent of the total Comrades training. (S1 Q8 value divided by value for Q9); and/or

- The total number of speed and/ or hill sessions was greater than three and/or (S1 Q10);
- The total number of kilometres run in preparation for the Comrades was more than 3000 (S1 Q8).

If the respondent had answered such that either one or more of these three factors were present, then the variable "strain" was assigned a "yes" value. If none of these factors was present then the "strain" variable was given a "no" value.

These values were chosen, based on the training of Bruce Fordyce (Fordyce, 1996). He recorded his training for the 1996 Comrades Marathon which was, according to him, his best training year. He set the new "up" record that year in a time of 5:27:42. It was decided to use his training as a benchmark against which to measure less serious, less talented and less biomechanically perfect athletes. It was assumed that anything done that far exceeded what Fordyce did must be excessive.

Fordyce ran a total of 2880 Kilometres that year between January and June, and "peaked" his mileage at 190 Kilometres (in his "peak" week), this is six and a half per cent of the total distance trained. It was decided that anything in excess of eight per cent would be considered to be straining the body. Fordyce did two "quality" sessions (hard training; either hill training or speed work) in an average week, when he did not feel his legs were too sore. It was assumed that three speed or hill sessions in a week would be straining the average runner's body. Since Fordyce ran a total of 2880 kilometres that year between January and May (Comrades was on May 31 in 1996), 3000 km's, between January and June (Comrades was on June 16 in 1999) was taken to be an excessive quantity of training, for the purposes of this study. Runners who had run in excess of this were considered to have strained themselves.

The Use of the "Pelvic Slouch" (Evans, 1979)

The question regarding the "pelvic slouch" (S1 Q14), was given a "yes" or "no" value. Part B was analysed independently to assess whether there was a correlation between the leg which the runner "slouched" on and the leg in which they developed ITBFS and/or BAOPTP.

Discomfort with Sitting, Continual Shifting with Sitting, Habitual Leg Crossing with Sitting, and Repeatedly Folding Arms or Resting Hands in Pockets When Standing

Four questions were used to produce the variable: "poor stabiliser control". The variable, "poor stabiliser control" was given a "yes" value when three or more of the four answers had been "yes". It was given a "no" when less than three were answered as "yes"

4.14 FORMATION OF GROUPS OF RESPONDENTS

Only respondents who had suffered from ITBFS filled in Section 2 of the questionnaire. Only those who had suffered from BAOPTP completed Section 3. Those who had endured both injuries were required to complete both of these sections (and they became the "both pains" group). Those who had never had either pain completed neither Section 2 or 3, and they became the "neither" group. Everyone was required to complete Sections 1 and 4.

Four distinct groups of runners were thus created and their data was analysed separately. The information gleaned from each separate section was used to produce a profile of the injury groups.

4.15 STATISTICAL ANALYSIS

Having identified four groups of runners (ITBFS, BAOPTP, 'both pains" and "neither pain"), a statistical analysis of the computed questionnaire results was done to determine what the risk factors were for each injury, and what the relationship between the two injuries was.

Dr P Becker from the South African Medical Research Council in Pretoria provided advice regarding the method of statistical analysis of the data, as well as the actual statistical analysis of the information. His team assisted with importing of data into the computer.

Risk factors for the ITBFS, BAOPTP and "both pains" groups were assessed in univariate analyses employing: contingency tables, followed by the chi square test,

and the calculation of crude odds ratios and ninety five per cent confidence intervals for these odds ratios.

In a multivariate analysis, a logistic regression was employed to assess the risk factors: BMI, "load per year / 5", "years run/ 5", gender, age, "non-ball sports", "ball sports", "gym", "strain", "stretch", "stop training", "posture-type-hollow", "pelvic slouch use", ITBFS and "poor stabiliser control" for BAOPTP development. BAOPTP, became the dependent variable. The causes of the development of BAOPTP were of primary importance in this study.

The important statistics to follow from this multivariate analysis was the adjusted odds ratio for the significant risk factors.

4.16 LEVEL OF SIGNIFICANCE

Testing took place at the 0.05 level of significance.

(Statistical significance here is defined as: less than five times in a hundred, results are obtained strictly due to chance.) The "p" value is the probability of the results occurring strictly due to chance. When probability ("p") is </= 0.05, then the results are statistically significant.

4.17 EXPLANATION OF STATISTICAL TESTS USED

A univariate analysis treated the repeated measurements of each of the dependent variables as single outcomes with multiple causes. (Each of the groups, ITBFS, BAOPTP and "both pains" were used as dependent variables.)

Contingency tables were used prior to carrying out a statistical test, to tabulate the data. (Each group was assigned to an appropriate cell and the data comparing the observed frequencies was cross- tabulated.)

The chi square test was used to determine whether the two injuries being studied, were related to each other.

Crude odds ratios were used to compare risk of disease when exposed to a risk factor divided by risk of disease when not exposed to a risk factor. Odds ratios were

used, because they have the advantage of not being constrained to lie between 0 and 1. They can take any value from zero to infinity.

A multivariate analysis was used, because it was necessary to analyse three dependent variables (ITBFS, BAOPTP, and "both pains"). Both continuous and categorical independent variables were used.

The logistic regression entered the independent variables (continuous and categorical) in a stepwise manner. This enabled the researcher to predict the probability that an individual in one of the groups would have been exposed to risk factors. The most relevant risk factors could therefore be identified.

4.18 THE COMPUTER SOFTWARE THAT WAS USED FOR THE STATISTICAL ANALYSIS

Data was analysed using the Statistical Analysis System computer software and the BMDPLR software for Stepwise Logistic Regression. Logistic regression is a computer intensive analysis. A Biostatistician (Dr Becker) performed the computer analyses from the South African Medical Research Council.

CHAPTER 5

RESULTS

5.1 INTRODUCTION

The vast volume of results that were obtained from the study are summarised and presented in either table or graph form, for ease of interpretation.

A questionnaire has been included in the appendices (see Questionnaire 5 in Appendix 1). Questionnaire 5 contains the total numbers of responses as received, without analysis of the information. Where applicable, means have been given, as well as ranges of responses, in this questionnaire.

5.2 RESULTS PRESENTED

The frequency of occurrence of each injury, as well as of "both" injuries is described, followed by an exploration of the risk factors for each injury, which will demonstrate the relationship which was found to exist between ITBFS and BAOPTP.

Figure 11

This is an exploration of the relationship between ITBFS and BAOPTP.

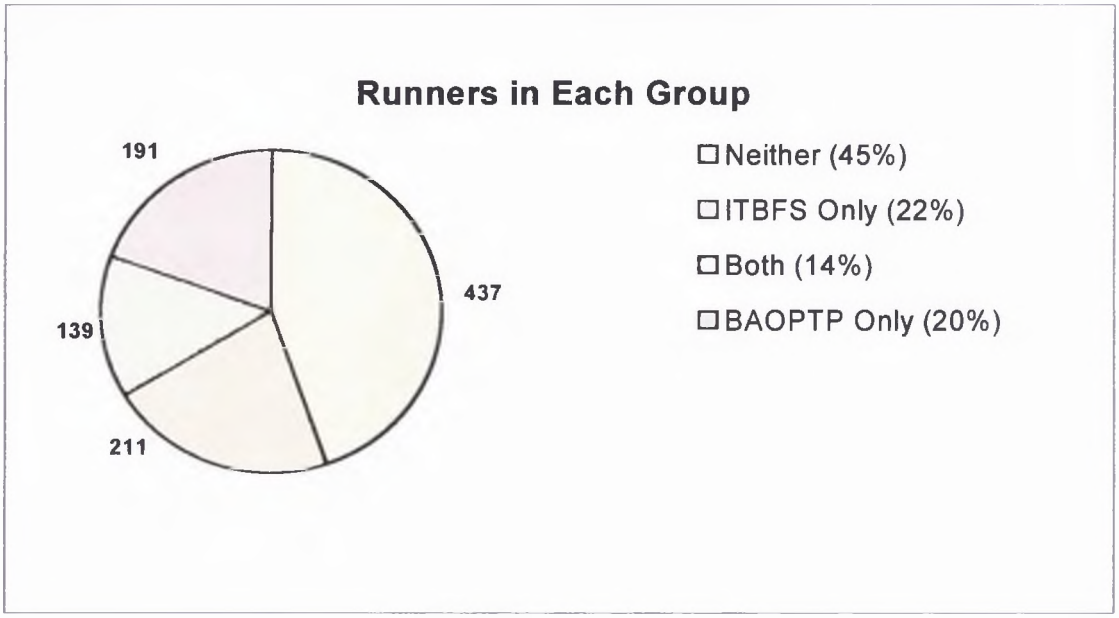


Figure 11: Illustrates the percentages of runners in each group

Nine hundred and seventy eight runners were assessed. Of these runners, 45% had neither of the injuries being studied, 20% had BAOPTP, 22% had ITBFS and 14%, had "both pains". This data is presented in Figure 11.

5.2.1 **Categorical Variables**

Figures 12 A, B and C

Figures 12 A, B and C illustrate the distribution of injury by gender

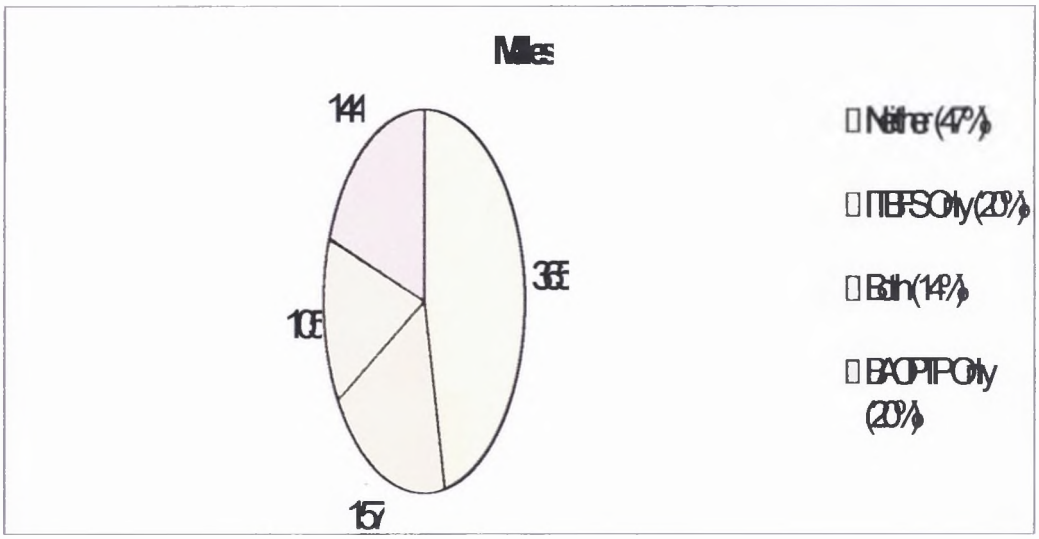


Figure 12A: Males

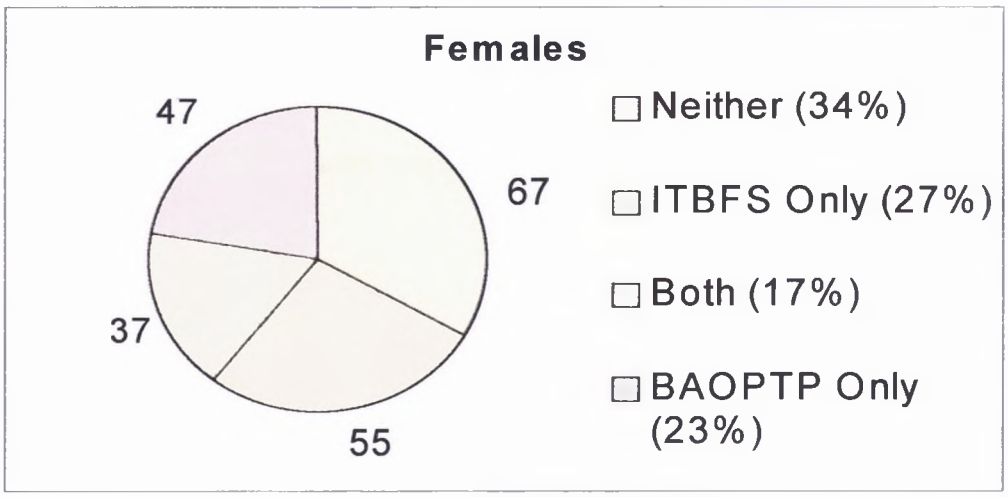


Figure 12B: Females

For gender, there is a statistically significant predominance of runners from each group among the female respondents (P= 0,021). This is further illustrated by

Figure 12 C, which compares genders with respect to the distribution of injuries. Of the 978 respondents, 81% were male and 19% were female.

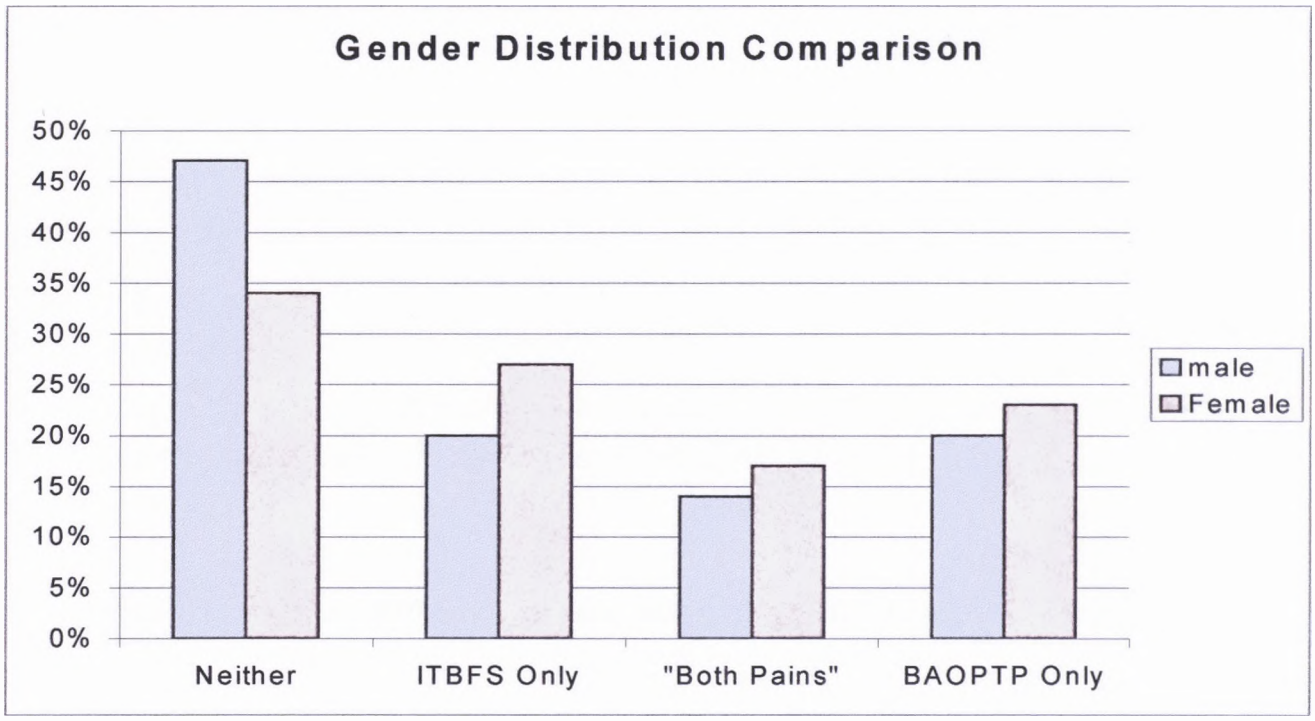


Figure 12C: Compares gender with respect to distribution of injury.

Table 6

Table 6 illustrates the distribution of injuries in each of the five age categories.

Table 6: The Comparison of Frequency of Each Injury with Respect to Age

Age Category	Neither Pain	BAOPTP	BAOPTP only	No BAOPTP	ITBFS	ITBFS Only	No ITBFS
Below 25	78%	23%	7%	77%	37%	21%	63%
26-35 years	49%	25%	14%	75%	37%	27%	63%
36-50 years	41%	40%	24%	60%	36%	19%	64%
51-60 years	42%	42%	29%	58%	29%	16%	71%
> 60 years	67%	33%	33%	67%	0%	0%	100%

The percentage of ITBFS sufferers was similar in all of the age groups, although when dichotomised there were fewer runners who were over 50 years of age in the ITBFS group.

Runners with BAOPTP and runners without BAOPTP differed significantly with respect to age, with the painful runners being older than 36 years of age ($P<0,0001$). A similar trend showed itself in the "both pains group". Runners with "both pains", and runners who did not have "both pains" differed with respect to age with a difference that tended towards significance ($P=0,071$).

Figure 13

Figure 13 compares runners over 50 years of age with runners under 50 years of age with respect to the distribution of injuries.

