An injury profile and management analysis of marathon runners at selected marathons in the greater eThekwini and uMgungundlovu Municipalities during 2014

By

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I, Giselle van Niekerk, do declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary)

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DEDICATION

To Van the Man. For teaching me that when the going gets tough, the tough laugh. I hope I’ve made you proud Dad.

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ABSTRACT

Background: Running injuries are increasingly common as participation in this sport increases. Health care providers need to be better able to treat and manage these injuries and prevent their recurrence. Thus, there is a need for profiles of different population groups to enable the development of health promotion and injury prevention strategies. This research study profiled and tracked runners over seven marathons held in the eThekwini and uMgungundlovu Municipalities during the first quarter of 2014.

Methods: This Durban University of Technology, Institutional Research and Ethics Committee approved retrospective Chiropractic Treatment Facility record analysis, analysed 741 recorded marathon visits. The records were based on a previously validated data collection tool (CSSA questionnaire) that allowed clinical data to be captured relating to patient demographics, anatomical site of the complaint, clinical impression, diagnosis and treatment. These fields were analysed for each visit, and then captured in SPSS version 22 with records only being excluded because they were unsigned. Descriptive and inferential statistics (McNemar's tests) were compiled and a p-value of 0.05 was used.

Results: The majority of the runners were Black males of approximately 40 years of age. A total of 95.6% of runners presented with overuse injuries, of which 73.6% and 89.3% had no history of previous injury or trauma respectively, and with 94.7% being able to continue participation. The shin and calf (21.7%), thigh (21.6%) and lumbar regions (16.1%) were most commonly affected by injuries which were predominantly muscle strains (23.2%) and SI syndrome (21.4%). These injuries were treated by manipulation (82.8%), massage (57.2%) and PNF stretching (33.6%). With runners that presented at subsequent marathons, a significant difference (McNemar's $p=0.013$) in history of previous injury between the first and second marathon was found, with the runner being more likely to report a history of previous injury at their second marathon visit. Specific trends, although not significant, were found for specific subgroups (defined by age, gender, ethnicity, history of previous injury / trauma and chronicity of the diagnoses).

Conclusion: The data is not dissimilar to the literature on running injuries, although specific trends in terms of sub categories were noted. These trends require further investigation through prospective, longitudinal studies.

Key terms: profile, athlete, musculoskeletal, injuries, sports injury, chiropractic.

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DEFINITIONS

Acute	(of a disease or disorder) having a short and relatively severe course (Dorland's medical dictionary for health care consumers, 2007).
Chiropractic Intern	A 5th or 6th Year Chiropractic student (or above) currently enrolled at the Durban University of Technology, who worked at the selected marathons throughout eThekwini and uMgungundlovu Municipalities.
Chronic	(of a disease or disorder) persisting over a long period of time (Dorland's medical dictionary for health care consumers, 2007).
Consultation	For the purposes of this research a consultation was defined as any clinical interaction that occurred at the Chiropractic Treatment Facilities (CTF) at the marathons which was recorded on the Chiropractic Student Sports Association (CSSA) Form during the respective marathons.
Diagnoses / Diagnosis	This term in singular or plural refers to a condition with which a patient presents, either in the form of an injury or a disease. The nature of the medical condition is identified by a medical doctor or other medically qualified professional in order for that patient to receive appropriate care. Therefore, this term is interchangeably used in identifying a disease or injury as these represent the same things (Colledge *et al*., 2010).
Dolorimeter	A pressure gauge used to evaluate pressure threshold or tolerance (has been used interchangeably with an algometer) (Fischer, 1987).
Extrinsic	External factors affecting the athlete that are related to the environment. Examples: Level of competition, skill level, shoe type, training errors, terrain, environmental factors (Meeuwisse, 1994).
Incidence	The rate at which a certain event occurs, as the number of new cases of a specific disease occurring during a specific period of time in a population at risk (Dorland's medical dictionary for health care consumers, 2007).
Injury	In terms of this study an injury refers to any musculo-skeletal complaint newly incurred due to competition and/or training and received medical attention regardless of the consequences with respect to absence from competition or training (Junge *et al.,* 2008).
Injury rate	Number of injuries per unit of exposure time (Hopkins *et al.,* 2007).
Injury risk	Proportion of athletes injured in a given time period (Hopkins *et al.,* 2007).
Intrinsic	Internal factors affecting the athlete and related to the athlete. Examples: Age, gender, previous injury, inadequate rehabilitation, aerobic fitness,