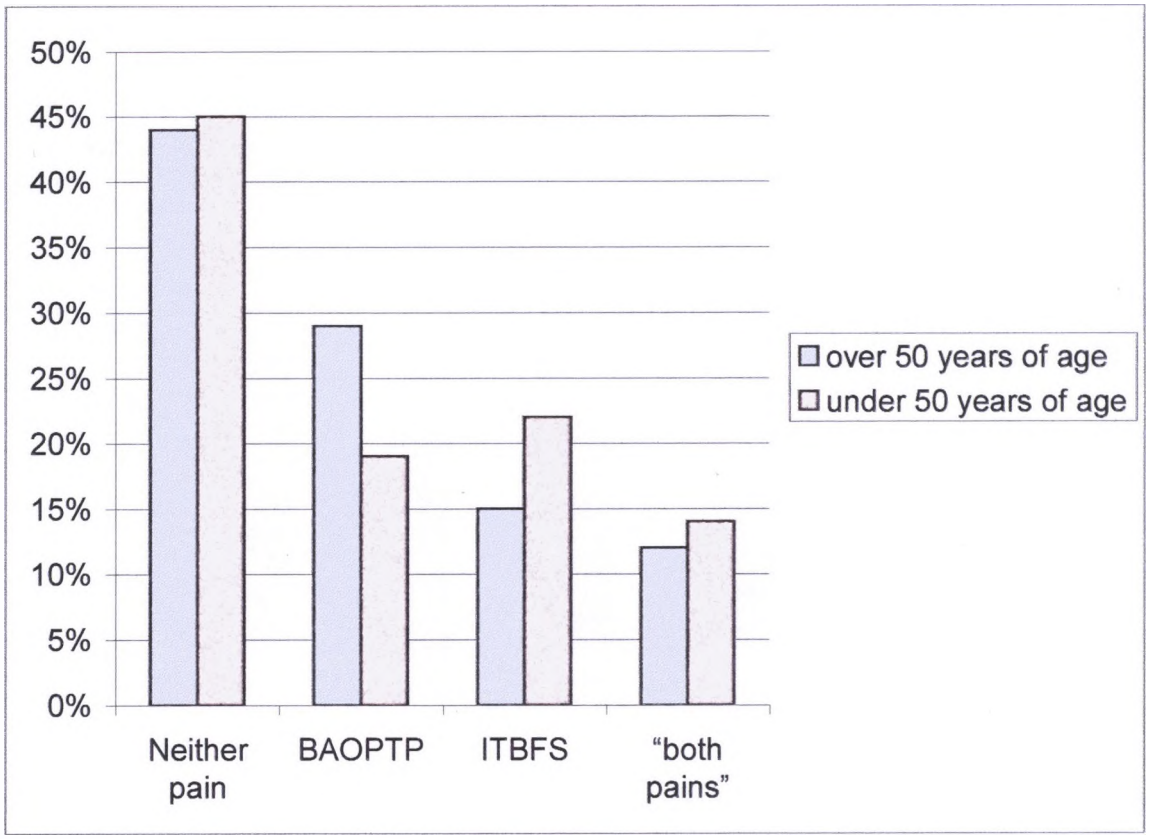


Figure 13: Compares runners in injury categories over 50 with those under 50 years of age.

From Figure 13, it can be seen that BAOPTP is more prevalent in the over 50 category, and ITBFS is more prevalent in the under 50 category.

Figure 14

Figure 14 illustrates that the association between ITBFS and BAOPTP is similar among runners who stopped training for at least a month after Comrades, compared to those who did not.

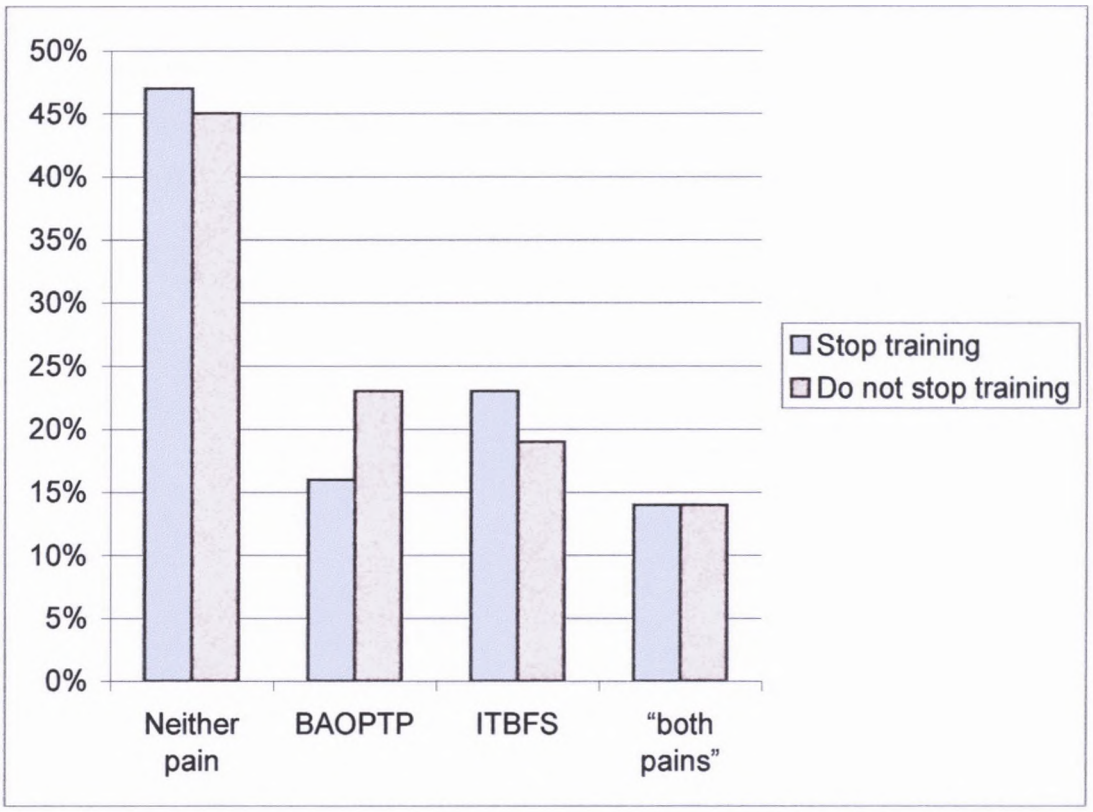


Figure 14: The association between ITBFS and BAOPTP with respect to runners who stop training compared to those who do not

As can be seen from Figure 14, stopping training for at least a month after Comrades had no effect on ITBFS or "both pains". It had, however, a protective effect on BAOPTP development.

The comparison of "strain" with no "strain" with respect to iliotibial band friction syndrome and buttock and/ or posterior thigh pain.

Strain (as per the definition of strain in Section 3) was not associated with any of the injury groups.

The comparison of cross-training, doing gym, and stretching with not doing these activities with respect to iliotibial band friction syndrome and buttock and/or posterior thigh pain

Participation in any or all of these activities was not associated with any of the injury groups.

Figure 15

Figure 15 compares the two different posture-types with respect to the distribution of injuries.

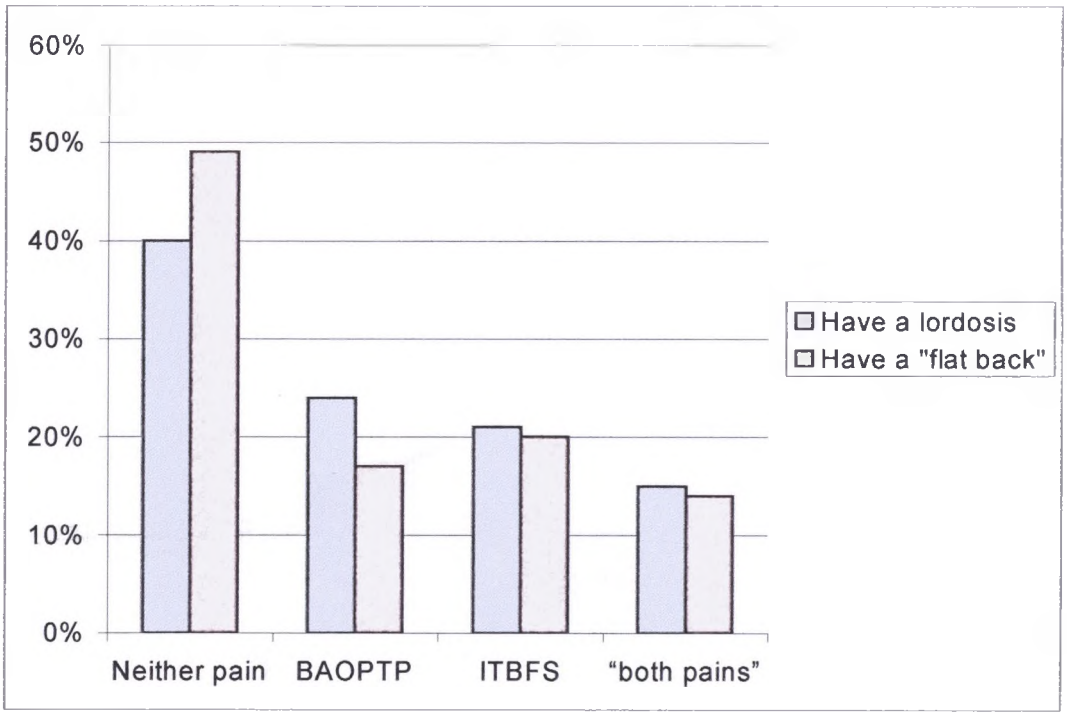


Figure 15: **The association between ITBFS and BAOPTP with respect to runners, who have, according to their own assessment, a lordosis compared with runners who do not**

The subjective perception of the runner's type of posture was found to be irrelevant to the ITBFS and to the "both pains" group (P= 0,581, P= 0,215 respectively), but was significantly relevant to the BAOPTP group (P=0,012). There were more runners with a self-assessed lordosis who had BAOPTP.

Figure 16

Figure 16 illustrates the association between ITBFS and BAOPTP with respect to runners who "pelvic slouch" compared with runners who do not.

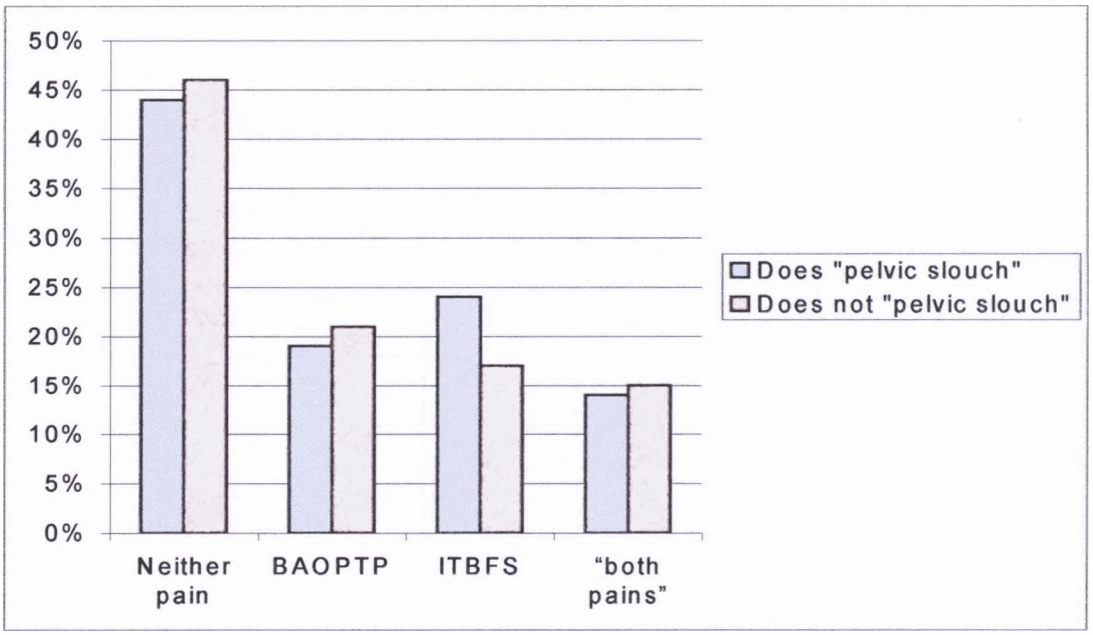


Figure 16: Compares runners who pelvic slouch with runners who do not with respect to distribution of injury.

In the ITBFS group, there was a trend towards significance in increased pelvic slouching (P= 0,123). It seemed irrelevant which leg was "slouched" on.

The BAOPTP and the "both pains" group were not significantly different with respect to "pelvic slouching" (P=0,232, and P=0,122, respectively), when considered in the univariate analysis. When "Pelvic slouching" was included in a multivariate analysis which included a stepwise logistic regression, it was found to be an important risk factors for ITBFS which was in turn an important risk factor for BAOPTP.

Table 7

Table 7 illustrates that in all four groups, especially BAOPTP and "both pains", "poor stabiliser control" and absence of "poor stabiliser control" differed significantly. ("Poor stabiliser control" meant that respondents had reported that three or more of the following signs existed: discomfort when sitting; the need to habitually cross their legs when sitting; the need to shift continually when sitting; and the urge to always fold their arms or rest their hands in their pockets when standing.)

Table 7: The Cross Tabulation of "Poor Stabiliser Control" with the Groups

	No "Poor Stabiliser Control"	% No "Stabiliser Control" Group	% of Total Sample	"Poor Stabiliser Control"	% " Poor Stabiliser Control" Group	% Total Sample	P value
Neither Pain	239	48%	24%	198	41%	20%	
BAOPTP	93	19%	10%	98	20%	10%	P=0,004
ITBFS	110	22%	11%	101	21%	10%	P=0,059
"Both Pains"	53	11%	5%	86	18%	9%	P=0,001
Total	495		51%	483		49%	

Of the total sample, 49% had "poor stabiliser control". Of the runners who had "poor stabiliser control" 41% had neither of the symptoms being tested. Of the athletes who had "both pains", 62% had "poor stabiliser control".

"Poor stabiliser control" presence was statistically significant (P=0,007) in all groups especially in the BAOPTP and "both pains" groups (P values as seen in Table 7). This seemed to be the most relevant of all the risk factors that were assessed.

Figure 17

Figure 17, illustrates graphically the information presented in Table 6. The graph illustrates the association between ITBFS and BAOPTP with respect to the presence of signs of "poor stabiliser control" compared with the absence of these signs.

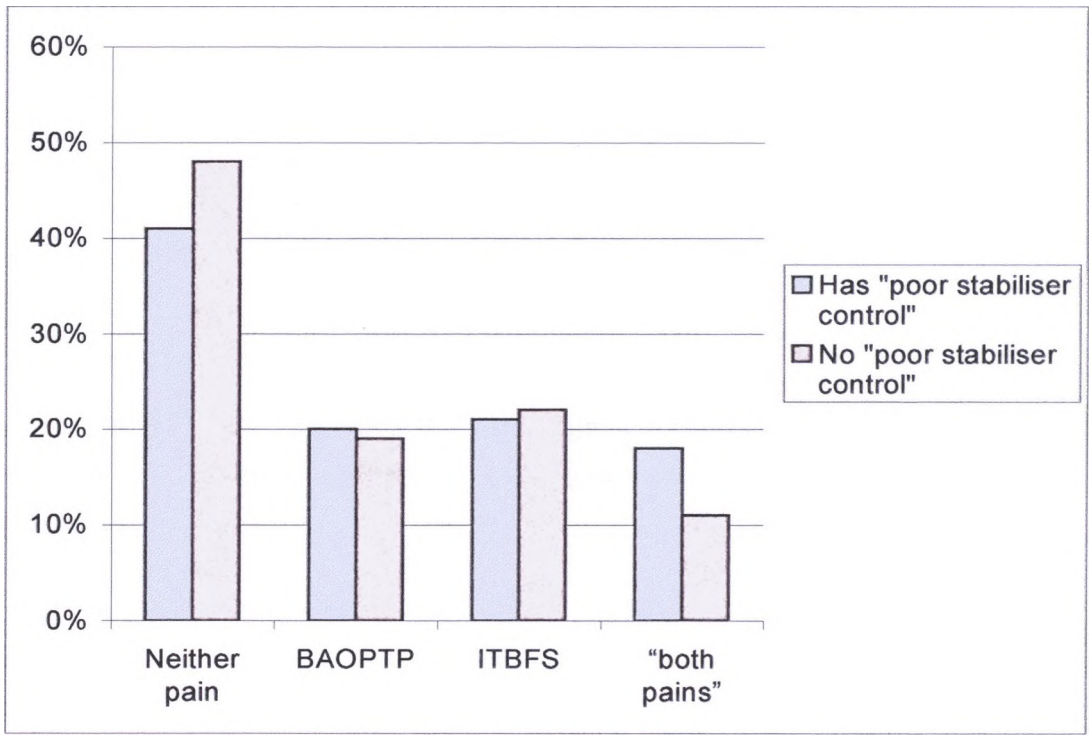


Figure 17: The association between ITBFS and BAOPTP with respect to runners with, compared to without "poor stabiliser control".

5.2.2 The Continuous Variables

Table 8

Three divided the BMI values. This gave a value "BMI 3". Table 8 cross tabulates the BMI 3 values with the groups.

Table 8: To show the cross tabulation of BMI / 3, with the groups

	Mean	Std Deviation	Minimum	Maximum
Neither	7,86	0,84	5,36	10,6
ITBFS	7,57	0,77	5,35	9,53
Both	7,55	0,97	5,3	10,9
BAOPTP	7,7	1,02	4,47	10,9

As can be seen, BMI 3 seemed to be a significant factor, especially in the ITBFS group. A higher BMI is significantly protective against both of the injuries in this study (P=0,05).

Table 9

Table 9, shows a cross tabulation between BMI and ITBFS.

Table 9: Cross Tabulation between BMI and ITBFS.

BMI Category	% Runners with ITBFS
BMI >= 27Category	25%
BMI 24< 27	30%
BMI 21< 24	38%
Bmi < 21	44%

There seemed to be a trend for the lighter runners to be more susceptible to ITBFS. The odds ratios for ITBFS was then calculated using 27 and above as the reference category.

Runners with a BMI of less than 21 have a significantly higher prevalence of ITBFS (P=0,008). The injury is still statistically more common in those with a BMI between 21 and 24 (P=0,04) and it is statistically very significantly more common in runners with a BMI of 24-27 (P=0,45).

None of the other continuous variables produced information of any significance. (P>0,05).

5.2.3 **The Multivariate Analyses**

A multivariate analysis was performed, which consisted of a logistic regression for BAOPTP.

From this logistic regression with BAOPTP, the outcome variable, and starting out with the risk factors - BMI 3, load per year / 5, years run/ 5, gender, age, non-ball sports and ball sports participation, gym use, strain, use of stretching, stopping training for a month after Comrades, presence of a lordosis, use of "pelvic slouch", ITBFS and signs of "poor stabiliser control" - a stepwise (manual) procedure was followed to assess the significant risk factors for BAOPTP.

Table 10

Table 10, illustrates the adjusted odds ratios, together with their 95% confidence intervals from the final logistic regression model.

Table 10: Logistic regression of BAOPTP on ITBFS, "stop training", use of "pelvic slouch", and signs of "poor stabiliser control"
Number of observations = 846

BAOPTP	Odds ratio	P>|Z|	95% Confidence Interval	
ITBFS	1.531	0.005	1.134	2.07
"Stop training"	0.752	0.059	0.56	1.011
"Pelvic slouching"	0.722	0.029	0.538	0.968
"Poor stabiliser control"	1.422	0.019	1.059	1.91

To better understand the relationship between BAOPTP and the risk factors, included in the final model, two further models were considered. In these two further models, the risk factors "stop training", use of "pelvic slouch" and signs of "poor stabiliser control" were considered among runners with and without ITBFS.

Table 11

Table 11 illustrates the odds ratios and 95% confidence intervals, for the variables "stop training", "pelvic slouching", "poor stabiliser control", and ITBFS.

TABLE 11: Logistic regression of BAOPTP for the variables "stop training", "pelvic slouching", "poor stabiliser control," and ITBFS
Number of observations = 554

BAOPTP	Odds Ratio	p>|Z|	95% Confidence Interval	
"Stop training"	0.685	0.049	0.469	0.999
"pelvic slouching"	0.869	0.457	0.6	1
"poor stabiliser control"	1	0.23	0.866	2

Table 12

Table 12, illustrates the odds ratios and 95% confidence intervals, for the variables "stop training", "pelvic slouching", "poor stabiliser control", for ITBFS = 1.

TABLE 12: To show the logistic regression of BAOPTP on "stop training", "pelvic slouching" and "poor stabiliser control" when ITBFS =1
Number of observations = 292

BAOPTP	Odds ratio	P>|Z|	95% Confidence Interval	
"Stop training"	0.833	0.457	0.514	1
"Pelvic slouching"	0.541	0.013	0.333	0.881
"Poor stabiliser control"	1.73	0.029	1.056	2.832

From Table 11, it is evident that the only significant factor was "stop training" and, in particular, it turned out to be protective in this group, while from Table 12, habitual use of the "pelvic slouch" and signs of "poor stabiliser control" were significant in the ITBFS group.

Table 13

Table 13, illustrates the odds ratios and 95% confidence intervals, for the variables "stop training", "pelvic slouching" and "poor stabiliser control".

Table 13: **Logistic Regression of BAOPTP on the Variables ITBFS, "Stop Training", "Pelvic Slouch", and Signs of "Poor Stabiliser Control"**

Number of observations = 846.

BAOPTP	Odds Ratio	P>|Z|	95% Confidence Interval	
"Stop training"	0.752	0.059	0.56	1
"Pelvic slouching"	0.722	0.029	0.538	0.968
"Poor stabiliser control"	1.422	0.019	1.059	1.91
ITBFS	1.531	0.005	1.134	2.067

Tables 12 and 13 were done to establish that "poor stabiliser control" and "pelvic slouching", lead on to ITBFS and all three of these are significant risk factors for BAOPTP. In the absence of ITBFS, stopping training for a month after Comrades is protective against the development of BAOPTP.

5.2.4 Results of Interest Value

The percentage of ITBFS injuries that became chronic was 53%.

The percentage of the chronic ITBFS who had been for surgery was 38%.

The percentage of ITBFS runners who went to surgery and also had BAOPTP was 42%.

There did not seem to be any correlation between the legs that were symptomatic in the "both pains" group.

The percentage of BAOPTP sufferers who became chronic was 44%.

Ninety two percent of the respondents felt that physiotherapy was a good way to treat a running injury. Of the runners who did not think it valuable, 25% felt it to be too expensive, 17% felt it too time consuming, 48% said it was ineffective, and 17% said it was too painful.

The majority of runners felt that strengthening their stabilizer muscles would be valuable. Many felt that their ignorance of what should be done had made any past attempts at strengthening, of little use. Only 19% said that they had never tried strengthening due to lack of either time or knowledge of what to do.

5.3 CONCLUSION

Nine hundred and seventy eight runners completed the questionnaire. Only 45 % had neither of the injuries being studied.

Being heavier was significantly protective against both the injuries, most especially ITBFS (P=0,0003).

"Pelvic slouching," when considered as part of the multivariate analyses, was a significant risk factor for ITBFS (P=0,013). In the presence of ITBFS and "poor stabiliser control" it was a significant risk factor for BAOPTP. "Stabiliser control", was significant to the development of ITBFS and, in the presence of ITBFS, was significant to the development of BAOPTP (P=0,029). Stopping training was mildly protective against the development of BAOPTP (P=0,049).

CHAPTER 6

DISCUSSION

6.1 INTRODUCTION

Approximately 7% of the field of the 1999 Comrades Marathon answered the questionnaire. Of these runners, only 45% had always been free of either ITBFS or BAOPTP. This is a low percentage when it is considered that this was a cross section of the general ultra-marathon population, and not a study of injured people. Of those who were not free of either of the injuries in question, 14 % had suffered "both pains". This figure suggests that ITBFS and BAOPTP may be connected by some common risk factors.

These results seem to indicate that a relationship does exist between these two injuries. It is therefore imperative that athletes who present with only one of the two be properly assessed, holistically treated and properly rehabilitated. This may avoid the development of the second injury. Athletes, coaches and medical personnel need to be aware of this relationship in order to avoid an injury cycle developing.

These figures of injury prevalence seem much higher than those suggested in the literature, (Sutker et al, 1985; Lysolm and Wiklander; 1987, Noble; 1979, Schwellnus et al; 1991; Gose and Schweizer, 1989; Lehman, 1984). However, these researchers have mostly studied injured athletes and not an essentially "normal" population group as was studied here, making comparison difficult. Also this researcher asked runners whether they had ever had either injury, which was necessary in order to establish whether an injury cycle had ever existed in that athlete, but this may have inflated the figure, if it was compared to a study where only injuries present at the time of study were considered.

Wojtys et al's comment that one of the most common risk factors for an injury is a previous injury (Wojtys et al, 1996; Van Mechelen et al, 1996), is a good basis for an explanation of the strong relationship found between ITBFS and BAOPTP.

6.2 DISCUSSION OF THE FINDINGS

6.2.1 With Respect to the Demographic Data

Gender

In this study, women were found to be at greater risk of developing either one or both of the injuries being studied. This is in contrast to the findings in the literature. All previous researchers had found a prevalence of most injuries and of ITBFS, in males (Noble, 1979; Sutker et al, 1981; Linenger and Christensen, 1992; Satterthwaite et al, 1999). Van Mechelen (1995), in contrast to other authors, however, states that age and sex are not risk factors for injuries. This paper is an article and not a study and this fact is not substantiated or proven.

The fact that more males run long distances than females (Barber and Sutker, 1992) has been offered as an explanation for the protection that they found to be provided by being female. The ratio of males to females who completed the 1999 Comrades Marathon was 87: 13, a figure that is in agreement with this explanation. The results found in this study refute these findings, however.

The ITB does not appear to be as taut in flexion in valgus knees as compared to neutral or varus knees. Women have more valgus knees than their male counterparts. They also have less prominent lateral femoral epicondyles. Women have more subcutaneous fat which is thought to lubricate the under surface of the band. These differences have been suggested in the literature as explanation for the protection found to be provided by being female. However, they have not been proven to be significant (Linenger and Christensen, 1992; Sutker et al, 1981; Barber and Sutker, 1992). These suggestions refute the findings of this study.

The controversial finding of this study may be explained by several factors. Considerable differences exist between the ligaments of the male and female pelvis. The male pelvis is designed for strength and the female pelvis is designed for mobility (Bellamy et al, 1983). According to Huston et al (1996) a correlation exists between "loose jointedness" and the frequency of joint injury. They stated that it caused increased and not decreased injury rates.

The excessive distance of the Comrades Marathon, as well as the difficult nature of the course, are also possibly relevant factors behind this contradictory result. It is

possible that the female body is less able to adapt and provide the required strength or endurance to complete both the race and the training required for it, without becoming injured.

Reproductive age and the number of offspring were not considered for this study, but it may have proven to be relevant, had it been examined.

Age

There were fewer injuries in runners over 50 years of age. A possible explanation for this is the "survival mechanism", described by Satterthwaite et al (1999). Older runners who are still able to run marathons are able to do so because they have survived the injuries that eliminated their peers along the way. Anyone in this age category who is still able to run an ultra-marathon as rigorous as the Comrades Marathon has an exceptional body, that is hardier than the average.

The number of years of running was shown to have no relevance in the development of either of the syndromes. Therefore, it can not be said that the older runners had been running for more years, and that this was thus a protective factor.

Age was significant in the BAOPTP group, people over 36 years of age being the most commonly afflicted. This may have been associated with the higher prevalence of disc disease in people in their mid thirties. It may also be a possible factor that older people have more sedentary lifestyles and spend a greater proportion of their time sitting than their younger counterparts. Possibly, the cumulative effect of years of sitting may have contributed. Muscle imbalances develop with time as a result of a sedentary lifestyle. This would lead to loss of stabiliser control. This would render the spine, SIJ and the connective tissues of the area vulnerable when put through the rigours of ultra-marathon training.

Lee (1996) states that the SIJ is vulnerable to shear forces until the third decade of life when the ossification of the joint is complete. She does not substantiate this claim. Bellamy et al (1983) reported that the width of the sacroiliac joint space varies according to age. They suggest that the joints lose their hyaline structure at an early age. This fact has not been confirmed by any of the more recent researchers in the field.

Twomey and Taylor (1994) found that many of the changes in the intervertebral discs thought to be associated with ageing are, in fact, part of the maturation process and occur well before "ageing" begins. This includes the process of water loss. They maintain that only a minority of the population show disc thinning and degeneration and that these changes, if they are present, are usually seen in L4-5 and L5-S1 discs. The only age-related change that their well researched, although controversial, study could find was the stiffening of the disc due to an increase in collagen fibres and a change in the type of collagen fibres. These changes account for the loss of range of movement and shock absorbing capacity seen in "old age," in their opinions. Their cadaveric study was performed on preserved cadavers, making the results less valuable than they might have been had fresh cadavers been used.

"Old age" is not defined in any of these studies. Any or all of these changes would be relevant to the development of lumbar-pelvic dysfunction, which may lead to injury.

There was a much less definite trend when considering age with respect to the "both pains" category, but the 36-50 category had the highest percentage of sufferers. The preceding explanation adequately explains this finding.

6.2.2 With Respect to the Risk Factors for Injury

Strain

Runners were judged to have strained themselves when: they had either run more than eight per cent of their total training distance in their "peak" week, done more than three quality sessions per week in their training, or run more than 3000 Kilometres in preparation for the race, between January and June.

The "strain" variable produced results that were unexpected, and varied from those found by most previous researchers. This was especially true in the case of ITBFS, where over-training was described by most authors as being one of the most causative factors (Noble, 1979; Sutker et al, 1981; Firer, 1989; Hooper, 1989).

"Strain" proved to have no effect on the development of either of the injuries being studied. According to Satterthwaite et al (1999) running distance, running frequency, and running experience may influence the risk of running injuries. They found a positive association between weekly running distance, training frequency and hamstring injuries. However, they found this association to be absent in the development of knee injuries (it was not specified which knee injuries). The researchers Barber and Sutker (1992), Lysolm and Wiklander (1987), Noble (1979), Schwellnus et al (1990), Orchard et al (1996) and Lehman (1984) have mostly blamed the development of lower limb musculoskeletal problems on training techniques, excessive hours of training or distance of training. Although the majority of injured runners in each category had strained, many had strained and not become injured.

A negative association has been found to exist between running injuries and running experience (Van Mechelen, 1995). Possibly, Comrades runners are sufficiently experienced to enable them to be resistant to the effects of strain. Every Comrades runner has run at least one marathon in order to qualify, most have run many more (Fordyce, 1996).

It is possible that the criteria used to ascertain strain were not sensitive enough. Three thousand kilometres may be strain to one runner, and two thousand may be strain to another. Also, since it was based entirely on the runners' subjective responses, it may have been an inaccurate measure. The majority of runners, however, are very scientific about their training and keep log books in which they record every run and a description of the course and the effort it involved (Fordyce, 1996). The questionnaire did not define "speed" and "hill" sessions; what one runner may describe as a "speed" session, another may call a normal, but hard training run. This variable may have proved to be more relevant if it had been differently assessed.

Furthermore, some of the runners who had strained themselves may not have been able to get to the exposition, due to the fact that their injuries may have eliminated them from the field relatively early on in the training season. A runner who is badly injured is unlikely to start the gruelling race. The runners who successfully survived the training season possibly had better training techniques.

Satterthwaite et al (1999) explained that there is a balance between overuse and under-conditioning among long-distance runners. This explanation may be the best one to explain the relatively inconclusive results that the strain variable produced in this study. Some runners were injured because they were insufficiently trained for the demands of the Comrades marathons previously run, and some were injured because they had overtrained and therefore strained themselves. Both would have led to "strain". Only strain due to too much or too intense training was measured here.

BMI

It is of interest, in the literature, that ITBFS is rarely found in endomorphs (Barber and Sutker, 1992). This is in keeping with the results found in this study. Barber and Sutker (1992) suggested endomorphs do not run as far, and are therefore less likely to become injured. Also the fat in the tissue around the knee may serve as lubrication under the taut ITB. This latter suggestion does not explain the reason for the higher prevalence of BAOPTP and "both pains" in the leaner runners. A possible explanation for this finding is that the larger frame and more sturdy muscles may have rendered the higher BMI runners more stable and less frail. This may have protected them from these injuries.

It is a well-known fact, however, that extra body weight is a predisposing factor for lower back injuries (Tancred et al, 1996). It would be natural to assume that extra weight would have the effect of producing increased load on the spinal joints which may result in back problems. Ultramarathon running, making this result difficult to explain would magnify the effect of this increased load. Possibly, the musculoskeletal systems of high BMI bodies adapt to the strain more readily than their lower BMI counterparts. It is possible that increased BMI allows the body more adaptive capacity.

The most significant variation in the percentage of injuries with respect to BMI was in the ITBFS group. The effect of increased fat under the band is probably the best explanation for this.

The Number of Years a Runner Has Been Running

The results of this study show that the number of years of running was not relevant to the development of either one of these injuries. This is in contrast to many other authors' findings (Satterthwaite et al, 1999; Anderson, 1991; Sutker et al, 1985).

Clarkson and Tremblay (1988) found that an adaptation occurred to exercise-induced damage, which makes muscle more resistant to damage and more able to repair any damage that does occur at a faster rate. This would lead one to expect that runners who had run for more years would be more resistant to developing these injuries, yet this was not the case. It is possible that the excessive distances and extreme terrain of the Comrades make for these variable results. Muscles are more excessively fatigued over very long distances especially if extremely steep and long hills are encountered along the way. Even if the symptom presented in the training and not during the event itself, most runners run as many long and hilly courses as possible in their preparation for the race. Perhaps the adaptive capacity is surpassed.

Another possible factor in explanation of this finding is that the effect of the imbalances that develop due to poor posture, poor technique and training beyond the point of exhaustion would be cumulative. Every year the continued demand would produce its negative effects. Therefore the protection provided by the years of experience would be negated, making the more experienced runners equally susceptible to injury.

Cross Training: Ball or Non- Ball Sports

It is of interest that neither cross training, in the form of participating in ball sports, nor in non-ball sports, had any significant effect on the prevalence of either pain. The author had suspected that cross training would have proven to be protective, because it would have assisted in the strengthening of the stabiliser muscles and would have taken the athlete's body out of the constantly repetitive position associated with heavy running training.

Satterthwaite et al (1999) found that regular involvement in such sports as cycling, swimming and aerobics was associated with increased risk of injury. They suggested that this was because runners only participate in other activities when

injury limits their running, therefore they were at increased risk of injury as a result of a previous injury. Their second hypothesis was that these activities contributed to a cumulative stress on the body, predisposing it to injury. Possibly the increased strain cross training produced negated the beneficial effects, and the overall effect was therefore not protective as suspected.

The non-ball sports that were identified most commonly were cycling and paddling, which place the body into the forward flexed position for extended periods of time. The fact that both sports required that the body be in the seated position for extended periods of time loads the lumbar-pelvic area (for the reasons already cited in Chapter 3 on the explanation of the "poor stabiliser strength" variable).

The ball sports identified included hockey, golf and racket sports. The former two, especially, produce a repetitive strain effect on the spine, because of the sustained forward bent position required to play them as well as the rotational demands they place on the spine. The load these other sports caused, may itself have led to injury.

Based on these findings, it cannot be said that runners are any better off doing cross training in their attempts to diminish their chances of sustaining either of these conditions.

Strength Training

Also of interest is the fact that strength training had no effect on the prevalence of these injuries. It is suspected that the lack of benefit may be due to the fact that athletes are not aware of what exercises they should do. This would make their training less beneficial than it should be.

Athletes may have strained themselves in their attempts at strength training, causing injury, or perpetuating imbalances. This may have negated the benefits it had the potential to produce.

Since lack of stabiliser control proved to be such an important factor in the development of these injuries, it is the author's opinion that runners should be carefully taught to do stabiliser muscle strengthening and that this should be an

integral part of the Comrades training programme. Such information should be disseminated among runners, personal trainers, coaches, running clubs, magazines, and gymnasiums where runners train.

Stretching

An unexpected finding was that stretching had no significant protective impact. A possible explanation is that most runners do not know how to stretch effectively. They do not know which muscles are important to stretch.

According to Paris (1997) stretching a muscle triggers an active contraction - the stretch reflex - therefore the muscle must be first relaxed before being stretched and must be stretched for a sufficient duration as to overcome the stretch reflex, if stretching is to be effective and not counter-productive. The fact that stretching may have been ineffective may be a possible explanation for the absence of protection regular stretching was found to produce.

It is also possible that runners only start stretching when they are already injured, rendering stretching unable to have the protective effect that it should have. Considering the fact that "poor stabiliser control" and, implied with it, muscle imbalance, are so critical to the development of these conditions, it would seem obvious that should the tightened and shortened muscles be stretched, then some of these imbalances would improve.

Proper and effective stretching would stretch the shortened muscles, and thereby diminish the inhibitory effect on their antagonists. The lengthened muscles, which become effectively weakened by virtue of their being held in the lengthened position, would be rendered better able to function. For stretching to have this effect, stretching would have to be directed at the correct muscles:

- The upper cervical extensors,
- pectoral muscles,
- upper trapezius muscles,
- levator scapulae; and
- sternocleidomastoid muscles as well as hip flexors,
- tensor fascia lata,
- piriformis,
- adductors; and

- erector spinae muscles (Norris 1995).
Most typical running stretching programmes involve stretching of the calves, quadriceps, hamstrings and ITB's only.