	musculoskeletal factors (Meeuwisse, 1994).
Lower extremity	The hip, thigh, leg, ankle, and foot. Also called inferior limb, pelvic limb, lower limb (Dorland's medical dictionary for health care consumers, 2007).
Lower leg	The part of the lower limb (below the hip) between the knee and ankle (Dorland's medical dictionary for health care consumers, 2007).
Management	The management plan includes the treatment of the area of complaint / injury (within the designated scope of practice of the practitioner) as well as addressing the overall health care of the athlete in order to ensure appropriate healing, recovery, rehabilitation and return to sport performance (Hyde and Gengenbach, 2007).
Massage	In terms of this study, can be defined as a collection of soft tissue techniques that range from Swedish massage right through to more specific applications such as ischaemic compression, cross friction or Graston technique. A range of gels may be used e.g. Voltaren, Arnica Ice, Reparil gel and Ice Man.
Muscle Strain	In the context of this study a muscle strain is a Grade I acute muscle injury (Grade II = partial tear and Grade III = complete tear) and may passively result in runners due to overstretching of a muscle without contraction. In a muscle strain there is less than 5% muscle fibre disruption, swelling and discomfort, with minimal impairment in strength and function of that region. (Chan *et al.,* 2012; Hyde and Gengenbach, 2007; Reid, 1992)
Myofascial Trigger Point	A clinical presentation of a "discrete, focal, hyperirritable knot located in a tight band of skeletal muscle" (Dommerholt *et al.,* 2006; Chaitow and DeLany, 2000; Travell and Simons, 1999).
Overuse injury	Overuse injuries occur due to repetitive sub maximal loading of the musculoskeletal system when rest is not adequate to allow for structural adaptation to take place (DiFiori *et al.,* 2014).
Pes Panus	(flat foot): an abnormally low medial longitudinal arch which causes a greater contact area with the ground (Banwell *et al.,* 2014).
Prevalence	The number of cases of a specific disease or injury present in a given population at a certain time (Dorland's medical dictionary for health care consumers, 2007).
Runner	Any individual who actively participated and ran in the respective marathons and voluntarily sought treatment at the CTF.
Subacute	Denoting the course of a disease of moderate duration or severity,

between acute and chronic (Dorland's medical dictionary for health care consumers, 2007).

Treatment The treatment includes the combination of directed therapies / interventions (within the designated scope of practice of the practitioner) utilised to address a particular injury / area of complaint in a patient (Hyde and Gengenbach, 2007).

ABBREVIATIONS

ACC	Accident Compensation Corporation
ACL	Anterior Cruciate Ligament
AMSMC	Allan McGavin Sports Medical Centre
BMI	Body Mass Index
CSSA	Chiropractic Student Sports Association
CTF	Chiropractic Treatment Facilities
DM	Diabetes Mellitus
DOMS	Delayed-onset Muscle Stiffness/Soreness
DUT	Durban University of Technology
IAAF	International Association of Athletics Federation
IREC	Institutional Research and Ethics Committee
ITBS	Iliotibial Band Syndrome
MFPS	Myofascial Pain Syndrome
MFTP	Myofascial Trigger Point
MTSS	Medial Tibial Stress Syndrome
PF	Plantar Fasciitis
PFPS	Patellofemoral Pain Syndrome
PMB	Pietermaritzburg
PNF	Proprioceptive Neuromuscular Facilitation
PRICE	Protection, rest, ice, compress, elevate
SI	Sacroiliac
WHO	World Health Organisation

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter introduces the study, provides a background on running and running injuries and presents the aims, objectives, rationale, hypotheses and limitations of the study.