Stretching of the hamstring muscle group is a complex subject. Shortened hamstrings have been described as a functional adaptation to pelvic instability. This may be explained by the findings of Vleeming et al (1995) that force applied through biceps femoris tendon increases the tension in the sacrotuberous ligament, as well as in the deep layer of the thoracolumbar fascia. This increased tension diminishes motion of the SIJ, thereby stabilising it (Vleeming et al, 1989). Stretching the hamstring muscle group in this instance would have no beneficial effect.

Increased tension in the neuro-meningeal structures would also lead to apparent hamstring muscle group shortness. Stretching of these structures would only be effective if directed at the tethered area, and over-stretch may lead to irritation and be counterproductive. Lastly, many runners stretch their hamstrings, by bending forward at the hips and attempting to touch their toes. This may lead to stress on the outer annulus fibrosis, and other pain sensitive structures of the lumbar spine. It is a position in which the hamstring muscle group contracts eccentrically in order to stabilise the body, thereby rendering it an ineffective mode of stretching. Runners who stretch in this way will at best be ineffective and at worst will aggravate their lumbar spines.

Stopping Training For At Least a Month After Comrades

Another unexpected finding was that stopping running for a short while after Comrades in order to allow the body some recovery time was not significantly protective except to the BAOPTP group. This would indicate that some runners are better off continuing training and not allowing any de-conditioning to occur.

The protection seen in the BAOPTP may be as a result of allowing soft tissue healing to occur. This may have prevented the development of a chronic, lumbar, pelvic or nerve injury. These injuries are susceptible to developing a self-perpetuating pain cycle. Perhaps the runners, for whom the rest made no difference, were already in a more chronic cycle of dysfunction, in which case rest would have been insufficient to make a difference.

Many researchers into the subject of ITBFS have found rest to be an effective mode of treatment (Renne, 1975; Sutker et al, 1985). Some suggest, however, reducing the mileage but not stopping altogether is sufficient to allow the injury to heal (Barber and Sutker, 1992; Gose and Schweizer, 1989; Noble, 1979). Certainly almost all runners would reduce their mileage in order to recover from the Comrades. Reducing mileage, without stopping, would have the effect of allowing healing to occur without de-conditioning and weakening the muscles.

Posture

The results of this study show that runners with a lordosis are significantly more likely to suffer from BAOPTP (p=0,012). Posture type made no significant contribution to the development of ITBFS or "both pains".

In the lordotic position, the thoracolumbar paravertebral musculature and fascia are shortened, the abdominals are overstretched and will therefore develop stretch weakness (Don Tigny, 1993). This means that the spine is without its own natural corset and is therefore poorly supported. The pelvis is anteriorly rotated and the sacrum is relatively horizontal. This position may lead to dysfunction at L4-5 and L5-S1, due to the pull of the iliolumbar ligaments. The hamstrings may tighten as a compensatory strategy, to lessen the lordosis (Norris, 1995).

Also weakened in this posture are all the gluteal muscles, causing further strain due to the weakness of the "lateral corset" (Lee, 1996). Quadratus lumborum tightens, causing the pelvis to be held in elevation. This response is accentuated by walking and even more by running. This would lead to further L5-S1 stress, and instability in the lumbodorsal junction (Chaitow, 1996; Janda, 1986). An increased lordosis leads to anterior buckling of the ligamentum flavum, which contributes to the diminishing of the space in the nerve root canals which may lead to nerve root compression (Twomey and Taylor, 1994).

Don Tigny (1983) maintains that in a spine with normal curves, the spinal ligaments store and release energy and the discs undergo intermittent compression, which pumps the cerebrospinal fluid and nourishes the discs. This is a most necessary occurrence for the maintenance of healthy discs in long distance running.

In the flat-back or sway back posture types, the sacrum lies in a position of counternutation (Norris, 1995). According to Vleeming et al (1989), this diminishes form closure of the SIJ. This in turn leads to increased shear forces on the lower lumbar discs (Don Tigny, 1997), as well as to dysfunction in the SIJ with its associated inhibitory effect on the function of gluteus maximus and other pelvic girdle stabilisers (as discussed in the literature review) (Lee, 1996). This would explain the increased incidence of BAOPTP with respect to this type of posture.

If ITBFS is due to impingement of the band, as Orchard et al (1996) suggest, which is due to inadequate muscular control of the band (Anderson, 1991), then posture-type would have been expected to be relevant. Although an increased lordosis leads to weakness of the gluteal muscles, an absent lordosis weakens the gluteus medius muscle. It also leads to shortening of the hamstrings (Norris, 1995), which would therefore be more readily recruited (Sahrmann, 1991) in the gait cycle. This would take over the role of gluteus maximus, which would leave the ITB less well controlled in the gait cycle. Thus ITBFS would be equally affected with respect to both posture types.

The flat-back posture causes a posterior pelvic tilt, hip and knee joint hyperextension (Norris, 1995). This may irritate the fat pad in the knee joint, causing swelling, vastus medialis weakness, patellar-femoral dysfunction and compensatory over tightening of the lateral thigh structures. ITBFS may result (Doucette and Goble, 1992).

These facts may explain the fact that posture-type had no effect with respect to the ITBFS and "both pains" groups. The comparison reveals no connection, because both postures result in changes, which may lead to ITBFS.

The questionnaire did not provide a place for runners to assess themselves as having a neutral posture. This would have been impossible for runners to assess themselves. Had this option been included and an objective assessment of posture type been given, this result may have been different.

Habitual "Pelvic Slouching"

"Pelvic slouching" made no difference to the onset of BAOPTP. It was, however, a contributing factor in the development of ITBFS. This result was surprising. The information from this variable was assessed independently of the "poor stabiliser control" variable, because it was suspected that it was more relevant to the ITBFS group, and therefore its results should be seen in isolation.

Habitual "pelvic slouching" is both a cause and a result of lumbar-pelvic-dysfunction. Asymmetric positions cause very high muscle and joint loading according to the somewhat unscientific, but significant findings of Friberg (1983), who found that leg length inequality could cause therapy resistant symptoms in the lumbar spine.

If a runner habitually "pelvic slouched", then muscle imbalances would develop. This would cause abnormal loads on joints and other structures, abnormal movement patterns, muscle fatigue and loss of co-ordination (Evans, 1979). Weakness would set in which would result in loss of the muscle patterning required for ideal force closure (Vleeming et al, 1990; Lee, 1996). A Trendelenburg, compensated or non - compensated type of gait pattern, may result (Lee, 1996) (see Figures 8, 9).

"Pelvic slouching" causes the weight-bearing knee to be thrust back into hyperextension; the pelvis sags, which leads to all the abductor torque being taken through the ITB. The pelvis on the weight bearing side lifts until it hangs on the IT tract. The tract thus carries the body weight in adduction. The upward pull on the lower attachment of the tract thrusts the knee into hyperextension, locking it and creating a rigid supporting pillar of the limb (Evans, 1979). In this position there is much less EMG activity in the gluteals (this was stated, but not proven by Evans). There is more activity in the TFL, especially on straightening from this position.

Habitual "pelvic slouching" will lead to posterior rotation of the innominate on the supporting leg. This will shorten the hamstring muscles on that side (Cibulka et al, 1988). Cibulka et al concluded that SIJ disease may cause altered muscle length. Conversely, altered muscle lengths may cause SIJ disease.

It was not relevant to injury development which leg was stood on. Imbalances are produced bilaterally by the posture.

"Poor Stabiliser Control"

Slightly more than half of the runners were classified as having "poor stabiliser control". Slightly more than half of the BAOPTP group had "poor stabiliser control", as did almost half of the ITBFS group. Most significantly, 61% of the "both pains" group had "poor stabiliser control." An injury cycle involving both conditions was significantly more likely to be set up in runners who had "poor stabiliser control". This variable was a risk factor for injury development, but when present, runners had a greater chance of having both rather than only one of the conditions. Although it is significant that 61% of the "both pains" group had "poor stabiliser control", it must be remembered that 41% of the respondents in the "neither pains" group wer also positive for this variable. Although it is a significant risk factor for developing "both pains", it is commonly present in runners who do not have either injury. Possibly they had other injuries and possibly injury had not yet set in, or it may be that their bodies were more resistant to break down, and breakdown point had not been exceeded.

Running, especially long-distance, running uses the mobiliser muscles almost exclusively. Stabilising muscles show predominantly type-1 activity, as opposed to mobilising muscles, which show type-2 activity. Rapid movements, continuous movement, as well as fatigue favour type-2 activity (Norris, 1995; Richardson and Jull, 1994). Running may therefore commonly produce muscle imbalances. When a runner becomes fatigued but must continue, they use whatever they can to drive themselves forward. Fatigued runners often assume a position of raised shoulders as they try to use their accessory muscles of respiration to assist in breathing (Noakes, 1992). A commonly assumed posture of a tired runner is seen in the photograph in Figure 18. Of all people, the ones who need their stabilisers the most are the people who are trying to run for many hours. When inadequate stabiliser control exists, the results may be profound.



Figure 18: **Common posture assumed by long distance runners**
Photograph from *Runner's World Magazine*, reproduced with verbal permission.

These injuries are only some of the results that such imbalances may produce. A significant number of runners in the "both pains" group had three or more of the answers to these questions regarding stabiliser control as "yes". Therefore "poor stabiliser control" may be an important factor with respect to these two injuries. It must not be overlooked, however that 41% of the "neither pain" group also had "poor stabiliser control".

Ultra-distance athletes need to be taught to use and to train their stabiliser muscles, as well as to stretch properly in order to prevent muscle imbalances from developing.

According to Gracovetsky's engine model of the human spine, the main feature of human locomotion is the ability of the spine to convert the lateral bend of the spine into an axial torque (1986). Failure of the control system to maintain the torque strength of the spine will result in torsional overload of the intervertebral joint and pathology will set in. Loss of stabiliser control may be the cause of torsional overload. Stabiliser muscles, more specifically the local stability muscles (Comerford and Mottram, 2001) function to control torsional stresses at each intervertebral

segment. This function would be diminished in the face of "poor stabiliser control". This may lead to referred pain into the posterior thigh, inhibition of the gluteus maximus muscle, and or overactivation of the piriformis muscle, with its associated syndrome. As has already been discussed this may give rise to either one or both of the injuries in question.

Stress applied to the body induces physiological changes, but it is easy to over stress the body and surpass the adaptation capacity. The adaptation demands are greater in the face of postural dysfunction and less than optimal use of the body. The threshold at which adaptation will fail and injury will set in is lowered.

6.2.3 The Factors Which Contributed to the "Poor Stabiliser Control" Variable

Sitting is described as a static-loading situation (Snijders et al, 1989). Creep occurs in the collagenous tissues when exposed to prolonged loading. The gravity loaded SIJs would be vulnerable to dislocation due to shear forces in the sitting position, due to their flat joint surfaces (Snijders et al, 1989). In the sitting position, there is a degree of loss of lordosis and of sacral nutation. This means that form closure is diminished and therefore force closure needs to be increased, in order to maintain stability. Components of muscle forces that cross the joints provide the compression required to combat this vulnerability (Snijders et al, 1989).

Additional compressive forces are needed to resist shearing of the SIJ surfaces in such positions of heavy load as prolonged sitting (undefined by Snijders et al, 1989). Ligaments being susceptible to tissue creep become unable to transfer lumbosacral load to the iliac bones. The additional compressive forces are provided by the concerted action of the abdominal muscles as well as those in the back, pelvis and legs. The abdominals, especially the obliques and the transversus abdominus provide the greatest effect. Snijders et al (1989) aptly describe the abdominal force as being like the mechanism of a nutcracker.

According to Lee (1997), it is endurance rather than strength that is lacking in the muscles required to produce low-level loads, in the face of chronic lower back pain. The muscles may therefore demonstrate an inability to produce a sustained hold.

Standing with the arms unsupported or the hands unfolded places high demand on the scapular stabilisers and the postural muscles of the upper back. Diminished endurance or strength in these muscles leads to the need to find an external support for the shoulder girdles. This need for support results in the resting of the hands in the pockets. This allows the trousers to carry the load. It may also result in folding the arms and resting the weight forward on the trunk. This posture may therefore be an adaptation to poor stabiliser control and conversely may lead to diminished stabiliser control, if habitually assumed.

O'Sullivan et al (1997), in their review of the literature on the evidence of neuromuscular dysfunction associated with low back pain, concluded that low back pain is sometimes associated with a loss of strength and endurance of the trunk muscles. Dysfunction may exist between and within trunk muscle synergies. This would cause disrupted patterns of co-ordination and co-contraction between synergists. Altered patterns of neuro-motor control would ensue. The muscles most commonly affected are those that have a primary role of segmental control provision. Thus the dynamic stability of the spine is diminished.

It is possible that the converse situation may also occur. Disrupted patterns of contraction may result from muscle imbalances, which are caused by poor postural habits and this may be a cause of low back pain, or dysfunction. The muscles found to be most vulnerable to these changes are the deep abdominals, and lumbar multifidus. Evidence was also found in the literature (O'Sullivan et al, 1997) that changes occurred to the neural control system. This would affect the timing of patterns of co-contraction, balance reflexes and righting responses. All of these dysfunctions may predispose a runner to be susceptible to injury. If these dysfunctions were not corrected and rehabilitated, biomechanical susceptibility to further injury or vulnerability to increased chronicity would ensue. See also Chapter 2 for further explanation.

6.2.4 Iliotibial Band Friction Syndrome as a Risk Factor for Buttock and/or Posterior Leg Pain.

Marshall et al (1972) reported their findings from a cadaveric study. They found that the biceps femoris muscle has connections to the ITB which assist in keeping the

tract taut in flexion, especially in 10 – 30 degrees of flexion. This is the time when the band is most susceptible to injury. This may explain the fact that ITB dysfunction would seem to be a predisposing factor for BAOPTP. If the band is over taut then the increased tension may be transferred into the attaching biceps femoris muscle. If the band is dysfunctional then its "controller" may have to overwork to support it.

Also poor gluteal strength and recruitment will lead to:

1. Over use of TFL and possible impingement of the IT band in the 10-30 degree flexion range (Anderson, 1991).

2. Loss of extensor power, which will lead to compensation in the hamstring muscle group. These muscles will overwork in an attempt to provide extensor power (Lee, 1992).

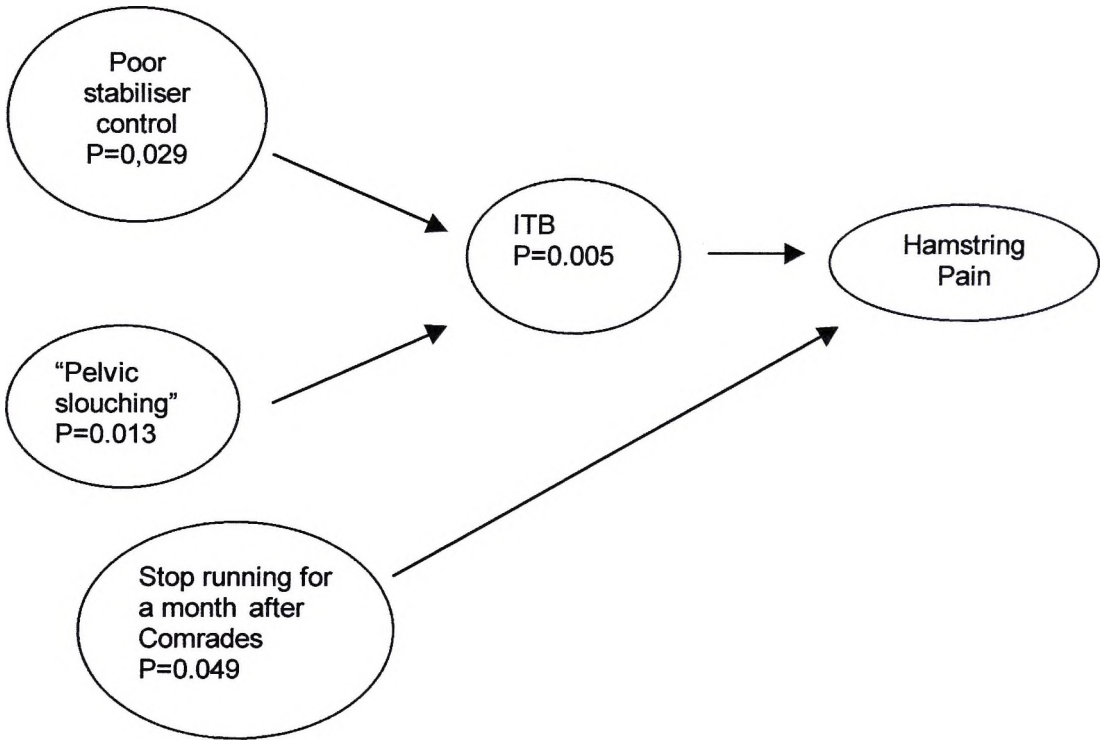
3. Loss of force closure of the SIJ, which will overload the hamstring muscles. Biceps femoris will attempt to enhance the stability through its attachment to the sacrotuberous ligament.

If these facts are considered then it is acceptable to assume that the two conditions would seem to be linked by common risk factors and aetiological conditions.

6.3 SUMMARY OF FINDINGS

On analysing the results, the most important risk factors for the development of ITBFS were identified. They are "poor stabiliser control" and recurrent "pelvic slouching". The most important risk factors for BAOPTP development are both of these factors as well as ITBFS. In the absence of ITBFS, stopping training for a period after Comrades is protective against BAOPTP development. These results are summarised in Figure 19.

Figure 19: Illustrates the summarized findings of the study



"Poor stabiliser control" has a p value of 0.029.

"Pelvic slouching" has a p value of 0.013.

ITBFS has a p value of 0.005.

These are the significant risk factors for the development of these injuries.

Stopping training after Comrades is a protective factor in the development of BAOPTP, and it has a p value of 0.049.

6.4 CONCLUSION OF DISCUSSION

In summary, there seems to be a strong relationship between ITBFS and BAOPTP in ultra-distance runners. ITBFS appears to be a predisposing factor for BAOPTP in ultra-distance runners and some of the same causative factors affect the development of both injuries. Although other factors are relevant to the development of these injuries, the key factor seems to be lack of stabiliser control.

The relevance of these findings cannot be overlooked when the numbers of Comrades runners continues to rise. In the year 2000, 25000 race entries were received. When the numbers are calculated, based on the percentages found in this study, it could be assumed that in the region of 4882 runners may have had

BAOPTP last year, and 5392 ITBFS and a further 3552 may be expected to have suffered from "both injuries".

These frequently encountered injuries result in diminished ability of injured athletes to participate in this healthy form of recreation. They require medical and therapeutic, as well as drug intervention, which is expensive to our health care system. These injuries may lead to long term morbidity and dysfunction, which may impact on other aspects of the lives of potentially healthy and problem free individuals.

Arthur Steindler, quoted by Gracovetsky (1986 p571), said that it has been generally held that human walking is " a unique activity during which the body, step by step, teeters on the brink of catastrophe." If this were his description of walking, then how would he describe running, especially after fatigue has set in many kilometres before?

6.5 PROBLEMS ENCOUNTERED IN THIS STUDY

Data obtained was self-reported and thus may not be completely reliable. This should be remembered when reviewing the results of this study.

It was necessary to evaluate all the suspected risk factors for injury. However, in retrospect the questionnaire was long and somewhat laborious to complete. More consultation with the statistics team prior to completion of the questionnaire, and getting their assessment of the computed pilot study results, would have led to elimination of several more questions from the final questionnaire.

The statistical analysis was long and drawn out owing to the length of the questionnaire and the enormous amount of information it collected. Some of the interest value information was irrelevant to the answering of the research question. It should not have been included.

6.6 LIMITATIONS OF THIS STUDY

This study had certain inherent limitations based on the fact that all the information was purely based on the runners' opinions, and memory. There was no objective

measure that confirmed answers provided. The questions asked were designed to elicit data that contained as little subjectivity as possible. Nevertheless the answers were opinion based. The questions that were included to ascertain whether stabiliser control was adequate were chosen for their ease and accuracy of being answered, but were possibly not the best and most accurate measure of stabiliser strength.

Since the completion of the questionnaire required literacy in English, a section of the Comrades population was excluded out of necessity. It is possible that this may have slightly biased the results.

6.7 SUGGESTIONS FOR FUTURE STUDIES

A future study would effectively confirm these findings as well as confirm the suggested explanations for the findings, by assessing a similar group of runners, but including both an objective and a subjective assessment of the respondents. This would enable a future researcher to establish whether loss of force closure, gluteal weakness and general muscle imbalance exist in runners who suffer from both of these injuries. It would also establish objectively what percentage of runners, both injured and not, have a form of instability. Comparison would then be possible of objectively obtained results with subjectively obtained results.

A future study should be undertaken to validate the tests used in questions 15-1.8 (These include: being uncomfortable when sitting, shifting and moving a lot when sitting, crossing legs when sitting, standing with arms folded or hands in pockets and "pelvic slouching" when standing.) This would ascertain whether they are in fact accurate measures of "poor stabiliser control".

A future study may question runners in more depth to ascertain not only whether or not they stretch, but also how they stretch.

Similarly, a future study may question runners in more depth to ascertain what strength training they do, in order to confirm the finding in this study that strength training does not assist in prevention of these injuries.

A future study may further assess the female population in order to ascertain whether their predisposition to injury found here has any connection with their obstetric history.

CHAPTER 7

CONCLUSION

The conclusion of this questionnaire-based study is that a relationship does exist between BAOPTP and ITBFS. This relationship is that ITBFS appears to be a risk factor for BAOPTP. Lack of stabiliser control and habitual "pelvic slouching" seem to be strong risk factors for the development of ITBFS, and the presence of ITBFS, as well as lack of stabiliser control and habitual "pelvic slouching" seem to be strong risk factors for the development of BAOPTP. Stopping training for a period of a month or longer was not relevant to ITBFS, but in the absence of ITBFS, it was protective against BAOPTP development.

Other factors also have a role to play in the existence of these injuries. The relevant factors are: gender, (being female is a risk factor), BMI (a higher BMI is protective against both injuries), age (being over 50 is protective. Age is especially relevant to the BAOPTP group; in which being over 36 is a risk factor), as well as the type of posture the runner has. Having a lordosis seemed to be a risk factor, but only for the BAOPTP group.

Lack of stabiliser control, appears to be an important risk factor, yet neither the strength training nor the stretching that was done by the Comrades runners protected them in any way from these injuries. It was also present in many runners who did not have either injury, this should not be overlooked.

It is the conclusion of this researcher in fulfilment of the sub-aim of this study (to make recommendations for the treatment and prevention of these injuries), that when an ultra-marathon runner presents with ITBFS and / or BAOPTP, that they be assessed for signs of "poor stabiliser control". It is an empirical observation that if signs of "poor stabiliser control" can be found objectively, then stability training should form part of their treatment. Such athletes should be advised regarding avoiding poor postural habits.

The incidence of runners who had ever suffered from these injuries in the 1999 Comrades Marathon field, was found to be: 22% who had ITBFS only, 20% who had BAOPTP only, and 14% who had suffered "both pains". Of the field, only 45% had never had either condition.

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APPENDIX I

QUESTIONNAIRE 1

PILOT STUDY 1 & 2

Dear Runner

Many people run with pain and have injuries that never go away or take a long time to go away and seriously impact on their running ability. I am doing a research project for my MSc degree on the relationship between pain on the outside of the knee or hip and pain in the buttock or in the back of the thigh. I need you , as a runner, to fill in a very short questionnaire if you are willing to . Filling in this questionnaire is completely voluntary and you are under no obligation to do so, but if you do fill one in and participate in the study, please be as accurate as possible. All data will be dealt with confidentially and no individual taking part in the survey will be identified.

Thank-you for your time and participation. I look forward to receiving your response.

Yours sincerely,

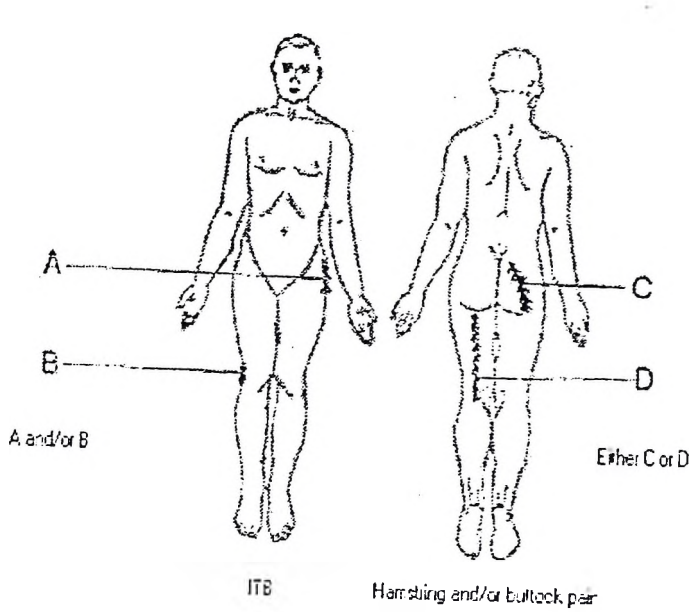
Sue Fuller-Good

SUE FULLER-GOOD BSc Physio UCT

"**ITBFS" (iliotibial band friction syndrome)**
Lateral knee pain - very sharp pain worse on down hills or pain in the upper outside of the hip over the top of the thigh bone.

"**hamstring pain or buttock pain**"

1 . Pain in the top of the back of the thigh right under the sitting bone .
2 . Pain anywhere in the back of the thigh.
3 . Pain in the buttock, in the fleshy part of the buttock muscle.



1. Do you suffer from A and/or B on the first body chart?

YES	NO

2. Would you answer a section on a questionaire entitled "Please only complete this section if you have, or have ever had ITB (A or B)?

YES	NO

3. Do you suffer from C and/or D on the second body chart?

YES	NO

4. Would you answer a section on a questionaire entitled "Please only complete this section if you have, or have ever had buttock and/or pain in the back of the thigh (C or D)?

YES	NO

QUESTIONNAIRE 2

PILOT STUDY 3

Dear Comrades runner

Many people run with pain and have injuries that never go away or take a long time to go away and seriously impact on their running ability. I am doing research for my MSc degree on the relationship between pain on the outside of the knee or hip and pain in the buttock or in the back of the thigh. To do this study, however, I need you as a runner, injured or not, to fill in a relatively short questionnaire if you are willing to . Filling in this questionnaire is completely voluntary and you are under no obligation to do so, but if you do fill one in and participate in the study, please be as accurate as possible.It should take you about 10 minutes. Please return it to someone at the Voltaren stand at the expo'. I will gladly send you a summary of the findings from the study as well as some strengthening exercises which I recommend. To receive this please address one of the available envelopes to yourself ,or include your email address. All data will be dealt with confidentially and no individual taking part in the survey will be identified.

If you need further information, or wish to discuss anything with me, please feel free to contact me on (011) 8035725, or email me on robuss@global.co.za .
Thank-you for your time and participation. I look forward to receiving your response.

Yours sincerely,

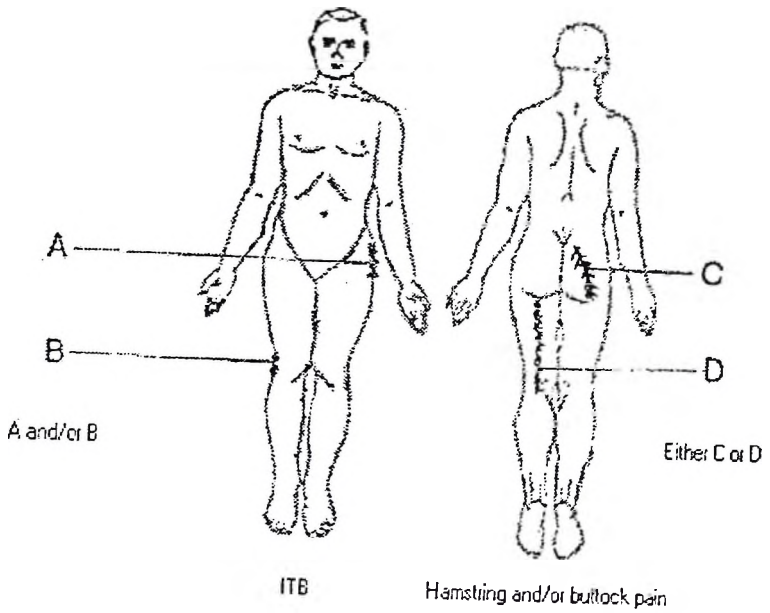
Sue Fuller-Good

SUE FULLER-GOOD BSc Physio UCT

"**<u>ITBFS" (iliotibial band friction syndrome)</u>**
Lateral knee pain - very sharp pain worse on down hills or pain in the upper outside of the hip over the top of the thigh bone.

"**<u>hamstring pain or buttock pain</u>**"

1 . Pain in the top of the back of the thigh right under the sitting bone .
2 . Pain anywhere in the back of the thigh.
3 . Pain in the buttock, in the fleshy part of the buttock muscle.



SECTION 1: (Please answer all questions)

Sex? | Male | Female |

Age? |

Weight in kilograms? | Height in metres? |

1. In your running career , how many comrades have you completed? |

2. How many standard marathons have you completed ? |

3. How many other ultra events have you completed ?

3a. More than 45km and less than 90km. | 3b. More than 90km. |

4. What year did you start running ? |

5. Do you participate in other sport ? If so, what?

| Cycling | Paddling | Hockey | Golf | Racket sports | other |

6. Do you do gym or strengthening of any sort ? | Yes | No |

7. If yes how many times per week ? |

8. How many kilometres have you run in preparation for the Comrades (January - June) ? |

9. What was your peak weekly mileage ? (In kilometres) (January - June) [ ]

10. How many of your runs are speed or hill sessions ?
(average each week in the four months before Comrades) [ ]

11. Do you stretch?

Before you run	After you run	Both	Sporadically, only if you have time

12. How flexible do you consider yourself to be?

[Very flexible] [Average] [Very inflexible]

13. Does you fitness level vary considerably between the running season and the "off season"?

Yes	No

14. Do you stop running completely for more than one month after Comrades ?

Yes	No

15. Do you consider yourself to have good posture?

Yes	No

16. Do you have.....

a. [Hollow back] or b. [Flat back]

17a. Do you perceive yourself to have strong stomach muscles?

Yes	No

17b. Do you perceive yourself to have strong back and buttock muscles?

Yes	No

18. Do you often stand with all your weight on one leg ?

Yes	No

If yes, which leg do you mostly stand on? | Left | Right | Varies |

19. Do you get uncomfortable when sitting for sustained periods ? | Yes | No |

If yes , after about how long ?

20. Do you usually cross your legs when you sit ? | Yes | No |

21. Do you shift and move a lot when you sit ? | Yes | No |

22. Do you usually stand with your arms folded or your hands in your pocket? | Yes | No |

23. How many times have you been injured in you running career? "injured" means at least having pain while running for more than three days or anything worse than that.

24. What injuries have you sustained? Please list in order of severity.

25. Have you seen a podiatrist before? | Yes | No |

26. Do you wear orthotics (inner soles)? | Yes | No |

27. Do you choose your shoes with expert advice? | Yes | No |

If you do not have ITB or hamstring or buttock pain please proceed to section 4.

If you have ITB please proceed to Section 2.

If you have Hamstring or buttock pain please proceed to section 3.

And if you have both, ITB and Hamstring or buttock pain, please answer all sections.

SECTION 2: (Please complete this section if you have ever had ITB pain)

28. When was your last incidence of ITB syndrome ?

Weeks ago	months ago	1 year ago	1-2 years ago	4-5 years ago	More

29. Which leg was it in ?

Left	Right	Both Legs

30. When you had ITB, what did you do to treat it ? (Mark all appropriate boxes)

Stretching	Rest	Physio	Anti inflammatories	Other please specify

31. Did you have surgery to it ?

Yes	No

If yes , after how long ?

32. For how long did it bother you?

Days	Weeks	Months	Years	Still there

33. Can you think of anything which may have caused the problem to start ?

Over training	Weakness	Inadequate stretching	Compensation due to other injury

Shoes	Camber of road	Unsure	Other, please specify

34. Did it ever stop you running for more than three days ?

Yes	No

35. Did it get completely better in your opinion ?

Yes	No

36. Do you still stretch it :

Always	If it is sore	Never

37. Did your other leg develop the same problem at any stage ?

Yes	No

38. Do you feel you still need to be careful of your knee/knees ?

Yes	No

39. What do you do to prevent its re-occurance ?

Stretch it	Train carefully	Ice it often	Buy new shoes early

Rub it	Other , please specify

SECTION 3

(Only complete this section if you have ever had pain in your buttock or the back of your leg.)

40. Have you ever had pain in your buttock and/or hamstring?

Yes	No

41. If yes, which buttock and / or hamstring did you have pain in?

The right side	The left side	Both sides

42. When did it begin to trouble you, and for how long was it a problem?

43. What did you do to alleviate it ?

Stretching	Rest	Physio	Anti inflammatories	Other, please specify

44. Did it get completely better in your opinion ?

Yes	No

45. Do you still protect it ?

Yes	No

46. If yes, how ?

Train carefully	Rub it often	Stretch it often	Ice it	Warm up

47. How intense was the pain ?

Mild	Moderate	Bad	very severe

48. Does / Has the pain ever stopped you running for more than three days ?

Yes	No

49. Can you think of anything which may have caused the problem to start ?

Over training	Weakness	Inadequate stretching	Your shoes

Compensation due to other injury	Unsure	Other, please specify

50. Did your other hamstring or buttock ever produce a problem ?

Yes	No

SECTION 4 **(Please all complete this section)**

51. What time do you hope to run in the 1999 Comrades ?

5 - 6 hrs.	6 - 7 hrs.	7 - 8 hrs.	8 - 9 hrs.	9 - 10 hrs.	10 - 11 hrs.

52. What is your previous best Comrades time?

53. Do you feel physiotherapy is a good way to treat a running injury ?

Yes

54. If not , why not ?

Too expensive	Too time consuming	Ineffective	Too painful	Other, please specify

55. Have you ever tried a strengthening programme in order to prevent injuries and help to heal already present injuries?

Yes tried and stopped.	Yes do strengthening exercises regularly - as it helps
	Yes do strengthening exercises regularly - although it does not help.
No Never tried - no time .	Yes do strengthening exercises - seldom as it does not help .
	No Never tried - did not know what to do.

56. Do you see the logic in strengthening your central body (stomach ; back and backside) in order to prevent running injuries?

Yes	Maybe	No

57. Would you make the time to do 3 - 4 specialised strengthening exercises. If it took 5 -10 minutes a day?

Yes	No

Please either fill in your address on one of the envelopes provided , or fill in your e-mail address, if you wish to receive information regarding the results and some strengthening exercises which should be valuable to you .

Email address : _____

QUESTIONNAIRE 3

SECTION 1: **(Please answer all questions)**

Sex ? Male | Female

Age ?

Weight in kilograms? Height in metres ?

1.In your running career, how many comrades have you completed?

2.How many standard marathons have you completed ?

3.How many other ultra events have you completed ?

a. More than 45km and less than 90km. b. More than 90km.

4.What year did you start running ?

5a.Do you participate in other sport ? Yes | No

5b. If yes, do you participate in.....

Ball Sports: Yes | No Non- Ball Sports : Yes | No

6 . Do you do gym or strengthening of any sort ? Yes | No

7. If yes, how many times per week ?

8. How many kilometres do you run in preparation for the Comrades (January - June) ?

9. What is your peak weekly mileage ? (In kilometres) (January - June)

10.How many of your runs are speed or hill sessions ? (average each week in the four months before Comrades)

11.Do you stretch before you run | after you run | both | sporadically, only when you have time

12. How flexible do you consider yourself to be? Unflexable | Average | Very flexible

13. Does your fitness level vary considerably before the running season and the "off season"?

Yes | No

14.Do you stop running completely for more than one month after Comrades ? Yes | No

15. Do you consider yourself to have good posture? Yes | No

16. Do you have a) Hollow back or b) Flat back

17a. Do you perceive yourself to have strong stomach muscles? Yes | No

17b. Do you perceive yourself to have strong back and buttock muscles? Yes | No

18. Do you often stand with all your weight on one leg ? Yes | No

If you do , which leg do you mostly stand on? Left | Right | Varies

19. Do you get uncomfortable when sitting for sustained periods ? Yes | No

If yes, after about how long ?

20. Do you usually cross your legs when you sit ? Yes | No

21. Do you shift and move a lot when you sit ? Yes | No

22. Do you usually stand with your arms folded or your hands in your pockets ? Yes | No

23. How many times have you been injured in your running career? "Injured" means having pain while running for at least more than three days, or anything worse than that.