1.1.1 Background

In the late 1960's and1970's, the public became increasingly interested in exercise due to the growing amount of research which showed the benefits of exercise (Macera, 1992; Macera *et al.,* 1989). Running became popular because of its convenience, proposed health benefits and low cost (Paluska, 2005; Noakes and Granger, 2003; Taunton *et al.,* 2002; Glover *et al.,* 1996; Macera, 1992; Macera *et al.,* 1989). However, as the numbers of athletes have increased, so have the number of injuries (Hreljac and Ferber, 2006; Noakes and Granger, 2003; Macera, 1992; Macera *et al.,* 1989). It is estimated that every year 25-50% of all runners sustain an injury that will alter their performance (Lavine, 2010; Renström *et al.,* 1993).

To understand the importance of running and injuries, it is vital to understand the biomechanics of gait and the gait cycle (Hyde and Gengenbach, 2007; Norkin and Levangie, 1992). The gait cycle is the basic unit of measurement in the gait analysis (Brolinson *et al.,* 2003; Gage, 1990), which follows from the heel strike of one foot to heel strike of the same foot after one cycle of the stance and one cycle of the swing phase have passed (Ren *et al.,* 2007; Lavine, 2010; Subotnick, 1999). In this sequence, the stance phase (60% of the gait cycle) (Ren *et al.,* 2007; Norkin and Levangie, 1992) consists of an initial heel strike, a mid-stance, a heel off and a toe off component (Ren *et al.,* 2007; Norkin and Levangie, 1992). By contrast, the swing phase begins at toe off and ceases just prior to heel strike. The swing phase makes up 40% of the gait cycle and has acceleration, mid-swing and deceleration components (Ren *et al.,* 2007; Norkin and Levangie, 1992). In walking, a period of double-limb support occurs, when the lower extremity of one side of the body is beginning its stance phase, and the lower extremity on the other side of the body is ending its stance phase (Norkin and Levangie, 1992), but both feet are in contact with the ground simultaneously (Ren *et al.,* 2007). In running, the periods of double support during the stance phase of the gait cycle give way to periods of double float which occur at the beginning and end of the swing phase of the gait cycle. The double float phase is characterised by both feet being simultaneously off the ground (Noakes and Granger, 2003; Novachek *et al.,* 1998).

Despite the wealth of literature regarding the biomechanics of walking and running, the relationship between the mechanics and injury of running are not well understood (DeLeo *et al*., 2004; Noakes and Granger, 2003). Renström *et al.* (2003) hypothesised that the prevalence of injuries in runners is due to the repetitive stress on the lower extremity, particularly as the ground reactive force during running at mid-stance is equivalent to a vertical force of 1.5 to 5 times the bodyweight. When this force is applied repetitively over long distances or for extended time periods, the resultant fatigue of the various body tissues is thought to lead to injury (Noakes and Granger, 2003).

Taking this into account, even small biomechanical abnormalities could result in a significant concentration of stress within a particular structure, which may in turn cause an injury (Hyde and Gengenbach, 2007; Van Gent *et al.,* 2007; Lun *et al.,* 2004; Andrews *et al.,* 1997).For example, runners with an abnormal quadriceps femoris angle seem to sustain more knee injuries (such as patellofemoral pain syndrome) than runners with a normal quadriceps femoris angle (Puckree *et al.,* 2007).

This is of particular significance in the modern era of running, where the standards are higher; there is more competition, more public exposure, more races to be won and ultimately more money to be made (Running USA 2015; Yeung and Yeung, 2001). There is an increased likelihood of injury (Rasmussen *et al.,* 2013)as a result of the increased competitiveness of running and competitiveness between participants, as well as the increasing actual total number of participants in marathon events (Running USA, 2015; Rasmussen *et al.,* 2013). Even though these increased demands on the runner have been associated with great advances in the manufacturing of the running shoe, the prevalence of injuries has yet to decrease (Rasmussen *et al.,* 2013; Yeung and Yeung, 2001).