24. What injuries have you sustained? Please list in order of severity.

_____

_____

25. Have you seen a podiatrist before? Yes | No

26. Do you wear orthotics (inner soles)? Yes | No

27. Do you choose your shoes with expert advice? Yes | No

If you <u>do not</u> have ITB or hamstring or buttock pain please proceed to <u>Section 4.</u>

If you have <u>only ITB</u> please proceed to <u>Section 2.</u>

If you have <u>only Hamstring or buttock pain</u> proceed to <u>section 3</u> and if you have <u>both ITB and hamstring or buttock pain,</u> please answer <u>all sections</u>.

SECTION 2:

28. When was your last incidence of ITB syndrome ?

Weeks ago	month ago	1 year ago	1-2 years ago	4- 5 years ago	More

29. Which leg was it in ?

Left	Right	Both Legs

30. When you had ITB What did you do to treat it ? (Mark all appropriate boxes)

Stretching	Rest	Physio	Anti inflammatories	Other please specify

31. Did you have surgery to it ?

Yes	No

If yes , after how long ? _____

32. How long did it bother you for ?

Days	Weeks	Months	Years	Still there

33. Can you think of anything which may have caused the problem to start ?

Over training	Weakness	Inadequate stretching

Compensation due to other injury	Shoes	Unsure

Other	Camber of road

34. Did it ever stop you running for more than three days ?

Yes	No

35.Did it get completely better in your opinion ?

Yes	No

36. Do you still stretch it :

Always	If it's sore	Never

37. Did your other leg develop the same problem at any stage ?

Yes	No

38. Do you feel you still need to be careful of your knee/knees ?

Yes	No

39. What do you do to prevent its reoccurance ?

Stretch it	Train carefully	Ice it often	Buy new shoes early

Rub it	Other, please specify	_____

SECTION 3:

(Only complete this section if you have ever had pain in your buttock or back of your leg.)

40. Have you ever had pain in your buttock / hamstring? Yes | No

41. Which buttock and / or hamstring did / do you have pain in;

The right side | The left side | Both sides

42. When did it begin to trouble you and for how long was it a problem ?

43. What did you do to alleviate it ?

Stretching | Rest | Physio | Anti inflammatories

Other, please specify? _____

44. Dit it get completely better in your opinion ? Yes | No

45. Do you still protect it ? Yes | No

46. If yes, how ?

Train carefully | Rub it often | Stretch it often | Ice it | Warm up

47. How intense was the pain ?

Mild | Moderate | Bad | Very severe

48. Does / Has the pain ever stopped you running for more than three days ? Yes | No

49. Can you think of anything which may have caused the problem to start ?

Over training | Weakness | Inadequate stretching

Compensation due to other injury | Your shoes | Unsure

Other, please specify? _____

50. Did your other hamstring or buttock ever produce a problem ? Yes | No

SECTION 4: (Please all complete this section)

51. What time do you hope to run in the 1999 Comrades ?

5 - 6hrs.	6 - 7hrs.	7 - 8hrs.	8 - 9hrs.	9 - 10hrs.	10 - 11hrs

52. Do you feel physiotherapy is a good way to treat a running injury ? | Yes | No |

53. If not , why not ?

Too expensive	Too time consuming	Ineffective	Too painful

Other, please specify? _____

54 .Have you ever tried a strengthening programme in order to prevent injuries and help to heal already present injuries ?

Yes, tried and stopped	Yes, do strengthening exercises regularly - as it helps

Yes, do strengthening exercises regularly - although it did not help

No, never tried - no time	No, never tried - did not know what to do

Yes, do strengthening exercises - seldom as it does not help

55. Do you see the logic in strengthening your central body (stomach ; back and backside) in order to prevent running injuries ?

Yes	Maybe	No

56. Would you make the time to do 3 - 4 specialised strengthening exercises. If it took 5 - 10 minutes a day ?

Yes	No

Please fill in your address on one of the envelopes provided , or fill in your email address if you wish to receive information regarding the results and some strengthening exerceses which should be valuable to you .

Email address : _____

QUESTIONNAIRE 4

Dear Comrades runner

Too many people run with pain and have injuries that never go away or take a long time to go away and seriously impact on their running ability. I am doing some research on the relationship between pain on the outside of the knee or hip and pain in the buttock or top of the back of the thigh. To do this study, however, I need you , as a runner, injured or not to fill in a relatively short questionnaire if you are willing to . Filling in this questionnaire is completely voluntary and you are under no obligation to do so, but if you do fill one in and participate in the study, please be as accurate as possible.It should take you about 10 minutes. Please return it to someone at the Voltaren stand at the expo'. I will gladly send you a summary of the findings from the study as well as some strengthening exercises which I recommend. To receive this please address one of the available envelopes to yourself ,or include your email address. All data will be dealt with confidentially and no individual taking part in the survey will be identified.

If you need further information, or wish to discuss anything with me, please feel free to contact me on (011) 8035725, or email me on robuss@global.co.za .
Thank-you for your time and participation. I look forward to receiving your response.

Yours sincerely,

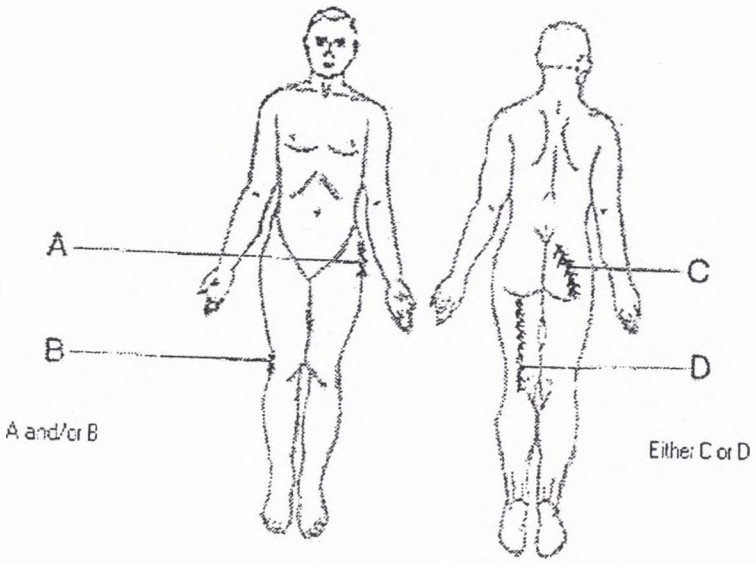
Sue Fuller-Good

SUE FULLER-GOOD BSc Physio UCT

"**ITBFS" (iliotibial band friction syndrome)**
Lateral knee pain - very sharp pain worse on down hills or pain in the upper outside of the hip over the top of the thigh bone.

"**hamstring pain or buttock pain**"

1 . Pain in the top of the back of the thigh right under the sitting bone .
2 . Pain anywhere in the back of the thigh.
3 . Pain in the buttock at the back in the fleshy part of the buttock muscle.



SECTION 1: (Please answer all questions)

Sex? | Male | Female |

Age? | | | |

Weight in kilograms? | | Height in metres? | |

1. In your running career , how many Comrades have you completed? | |

2. How many standard marathons have you completed ? | |

3. How many other ultra events have you completed ?

3a | More than 45km and less than 90km. | 3b. | More than 90km. |

4. What year did you start running ? | |

5. Do you participate in other sport ? | Yes | No |

5b. If yes do you participate in.....

Ball Sports: | Yes | No | Non-ball Sports: | Yes | No |

6. Do you do gym or strengthening of any sort ? | Yes | No |

7. If yes how many times per week ? | |

8. How many kilometres have you run in preparation for the Comrades (January - June) ?

9. What was your peak weekly mileage ? (In kilometres) (January - June)

10. How many of your runs are speed or hill sessions ?

(average each week in the four months before Comrades)

11. Do you stretch?

Yes	No

12. Do you stop running completely for more than one month after Comrades?

Yes	No

13. What type of posture do you have?

Do you have a Hollow back or a Flat back

14. Do you often stand with all your weight on one leg ? (see diagram for explanation)

Yes	No

14b. If yes. which leg do you mostly stand on?

Left	Right	Varies

15. Do you get uncomfortable when sitting for sustained periods ?

Yes	No



Figure to show what is meant by standing with all your weight on one leg

15b. If yes , after about how long ?

16. Do you usually cross your legs when you sit ?

Yes	No

17. Do you shift and move a lot when you sit ?

Yes	No

18. If you need to stand. do you usually stand with your arms folded or your hands in your pocket?

Yes	No

If you do not have ITB or hamstring or buttock pain please proceed to section 4.

If you have ITB please proceed to Section 2.

If you have Hamstring or buttock pain please proceed to section 3.

And if you have both, ITB and Hamstring or buttock pain,
please answer all sections.

SECTION 2: (Please complete this section if you have ever had ITB pain)

19. When was your last incidence of ITB syndrome ?

Weeks ago	months ago	1 year ago	1-2 yrs ago	4-5 yrs ago	More

20. Which leg was it in ?

Left	Right	Both Legs

21. When you had ITB, what did you do to treat it ? (Mark all appropriate boxes)

Stretching	Rest	Physio	Anti inflammatories	Other please specify

22. Did you have surgery to it ?

Yes	No

22b. If yes , after how long ?

23. For how long did it bother you?

Days	Weeks	Months	Years	Still there

24. Can you think of anything which may have caused the problem to start ?

Over training	Weakness	Inadequate stretching	Compensation due to other injury

Shoes	Camber of road	Unsure	Other, please specify

25. Did it ever stop you running for more than three days ?

Yes	No

26. Did it get completely better in your opinion ?

Yes	No

27. Do you still stretch it :

Always	If it is sore	Never

28. Did your other leg develop the same problem at any stage ?

Yes	No

29. Do you feel you still need to be careful of your knee/knees ?

Yes	No

30. What do you do to prevent its re-occurance ?

Stretch it	Train carefully	Ice it often	Buy new shoes early

Rub it	Other , please specify

SECTION 3

(Only complete this section if you have ever had pain in your buttock or the back of your leg.)

31. Which buttock and / or hamstring did you have pain in?

The right side	The left side	Both sides

32. When did it begin to trouble you?

32b. For how long was it a problem?

33. What did you do to alleviate it ?

Stretching	Rest	Physio	Anti inflammatories	Other, please specify

34. Did it get completely better in your opinion ?

Yes	No

35. Do you still protect it ?

Yes	No

35b If yes, how ?

Train carefully	Rub it often	Stretch it often	Ice it	Warm up

36. How intense was the pain ?

Mild	Moderate	Bad	very severe

37. Does / Has the pain ever stopped you running for more than three days ?

Yes	No

38. Can you think of anything which may have caused the problem to start ?

Over training	Weakness	Inadequate stretching	Your shoes

Compensation due to other injury	Unsure	Other, please specify

39. Did your other hamstring or buttock ever produce a problem ?

Yes	No

SECTION 4 (Please all complete this section)

40. What time do you hope to run in the 1999 Comrades ?

5 - 6 hrs.	6 - 7 hrs.	7 - 8 hrs.	8 - 9 hrs.	9 - 10 hrs.	10 - 11 hrs.

41. Do you feel physiotherapy is a good way to treat a running injury ?

Yes	No

42. If not , why not ?

Too expensive	Too time consuming	Ineffective	Too painful	Other, please specify

43. Have you ever tried a strengthening programme in order to prevent injuries and help to heal already present injuries?

Yes tried and stopped.	Yes do strengthening exercises regularly - as it helps

Yes do strengthening exercises regularly - although it does not help.

No Never tried - no time .	Yes do strengthening exercises - seldom as it does not help

No Never tried - did not know what to do.

44. Do you see the logic in strengthening your central body (stomach ; back and backside) in order to prevent running injuries?

Yes	Maybe	No

45. Would you make the time to do 3 - 4 specialised strengthening exercises. If it took 5 -10 minutes a day?

Yes	No

Please either fill in your address on one of the envelopes provided , or fill in your e-mail address, if you wish to receive information regarding the results and some strengthening exercises which should be valuable to you .

Email address : _____

APPENDIX II

QUESTIONNAIRE 5

SECTION 1: (Please answer all questions)

Sex?

Male	Female
81%	19%

Age?

Mean	Minimum	Maximum
38	18	75

Weight in kilograms?

Mean	Min.	Max.
71kg	44	110

Height in metres?

Mean	Min.	Max.
175m	145	211

1. In your running career , how many Comrades have you completed?

Mean	Min.	Max.
4	0	25

2. How many standard marathons have you completed ?

Mean	Min.	Max.
24	0	300

3. How many other ultra events have you completed ?

3a. More than 45km and less than 90km.

Mean 15 Min. 0 Max. 99

3b. More than 90km.

Mean 6 Min. 0 Max. 50

4. What year did you start running ?

Mean	Min.	Max.
1990	1952	1999

5. Do you participate in other sport ?

62%	
Yes	No

5b. If yes do you participate in.....

	51%	
Ball Sports:	Yes	No

	30%	
Non-ball Sports:	Yes	No

6. Do you do gym or strengthening of any sort ?

52%	
Yes	No

7. If yes how many times per week ?

Mean:	1,48
Std. Dev.	0,49977
Min.	1
Max.	2

8. How many kilometres have you run in preparation for the Comrades (January - June) ?

Mean	Min.	Max.
1357	250	6240

9. What was your peak weekly mileage ? (In kilometres) (January - June)

Mean	Min.	Max.
104	40	320

Strain YES

31%

10. How many of your runs are speed or hill sessions ?

(average each week in the four months before Comrades)

Mean	Min.	Max.
1,8	0	6

11. Do you stretch?

60%	
Yes	No

12. Do you stop running completely for more than one month after Comrades?

42%	
Yes	No

13. What type of posture do you have?

Do you have a	48%	or a	52%
	Hollow back		Flat back

14. Do you often stand with all your weight on one leg ?

54%	
Yes	No

14b. If yes, which leg do you mostly stand on?

Left	Right	Varies

15. Do you get uncomfortable when sitting for sustained periods ?

532 (59%)	365 (41%)
Yes	No

15b. If yes , after about how long ?

Mean	Min.	Max.
1.2 hrs	5/60min	4 hrs

16. Do you usually cross your legs when you sit ?

480 (53%)	422 (47%)
Yes	No

17. Do you shift and move a lot when you sit ?

643 (71%)	260 (29%)
Yes	No

18. If you need to stand. do you usually stand with your arms folded or your hands in your pocket?

603 (70%)	258 (30%)
Yes	No

If you do not have ITB or hamstring or buttock pain please proceed to section 4.

If you have ITB please proceed to Section 2.

If you have Hamstring or buttock pain please proceed to section 3.

And if you have both, ITB and Hamstring or buttock pain, please answer all sections.

SECTION 2:

(Please complete this section if you have ever had ITB pain)

350 36% ITB

19. When was your last incidence of ITB syndrome ?

21%	20%	18%	16%	12%	14%
Weeks ago	months ago	1 year ago	1-2 yrs ago	4-5 yrs ago	More

20. Which leg was it in ?

37%	45%	18%
Left	Right	Both Legs

21. When you had ITB, what did you do to treat it ? (Mark all appropriate boxes)

48%	47%	41%	36%	4%
Stretching	Rest	Physio	Anti inflammatories	Other please specify

22. Did you have surgery to it ?

40 (11%)	
Yes	No

22b. If yes , after how long ?

In 1 Year: 37%

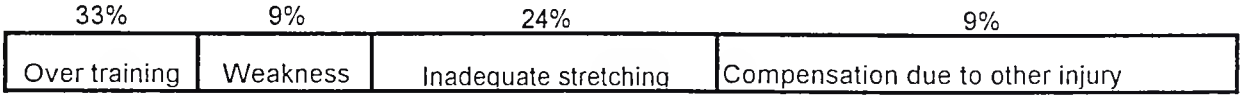
after 1 Year: 55%

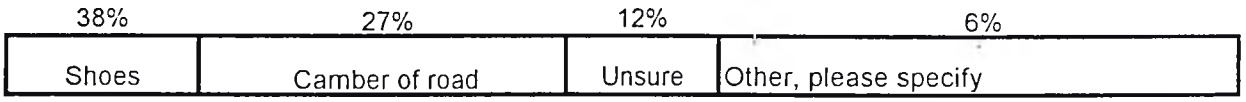
After 3 years: 9%

23. For how long did it bother you?

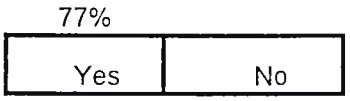


24. Can you think of anything which may have caused the problem to start ?





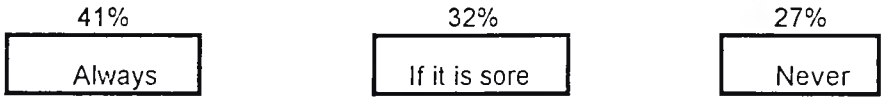
25. Did it ever stop you running for more than three days ?



26. Did it get completely better in your opinion ?



27. Do you still stretch it :



28. Did your other leg develop the same problem at any stage ?

31%	
Yes	No

29. Do you feel you still need to be careful of your knee/knees ?

69%	
Yes	No

30. What do you do to prevent its re-occurance ?

52%	43%	17%	31%
Stretch it	Train carefully	Ice it often	Buy new shoes early

24%	2%
Rub it	Other , please specify

SECTION 3

(Only complete this section if you have ever had pain in your buttock or the back of your leg.)

330 34%

31. Which buttock and / or hamstring did you have pain in?

33%	41%	26%
The right side	The left side	Both sides

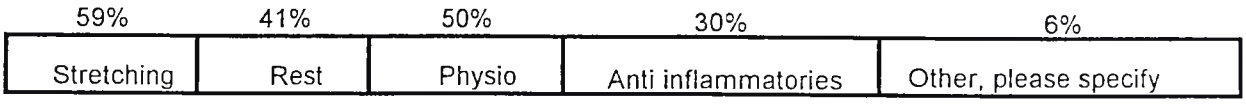
32. When did it begin to trouble you?

32b. For how long was it a problem?

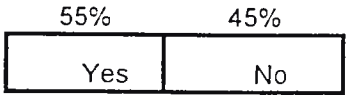
Chronic

44%

33. What did you do to alleviate it ?



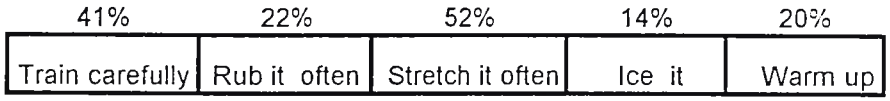
34. Did it get completely better in your opinion ?



35. Do you still protect it ?



35b If yes, how ?



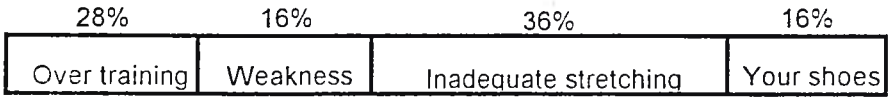
36. How intense was the pain ?

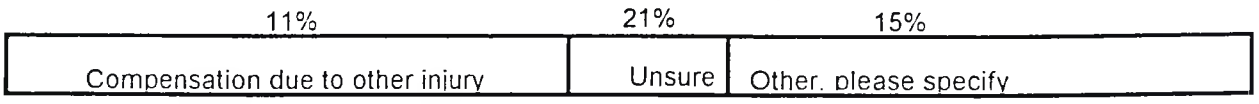


37. Does / Has the pain ever stopped you running for more than three days ?



38. Can you think of anything which may have caused the problem to start ?



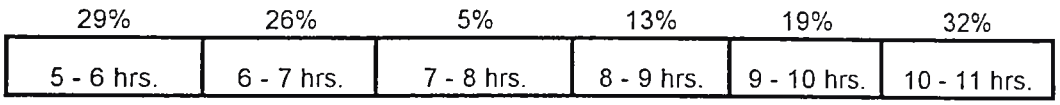


39. Did your other hamstring or buttock ever produce a problem ?

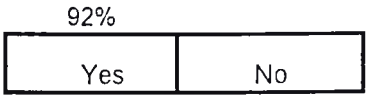


SECTION 4 (Please all complete this section)

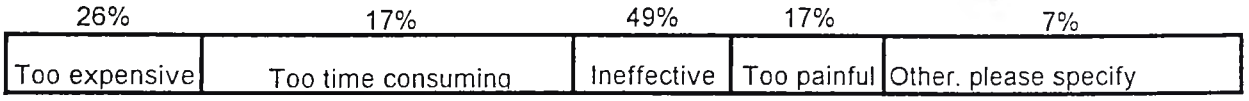
40. What time do you hope to run in the 1999 Comrades ?



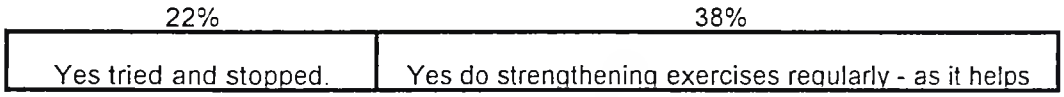
41. Do you feel physiotherapy is a good way to treat a running injury ?

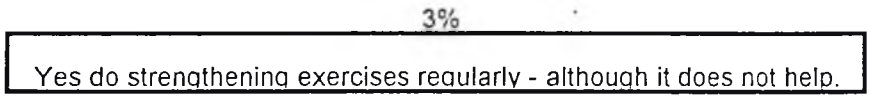


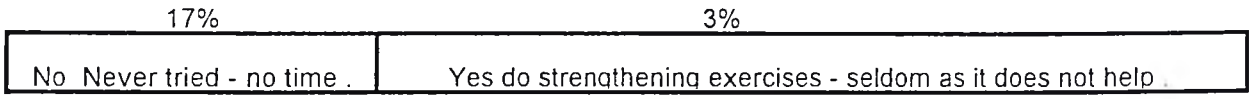
42. If not , why not ?

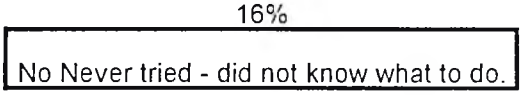


43. Have you ever tried a strengthening programme in order to prevent injuries and help to heal already present injuries?









44. Do you see the logic in strengthening your central body (stomach ; back and backside) in order to prevent running injuries?

87% 11% 2%

Yes	Maybe	No

45. Would you make the time to do 3 - 4 specialised strengthening exercises. If it took 5 -10 minutes a day?

95%

Yes	No

Please either fill in your address on one of the envelopes provided , or fill in your e-mail address, if you wish to receive information regarding the results and some strengthening exercises which should be valuable to you .

Email address : _____

APPENDIX III

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

COMMITTEE FOR RESEARCH ON HUMAN SUBJECTS (MEDICAL)
Ref: R14/49 Fuller-Good

CLEARANCE CERTIFICATE **PROTOCOL NUMBER** M990438

PROJECT Is There A Correlation Between Iliotibial Band Syndrome And Chronic Buttock And Or Hamstring Pain In Ultra Distance Runners? Are There Identifiable Predisposing Factors For These Injuries?

INVESTIGATORS Ms S Fuller-Good

DEPARTMENT Physiotherapy Department, Private Practice

DATE CONSIDERED 990430

DECISION OF THE COMMITTEE *

Approved unconditionally

DATE 990609 **CHAIRMAN** .....(Professor P E Cleaton-Jones)

* Guidelines for written "informed consent" attached where applicable.

c c Supervisor: C Dr Eales
Dept of Physiotherapy Department, Wits University

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DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10001, 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.

DATE 30/7/99 SIGNATURE .....

PROTOCOL NO.: M 990438

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

APPLICATION TO THE COMMITTEE FOR RESEARCH ON HUMAN SUBJECTS (MEDICAL) FOR CLEARANCE OF RESEARCH INVOLVING HUMAN SUBJECTS, OR PATIENT RECORDS [1]

CLEARANCE NUMER (for office use only): _____

This application must be typed or handwritten in capitals

NAME: Prof/Dr/Mr/Mrs/Miss/Ms Ms FULLER-GOOD

PROFESSIONAL STATUS (if student, year of study) Post graduate 2nd year Physiotherapist

UNIVERSITY DEPARTMENT [2] Physiotherapy P.O Box 1947 GALLOMANOR 2052.

HOSPITAL/INSTITUTION WHERE EMPLOYED Self employed private practice

FULL-TIME OR PART-TIME full-time

TELEPHONE NO AND EXTENSION 803-5725.

TITLE OF RESEARCH PROJECT: *(Use no abbreviations)*

IS THERE A RELATIONSHIP BETWEEN ILIOTIBIAL BAND SYNDROME AND CHRONIC BUTTOCK AND OR HAMSTRING PAIN IN ULTRA DISTANCE RUNNERS?

WHERE WILL THE RESEARCH BE CARRIED OUT? *(Please furnish name of hospital/institution and particular department)*

A QUESTIONAIRE SENT TO OR HANDED TO COMRADES RUNNERS.

All the following sections must be completed. [3] *Please tick all relevant boxes*

1. PURPOSE OF THE RESEARCH:

postgraduate: degree/diploma *(state which)*	[X]	MSC degree
undergraduate: degree/diploma *(state which)*	[ ]	
not for degree purposes	[ ]	

2. OBJECTIVES OF THE RESEARCH *(please list)*:

1 TO ESTABLISH A CONNECTION BETWEEN ITB AND POSTERIOR LOWER LIMB PAIN OR BUTTOCK PAIN

2 TO ESTABLISH WHETHER LACK OF CORE STABILISER STRENGTH IS A PREDISPOSING FACTOR, OR WHETHER OTHER FACTORS ARE CAUSATIVE USUALLY: 1 LACK OF STRETCHING
2 POOR TRAINING
3 EXCESSIVE MILEAGE

[1] *Unless received by the **15th of the month**, applications will be carried over to the next month for consideration.*

[2] *If not employed by the University or one of the University's teaching hospitals, please indicate clearly where correspondence should be sent.*

[3] *This requirement holds even if, to assist the Committee, a protocol detailing the background to the research, the design of the investigation and all procedures, is submitted with the application.*

3. SUMMARY OF THE RESEARCH *(give a brief outline of the research plan):*

A QUESTIONAIRE HAS BEEN DEVISED WHICH WILL BE CIRCULATED TO A RANDOM SAMPLE OF COMRADES RUNNERS USING ONE OF TWO METHODS. METHOD ONE : EVERY SECOND RUNNER WHO WALKS PAST A STAND AT EITHER THE DURBAN OR PIETERMARITSBERG 'PRE RACE EXPO'. THE RUNNERS WILL BE REQUIRED TO COMPLETE THE QUESTIONAIRE AND HAND IT BACK TO THE STUDENT AT THE STAND. METHOD TWO : EVERY THIRD RUNNER WILL BE MAILED A QUESTIONAIRE WITH THEIR RACE INFORMATION FROM THE COMRADES COMMITTEE. THE RUNNERS WILL BE REQUIRED TO RETURN THE QUESTIONAIRE TO THE RESEARCHER IN THE SELF ADDRESSED POSTAGE PREPAID ENVELOPE PROVIDED. RESULTS WILL BE STATISTICALLY ANALYZED. PARTICIPANTS WILL BE POSTED RESULTS FROM THE DATA.

4. REQUIREMENTS:

4.1 If this project involves studies with drugs at a teaching hospital associated with this University, approval must first be obtained from the relevant Pharmacy and Therapeutics (P&T) Committee [4].

Is this attached? *If not, the application cannot be considered.* Yes [ ] N/A [X]

4.2 If radiation or isotopes are to be used, written approval must be obtained from the Nuclear Medicine Department, Diagnostic Radiology Department, Radiation Therapy Department, or NUCOR representative.

Is this attached? *If not, the application cannot be considered.* Yes [ ] N/A [X]

4.3 Subject Information Sheet [5] is attached Yes [ ] N/A [ ]
(for written and verbal consent).
Informed Consent Form [6] is attached *(for written consent)* Yes [ ] N/A [ ]

Consent will be verbal Yes [ ] N/A [ ]

Informed consent is not necessary. If not, state why not: Yes [ ] N/A [X]

Athletes are required to complete a questionaire only.

4.4 If a questionnaire or interview form is to be used in the research, it must be attached.
Is it attached? *If not, the application cannot be considered.* Yes [X] N/A [ ]

5. SUBJECTS FOR STUDY

5.1 If patients are being studied, state where and how the subjects are selected:

All the Comrades 1999 runners will be sent a questionaire and asked to complete it - this is however voluntary and may remain anonymous.

[4]

Johannesburg Hospital	Ms Karen Robertson	488-4310
Baragwanath Hospital	Ms Sonette Schwarz	933-8136
Hillbrow Hospital	Miss Lenore Terreblanche	720-1121 ext 2516
Coronation Hospital	Dr S Levin	470-9287
Faculty of Health Sciences (Dentistry)	The Dean	407-8596
J G Strijdom Hospital	Miss Judy Fuller	489-0283
Tara Hospital	Matron E Jackson	783-2010
Sterkfontein Hospital	Mr D M C de Koker	956-6324 ext 261

[5] Whether written or verbal consent is to be obtained, the CRHS requires a Subject Information Sheet written in language understandable to the subject (or guardian) detailing what the subject will be told. This should normally include the following: (1) participation is voluntary, and refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled; (2) the subject may discontinue participation at any time without penalty or loss of benefits; (3) a brief description of the research, its duration, procedures, and what the subject may expect and/or be expected to do; (4) any foreseable risks, discomforts, side-effects, or benefits, including those for placebo; and (5) disclosure of alternatives available to the subject. If risks are involved, (6) a professional contact and telephone number; and (7) explanation whether medical treatment will be provided in the case of a complication developing.* The Subject Information Sheet may be incorporated into the consent form, or the consent form may be submitted separately. Examples are available from the Deputy Registrar (Research).

[6] The Informed Consent Form should include a clear statement that the subject is consenting to involvement in research and not to treatment which will necessarily provide personal benefit. Any personal benefit should be mentioned when this is possible. In a trial containing a placebo, the subject must be made aware that, although the potential risks and benefits of all the substances under trial have been explained, none of the active substances may be administered and it will not be possible for the researcher to reveal whether an active substance or placebo is being administered. An important piece of information is that the subject is free to withdraw from the trial at any time without prejudicing any treatment that is required for existing or future medical conditions. If this is not made clear, the researcher risks the accusation that consent was obtained by subtle coercion (that is, the possibility of prejudice against the subject as a current or future patient).

* *See attached guidelines on compensation.*

5.2 Where the subjects are not patients, they will be asked to volunteer [X] they will be selected [ ]
State how the subjects are selected, or who is asked to volunteer:

All 1999 Comrades runners who have had ITB and hamstring pain will fill in a questionaire if they wish to do so.

Are the subjects subordinate to the person doing the recruiting? Yes [ ] No [X]
If yes, justify the selection of subordinate subjects:

5.3 Will control subjects be used? Yes [ ] No [X]
If yes, explain how they will be recruited:

5.4 Subject records: state what records will be used and how they will be selected:

NO RECORDS USED, only volunteered information.

5.5 Age range of patients/subjects/controls: any age.
If under 18 years, from who will the consent be obtained?

N/A. Under 18 year olds are not permitted to enter the Comrades.

5.6 Sex: Male [X] Female [X]

5.7 Number of: patients [ ] non-patient subjects [UNSURE.] controls [ ]

5.8 Benefit to patients or subjects: will the research benefit the patient(s) or subject(s) in any direct way?
If yes, explain in what way: Yes [X] No [ ]

They will receive strengthening exercises and information about results of study.

5.9 Disadvantages to patients/subjects/controls. Will participation or non-participation disadvantage them in any way? If yes, explain in what way: Yes [ ] No [X]

6. PROCEDURES:

6.1 Mark research procedure(s) that will be used:

- [ ] Record review
- [ ] Interview form *(must be attached)*
- [X] Questionnaire *(must be attached)*
- [ ] Examination *(state below nature and frequency of examination)*
- [ ] Drug or other substance administration *(state below name(s) of drug(s)/substances(s) and dose(s) and frequency of administration)*
- [ ] X-rays
- [ ] Isotope administration *(state below name(s) of isotope(s) and frequency)*
- [ ] Blood sampling [ ] venous [ ] arterial *(state below amount to be taken and the frequency of blood sampling)*
- [ ] Biopsy *(state below what will be biopsied and frequency thereof.)*
- [ ] Other procedures *(explain)*

Use this space to elaborate procedures marked above:

QUESTIONAIRE IS INCLUDED. - APPENDIX 1
LETTER TO COMRADES RUNNERS - APPENDIX 2.

6.2 Is/are procedure(s) routine for diagosis/management? [ ] specific to the research? [ ]

N/A.

6.3 Who will carry out the procedure(s)? (State name(s) and position(s) held) I have written the questionaire and will interpret the answers with help from Dr [illegible] at the Research Institute

6.4 When will the research commence, and over what approximate time period will the research be conducted?
Commence emmediately - questionaire to be sent out well before 16/06/99 i.e race day. Results interpreted emmediately

7. RISKS OF THE PROCEDURE(S) subjects/controls will suffer:

- [X] No risks
- [ ] Pain
- [ ] Side effects from agents used
- [ ] Discomfort
- [ ] Possible complications

If you have checked any of the above boxes except "No risks" provide details here:

8. GENERAL

8.1 Has permission of relevant authority/ies been obtained? Yes [X] No [ ] N/A [ ]
State name of authority/ies:
Comrades association.

8.2 Confidentiality: how will confidentiality be maintained so that patients/subjects/controls are not identifiable to persons not involved in the research?
They may chose not to put their names on their questionaires.

8.3 Results: to whom will results be made available?
All participants of study.

8.4 Finances. There will be financial costs to:

Patient/subject	Yes [ ]	No [ ]
Hospital/institution	Yes [ ]	No [ ]
Other	Yes [X]	No [ ]

Explain any box marked "yes":
ONLY TO THE RESEARCHER USUALLY MYSELF.

How will the research be funded?
Funding will be sought.

8.5 Any other information which may be of value to the committee should be provided here:

Date: 10/0 Applicant's signature: [signature]

Who will supervise the project?

Name DR EALES AND MR F. COHEN Department PHYSIOTHERAPY

Telephone no. 488 3450 Date 12/4/99 Signature [signature]

Head/Research Coordinator of Department/Institution in which study will be conducted:

Name DR EALES

Date 14/4/99. Signature [signature]

APPENDIX IV

Name : **Sue Fuller-Good**
Subject : **MSc Physiotherapy in OMT**
Wits University

Supervisors : **Dr. S. Eales**
Mr. F. Cohen
Assistance : **Proff. M. Lambert**

Summary Page:

A questionnaire will be circulated to a random sample of Comrades runners.

This will be achieved, either by students handing it to every second runner who comes past a stand at the Durban or Pietermaritzberg pre-race exposition, or by postage to every third race entrant with their Comrade's mail. Questionnaires will be completed and collected immediately at the exposition, or will be posted back to the researcher in a self addressed postage prepaid envelope.

Data will be statistically analysed and interpreted, results will be used to prove or disprove the hypothesis that a connection exists between iliotibial band friction syndrome (ITBFS) and chronic posterior thigh and / or buttock pain (PT and / or BP) in ultra distance runners. Further information will be used to ascertain what predisposing factors are relevant in ITBFS and PT and / or BP.

RESEARCH QUESTION

Is there a relationship between iliotibial band friction syndrome and chronic buttock and / or posterior thigh pain in ultra distance runners?

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Appendix 1 (letter)

Appendix 2 (questionnaire)

RESEARCH METHODS

A questionnaire has been devised. A pilot study will be used to establish its effectiveness, ease of completion and the time required to complete it. This will involve runners being asked to complete the questionnaire and feed their responses to the researcher. The questionnaire will be adapted accordingly. This questionnaire will be distributed to a comprehensive, randomised sample of Comrade's Runners at either the Durban or Pietermaritzburg exposition which Comrade's runners are forced to attend in order to register for the race. Students will ask every second runner who passes the stand to complete the questionnaire and address an envelope to themselves if they wish to receive results from the study. Alternatively, a questionnaire will be sent to every third runner with their comrades mail; together with a self addressed, postage paid envelope for its return to the researcher. Which method of questionnaire distribution will be used will depend on the Comrades committee and their ability to assist with postage.

Questionnaire information will be analysed to provide answers to two main questions:

1. Is there a connection between ITB and PT and / or BP?
2. Is lack of stabiliser strength the predisposing factor in these injuries or do other factors also contribute.