To this end, research has shown that the common causes of running injuries are usually multi-factorial and can be intrinsic or extrinsic in nature (Hyde and Gengenbach, 2007; Wen, 2007; Noakes *et al.,* 2003; Renström *et al.,* 2003; James, 1995; Meeuwisse, 1994; van

Mechelen, 1992; Powell, 1986). Renström *et al.* (2003) report that 60-80% of all running injuries are a result of extrinsic factors (e.g. the presence or absence of a coach (Collins *et al.,* 1989), provision and access to medical care at an event or during training periods (Egermann *et al.,* 2003), in addition to the number of training hours per week (O'Toole *et al.,* 1989), the running distance per week (Massimino *et al.,* 1988), the number of running sessions per week (Vleck and Garbutt, 1998), the running intensity (Manninen and Kallinen, 1996), the type of running surface (Korkia *et al.,* 1994) and cross training / participation in other sporting codes (Gosling *et al.,* 2008). By contrast the majority of intrinsic factors (Taimela *et al.,* 1990) seem to be related to structural abnormalities (i.e. the biomechanics of running (Gosling *et al.,* 2008)) as well as gender (Egermann *et al.,* 2003), age (Burns *et al.,* 2003), the runner's anthropometric characteristics (Vleck and Garbutt, 1998), the runner's running experience (Villavicencio *et al.,* 2006) and the presence of prior injury or lack thereof (Korkia *et al.,* 1994).

The most common structures injured in order of most prevalent to least prevalent are: muscle and fascia, tendon and muscle insertion, joint surfaces, tendons, bursae, bones and nerves (Hyde and Gengenbach, 2007; Renström *et al.,* 2003). As a result, the most common anatomical site of injury is the knee (Ellapen *et al.,* 2013; Chang *et al.,* 2012; Noakes, 2003; Renström *et al.,* 2003), followed by the lower leg, foot, hips, upper leg/thigh and low back (Renström *et al.*, 2003; Ellapen *et al.*, 2002). However, previous research has highlighted that the most common diagnoses (associated with running), irrespective of the anatomical region of injury, are medial tibial stress syndrome (MTSS), Achilles tendinopathy, plantar fasciitis (PF), patellofemoral pain syndrome (PFPS), runners' knee or chondromalacia, patellar-tracking syndrome, iliotibial band friction syndrome (ITBS)and metatarsal stress syndrome (Hamstra-Wright and Preish, 2014; Hyde and Gengenbach, 2007; Puckree *et al.,* 2007; Egermann *et al.,* 2003). It would thus seem that the region of complaint is not necessarily related to the eventual diagnoses made, although there may be a cause-effect relationship which has yet to be determined. It is important to determine this relationship as well as the relationship of the region of complaint / diagnoses and the mechanism of injury, as this may be a co-variate or modifying agent (Gujarati and Porter, 2009). This information is important as it would allow for health care practitioners to develop injury management (Finch and Cook, 2014; Junge *et al.,* 2008; Hyde and Gengenbach, 2007) and injury prevention strategies (Finch and Cook, 2014; Junge *et al.,* 2008; Hyde and Gengenbach, 2007) in order to better assist athletes – in particular runners – to avoid injury and therefore increase the runner's lifetime participation in the sport (Movassaghi *et al.,* 2012; Ramasamy *et al.,*2009; Lindsay, 2004), and decrease their mortality and morbidity (Dagenais *et al.,* 2008).

This is particularly important for chiropractors who are active in Sports Chiropractic, which is growing rapidly as athletes now more frequently seek chiropractic manipulative treatment for their injuries (Sports Chiropractic, 2013; Dagenais and Haldeman, 2012; Hyde and Gengenbach, 2007; Haldeman and Rubenstein de Koekkoek, 1996).