The data will be summarised using frequencies and percentages. It will then be analysed using contingency tables, the Chi square test, Fisher's Exact test, the Log Linear model and Logistic regression. This analysis will be done by Dr. Becker from the Medical Research Council.

Results and strengthening exercises will be posted to runners or emailed to them should they have access to this facility.

STUDY DESIGN

This study will involve quantitative research. An attempt will be made to explain the connection between ITBFS and PT and / or BP, should one be found to exist. . The purpose of seeking this connection is to enable such conditions as ITBFS to be better managed in order to prevent their re-presenting as another disorder. If it is found that lack of central stabiliser muscle strength is a major causative factor in the incidence of these injuries, an explanation for this will be given as well as possible suggestions as to improved future management of these injuries.

SUBJECTS

Between one and four thousand Comrade's runners, will be randomly selected as subjects for the study.
Participants will either be identified at the Comrade's pre-race exposition in Durban or Pietermaritzburg or will be sent a questionnaire by post and will be included should they respond timeously.

INCLUSION AND EXCLUSION CRITERIA

All questionnaires will be used unless they have been incompletely completed or are illegible.

APPARATUS

The only apparatus used will be the questionnaire

DEFINITIONS

ITBFS is defined as:

Pain felt anywhere along the ITB from its origin to its insertion. This may typically be sharp pain felt on the lateral aspect of the knee which is worsened by downhill running and may cause cessation of running. It may also be pain felt over the greater trochanter of the femur or at the origin of the band from the ilium.

PT or BP is defined as:

Pain felt above, or on, or below the ischial tuberosity or in the hamstring muscle belly. This pain is left undefined for the purposes of this study as it is possible that it will be inaccurately specified by the runner in a purely subjective assessment.

ASSUMPTIONS

It will be assumed that runners will answer the questionnaire accurately and honestly. It will be assumed that runners remember the information exactly.

LIMITATIONS OF STUDY

The information is purely subjective and no objective assessment will be made. Information may be inaccurate due to poor understanding of questions or poor recall of events.

AIM OF STUDY

To establish a relationship between ITBFS and PT and / or BP and to interpret this finding in order to attempt to prevent an injury cycle from developing in the future in ultra distance runners.
To ascertain whether lack of stabiliser strength is a fundamental predisposing factor or whether other factors are equally causative.

OBJECTIVES

1. To establish a connection between ITBFS and PT and / or BP.

2. To establish whether the following are relevant predisposing factors:

   2.1 Exclusive running
   2.2 Failure to stretch.
   2.3 Poor training techniques and excessive distance running.
   2.4 Allowing deconditioning to occur in the off season.

   Or whether lack of central core stability is the primary factor.

3. To establish what attitude injured athletes have toward physiotherapy.

HYPOTHESES

1. There is a connection between ITBFS and PT and / or BP. It is suggested that ITBFS, is a symptom of pelvic dysfunction which, if not corrected in the case of continued running, may lead to PT and / or BP due to hamstring muscle overload or chronic ligamentous spraining.

   If this is true then a stabilisation programme embarked upon early in a runner's running career, or at the initial symptom presentation could prevent further problems.

2. The most significant predisposing factors for ITBFS and PT and / or BP is poor strength in the stabiliser musculature and other factors are less significant.

3. Runners would be prepared to do a stabilisation programme, if its value could be proven to them.

IDENTIFICATION OF RESOURCES AND BUDGET

Funding has been sought to cover expenses. Expenses include:

1. Cost of printing 4000 questionnaires

2.1 In the event of handing the questionnaires to runners at the exposition

2.1.1 Student wages
2.1.2 Sign boarding at exposition
2.1.2 Stationary - pens, clipboards, envelopes

2.2 In the event of sending letters out with Comrades mail to every third athlete

2.2.1 4000 Envelopes - R200,00
2.2.2 Prepaid postage for responder's answers approximately 1500 returns expected - R 2000,00

3. Costs of printing and postage of results to responders expected approximately 1500 = R2000,00 less those with email leaves approximately R1000,00

TIME REQUIRED FOR STUDY

Questionnaires will be posted in May or handed out to runners on the 13th, 14th and 15th of June 1999.
Results would be received by end of June.
Data will be analysed between July and August

Study should be completed by November 1999.

LITERATURE REVIEW

Ultra distance athletes suffer from a high injury rate. It is a widely accepted fact that a previous injury is the greatest risk factor for sustaining a new or recurrent injury (1)

ITBFS is a well described overuse injury of the knee, characterised by pain in the lateral aspect of the knee which is aggravated by long distance running or excessive striding and by down hill running (2). The pain is relieved by walking with an extended knee. (3) In a series of 200 knee injuries in long distance runners, 52% were secondary to ITBFS. (4)

The iliotibial band (ITB) is a thickened strip of fascia lata which receives part of the insertion of the tensor fascia lata (TFL) and gluteus maximus muscles. (5) It runs down the thigh in continuity with the lateral intermuscular septum and inserts at Gerdy's condyle of the tibia (4). The ITB, moves forwards and backwards with extension and flexion of the knee (5) The lateral femoral condyle is protrusive and in flexion the band passes over the epicondyle. At 30° of flexion, the posterior fibres of the band abut on the lateral epicondyle (3). There is evidence of a bursa, which lies over the epicondyle (2 ; 3). Repeated flexion and extension of the knee as in long distance running causes friction of the ITB and this may lead to inflammation at the meeting point:- of the band with the epicondyle, or of the periosteum of the epicondyle, or of the bursa itself. (5;2;3)

In ITBFS pain occurs in the outer aspect of the knee and may extend distally, it is poorly localised, swelling, thickness and crepitus may occur at the friction site (3) The Pain is remarkably resistant to treatment. Cortisone injections are sometimes effective, up to 3 may be required, rest always assists healing, but up to 6 week's rest may be required (3)

M. Schwellnus et al, who found physiotherapy in conjunction with non-steroidal anti inflammatory medication and analgesia to be effective (1)

The traditional explanation for the development of ITBFS includes a combination of extrinsic factors such as training errors, poor footwear and training surfaces (4 ; 2 ; 3) Also intrinsic causative factors have been identified such as tightness of the band, abnormal foot biomechanics, leg length discrepancy (syndrome develops in the shorter leg), increased "Q angle", also thicker bands as seen on MRI scan seem to be more predisposed to the syndrome (4).

It has been postulated that the friction occurs because of repetitive knee movement through an impingement zone (similar to the development of an impingement in the shoulder). This impingement zone is in the early stance phase of gait. Electromyographic study of joggers have shown that glutens maximus and TFL are only active in the first 35% or less of this stance phase. It is on this basis that it is postulated that weakness or inadequate contraction of these muscles (gluteus maximus especially) may be a causative factor in the development of ITBFS, in the same way as weak stabilizers of the shoulder cause impingement in the shoulder.

The hamstring muscles are: the semimembranosis, semitendinosis and biceps femoris muscles and that portion of adductor magnus which is innervated by the tibial nerve. The hamstring muscles originate in a conjoined tendon at the postero-lateral aspect of the ischial tuberosity, except for the short head of biceps femoris which originates on the femur. Distally, the muscles cross the knee joint - semitendinosus anteromedially to become part of pes anserinus and semimembranosus into a flat tendon which inserts into the posterior knee joint capsule and the posteriomedial tibia below the joint line. Biceps femoris inserts into the head of the fibula (6). Most hamstring injuries occur at the proximal end to the tendon or musculotendinous junction.

Muscles which cross two joints function eccentrically and have more fast twitch (type II) than slow twitch (typeI) fibres and are at greater risk of strain (7)

It has been found that a balance of power exists between hamstring and quadriceps muscles which is maintained by a neuromuscular servomechanism. This appears to be controlled partly by afferent input, originating in the anterior cruciate ligament and by other joint afferants (8). It is possible that the altered tension placed on the knee joint with a tight ITB may alter this servomechanism leading to an imbalance between the quadriceps and hamstring muscles. This may predispose the hamstring to injury or merely lead to altered biomechanics in that limb which in turn may cause injury. Also, the proprioseptive function of the affected limb would be disturbed in an acute ITB.

During running, mobility as well as stability in the pelvis must be optimal and ligament and muscle forces are needed to provide compression of the sacro iliac joint (SIJ) especially with unilateral leg loading (9)

The sacrotuberous ligament originates from the dorsal side of the sacrum and attaches to the ischial tuberosity. It's tension can be influenced by increased tension in the long head of the biceps femoris muscle. In 50% of specimens investigated by Vleeming et al the tendon of biceps femoris is continuous with the sacrotuberous ligament (10). Also, tension in the sacrotuberous ligament can be influenced by gluteus maximus and piriformis muscles, because of the anatomic connections between these muscles and the ligament.(9) Therefore it could be possible that a weak or dyfunctional gluteus maximus muscle could cause a slackening of the sacrotuberous ligament, a loss of force closure thereby causing an "instability" of the SIJ. This would alter the activity in biceps femoris muscle predisposing it to injury. (10) It would also potentially sprain the sacrotuberous ligament or its "antagonist" the dorsal sacro iliac ligament. (9) This may cause buttock pain or referred SIJ pain.

It was previously suggested that a weak gluteus maximus muscle may cause impingement of the ITB. It could therefore be the connecting factor between ITBFS and PT and / or BP

SIJ pain is normally described as a dull ache and is characteristically experienced over the back of the SIJ and buttock. It may also refer to areas including the greater trochanter and posterior thigh (11)

Disparity in leg lengths, functional or structural, and pelvic muscle length asymmetry are considered prime factors in detecting SIJ dysfunction. It was discussed previously that a leg length discrepancy may cause ITBFS in the shorter leg (4) The shorter leg would be on the side of a posteriorly rotated innominate bone in a rotated pelvis (11). This innominate position would place the hamstring muscle in the shortened position and gluteus maximus would be inhibited.

Lastly, runners commonly have sway back type postures with associated weakness in the gluten and abdominal (especially transversus abdominus) muscles. (12)

This posture is often combined with dominance of one leg standing, causing further weakness in gluteus medius, allowing the pelvis to tip laterally which causes compensatory increased tone in TFL and shortening of the ITB on that side (12) The sway back posture also places the sacrum in counternutation which is its unstable position (9) and in this position the gluteus maximus muscles are inhibited and the hamstrings are shortened (12)

It seems possible that lack of strength in the core stabiliser muscles could be a very dominant predisposing factor for both ITB and PT and / or BP.

APPENDIX V

SUE FULLER-GOOD'S PHYSIOTHERAPY PRACTICE
Deck Area, Euro Centre, 363 Rivonia Boulevard, Rivonia ~ P.O. Box 1947 Gallo Manor ~ 2052
Phone 803-5725 27 ~ Fax 803-5730
Cell No. 082-570-0824

Dear Comrades Runner:

re: Report back from Thesis Questionnaire.

Thank you for taking the time and trouble to complete my form for me, it was a great help and I have at last got some results which I am glad to forward to you. Forgive the delay, but it is a slow business.

I found that 44% of runners had had ITB problems at some stage of their lives and of those, 71% had had posterior leg pain as well. This leads me to conclude that ITB is very probably, as I had suspected, a symptom of weakness and dysfunction in the pelvic girdle. I believe that commonly this symptom clears up with medication, rest, surgery and/or treatment, but since the cause persists, the symptoms may merely represent in another place or form at a later stage.

The vast majority of runners stand on one leg or fold their arms and cross their legs when sitting, which is not a good thing and should be discouraged. All of these are signs of and causes of weakness. Standing on one leg is a cause of asymmetry and muscle imbalance; folding arms is a cause of a weakness of the muscles of the upper back - make your muscles hold your arms up and keep your shoulders back. The same goes for hands on hips. Crossing legs when sitting allows the deep stomach muscles not to work to keep the pelvis stable, so try not to do this as it becomes a lazy habit.

Two exercises I recommend to treat this pelvic weakness:

1. Lying on your back, one knee bent; move straight leg towards other leg and at the same time do a crosswise crunch taking your opposite elbow towards your straight leg. This strengthens the inner muscles of your thigh which attach to your pubic bone. If these muscles learn to work with your abdominal muscles - specifically the oblique ones it creates a closing force on your pelvis which stabilises it.

2. Standing against the wall, knees bent to 90 degrees and feet hip width apart. Keep one hand's breadth behind your spine to ensure that you hold your curve in your lower back. (with your stomach muscles). Now lift your left leg and lower your left arm using self resistance, (making it difficult for you to lower your arm). This uses your standing leg backside muscles (gluteus maximus) and your opposite latissumus dorsi muscle which again make a cross sling which stabilises your pelvis.

3. Lie on your back, knees bent, with a bottle under your one foot. Lift your backside off the floor, (roll it up) and try to straighten your other leg, keeping the hips absolutely straight, do not allow one to dip downwards. The unstable surface of the bottle, which can roll, will help develop your stabiliser muscles. Do not use a breakable bottle, or a plastic one, but one which tends to roll and requires you to keep it still.

If you do ten repetitions of each exercise on each leg, daily you will make your pelvic girdle much more stable, enabling you to run more easily and with less effort and sway. Hopefully this will help prevent injuries by preventing excessive unnecessary movements and overwork of muscles.

Good luck with your training, hope this helps. If you need more information don't hesitate to call me on 803-5725, I'd be glad to help.

Yours faithfully,

Sue Fuller-Good BSc. Physio (UCT)

APPENDIX VI

SueFuller-Good
Physiotherapy practice.

Po Box 1947
Gallomanor
2052
Johannesburg
SA

July 24, 2000

Ms Diane Lee
302 11950 80th Ave
Delta
B.C.V4C 1Y2
Canada

AUG 15 2000

Dear Ms Lee

I am doing my MSC through the University of the Witwatersrand, and would like your permission to use some of the diagrams included in your article: " Instability of the Sacroiliac joint and the Consequences to Gait", which was published in 1996, in the Journal of Manual and manipulative Therapy. Vol. 4 No1. This article was incredibly informative and I found the diagrams you used remarkably helpful, and very clear. For this reason, I would be grateful if I could use some of them to assist me in explaining my own concepts in my master's thesis on pelvic instability in long distance runners. The diagrams I am wanting to copy are:

Figure 7, page 25:"Posterior Oblique System".

Figure 10 and 11, page 27: "Compensated and Non- compensated Trendelenberg."

Your permission to use these diagrams in order to illustrate the concepts on pelvic instability which I am discussing, will be appreciated. I eagerly await your response.

Sincerely,

Sue Fuller-Good

Sue Fuller- Good (Ms)

Permission Granted as long as credit to original source (Diane Lee) + article published is made.

Diane Lee Aug 16/00.

SueFuller-Good
Physiotherapy practice.

Po Box 1947
Gallomanor
2052
Johannesburg
SA

July 18, 2000

CHL

Churchill Livingstone
Robert Stevenson House
1-3 Baxter's Place
Leith Walk
Edinburgh
EH1 3AF

Dear Sir/ Madam

I am doing my MSC through the University of the Witwatersrand, and would like your permission to use some of the diagrams included in the book: "Movement, Stability and Low Back Pain", which was published in 1997, by yourselves. The diagrams I am wanting to copy are:

Figure 18.1, on page 231, "At heel strike, the Biceps Femoris contracts and increases tension in the sacrotuberous ligament.. This facilitates force closure of the SIJ.(Redrawn from Vleeming et al 1995a).

Figure 19-1 –19-8. On page 240, " Combined activities of right and left innominates, sacrum and spine during walking."

Figure 18-3, on page 232, " Compensated Trendelenburg sign."

Figure 18-4, on page 233, "Non- compensated Trendelenburg sign."

Figure 3-12, on page 67, (A) Lower part of oblique dorsa muscle-fascia-tendon sling...(B) The longitudinal muscle-tendon-fascia sling...

You permission to use these diagrams in order to illustrate the concepts on pelvic instability which I am discussing, will be appreciated. I eagerly await your response.

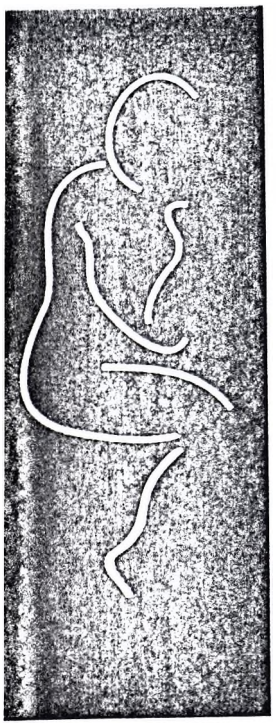
Sincerely,

Sue Fuller-Good

Sue Fuller- Good (Ms)

Permission is granted subject to your research confirming the material in question is original to our text. Permission is granted on a non-exclusive one-time only ~~or life of an edition basis, with distribution rights throughout the world~~. The permission is subject to the use of a standard credit line on the same page where our text or illustration will appear.

signed S Boyle date 11th Aug. 2000
Permissions Executive for Harcourt Publishers Ltd
Edinburgh.



Faxed. 13/04/99

SUE FULLER-GOOD'S PHYSIOTHERAPY PRACTICE

Deck Area, Euro Centre, 363 Rivonia Boulevard,Rivonia
Tel.: (011) 803-5725/27 · Fax: (011) 803-5730 ·Cell.: 082-570-0824

13 April 1999

The Chairman
Comrades Committee
PIETERMARITZBURG

Fax No: 0331 427548

Dear Sir,

re: My research project and the need to distribute a questionnaire to all Comrades runners.

I am doing my MSc through WITS University at the moment. My study involves distributing a questionnaire to all, or as many as possible, Comrades runners. I am looking to establish whether a relationship exists between ITB and chronic hamstring or buttocks injuries. I would be extremely grateful if you could assist me with the distribution of the questionnaire. Obviously the more runners who receive and respond to the questionnaire, the more accurate the information which can be derived from it will be.

My original proposition, was to send the questionnaire out with one of your postage cirulations, however it has been suggested that I should give them out at the expo', enabling runners to fill them in immediately. I am, however, running the race myself and will be unable to be continually at one of the expo's, I, therefore, prefer the postage option. Would this be at all possible to arrange?

If it is possible, when do you need to receive the questionnaires by, and what other information do you need prior to this date?

Your assistance will be enormously appreciated.

Yours faithfully,

P.P

Sue Fuller-Good (BSc Physio UCT)