Chiropractic treatment of an acute running injury should include: protection, rest, ice, compression, elevation and pain relief medication (Hyde and Gengenbach, 2007; Bahr and Maehlum, 2004; Noakes and Granger, 2003; Renström *et al*., 2003; Juhn, 1999; Subotnick, 1991). Treatment for more chronic running injuries should include the restoration of the normal kinematic chain by manipulation, mobilising, stretching and strengthening and soft tissue work (Renström, 1993). However to be effective, it is also vital to identify the cause of injury (e.g. whether it is extrinsic or intrinsic), and correct the cause through offering advice. This is particularly true in that most literature states that prevention is better than cure in relation to running injuries (Noakes and Granger, 2003; Renström *et al.,* 2003; Andrews *et al.,* 1997; Subotnick, 1991), so chiropractors should offer periodic talks at relevant sports clubs to highlight how injuries may come about. However, the literature on the relationships between region of complaint / diagnoses and the mechanism of injury have yet to be identified conclusively, and the effect of extrinsic factors has not been investigated in a multitude of conditions. This hampers the ability of the practitioner to drive the clinical interaction based on an effective combination of research evidence, clinical experience and patient preference (Montori *et al*, 2013; Murray, 2007).

Thus, this study aimed to show the injury profiles and injury management of competitive marathon runners in the greater eThekwini and uMgungundlovu municipalities by comparing and contrasting their injuries and treatments. This study may provide future event organisers, athletes, and practitioners an understanding of the mechanisms of common injuries, treatment protocol and preventative measures (Finch and Mitchell, 2002; Finch *et al.,* 1999). This research also may provide relevant information to the DUT Chiropractic teaching faculty on the injuries and methods of management that are commonly seen at these events so they may be adequately addressed in the curriculum.

1.1.2 Aim of the study

The aim of this study was to analyse the demographics, the injury patterns of and treatment received by runners who participated in selected marathons in the eThekwini and uMgungundlovu municipalities during 2014. Additionally, the study tracked runners from event to event to determine whether they had ongoing problems or new complaints over the running season during the time that these marathons took place.

1.2 Objectives

The objectives of this study:

1. The first objective was to determine the demographic characteristics of the runners who presented at the onsite DUT Chiropractic Treatment Facilities (CTF).

2. The second objective was to determine an injury profile of runners who presented as a patient at the onsite DUT CTF in terms of injury prevalence and treatment intervention.

3. The third objective was to determine the treatment profile utilised in the management of the runners who presented as a patient at the onsite DUT CTF.

4. The fourth objective was to determine any associations between selected demographics, injury and treatment profiles.

5. The fifth objective was to track repeat runners that presented to the onsite DUT CTF at each selected marathon and to determine any associations between their initial and repeat injury profile.

1.3 Rationale behind the study

Retrospective injury profiling is an important tool and can effectively aid event organisers, athletes, future athletes, and coaches in preparing adequately for the circumstances in which they place themselves , as well as safety procedures that may be required (Finch and Cook, 2014; Junge *et al.,* 2008).

The main goal of injury profiling is to ensure the safety of future participants in a certain event (Finch *et al*., 1999). Injury profiling may also aid practitioners and future practitioners' in understanding mechanisms of common injuries, treatment protocols and preventative measures (Finch *et al*., 1999).

In addition to injury profiling, understanding the relationship between the intrinsic and extrinsic factors affecting runners and how these are or are not modified by health practitioners actions, the actions of the runner, the effects of medical conditions and their medications (that a runner may consume) and the actions of coaches and trainers, is important. Once this is understood by the health care provider, it is also critical to be able to ascertain which intrinsic / extrinsic factors are amenable to change or not. This allows manipulation of these factors to achieve the optimum outcome for the runner. This can however only be achieved by a combination of "multi-faceted, multi-disciplinary, multi-layered approaches" to treating and managing the runner / patient (Boon and Kachan, 2008; Kopansky-Giles *et al.,* 2007; Sackett *et al.,* 2000).

Therefore, this study aimed to identify the demographic data of participating marathon runners, mechanism of injuries, the type and location of the injuries and the treatment of such injuries. It also aimed to track active marathon runners and to determine if the runners who participated in repeat marathons throughout eThekwini and uMgungundlovu municipalities presented with repetitive injuries and if they received treatment for these injuries. Therefore, this study hoped to achieve a better understanding of the common injuries of marathon runners, the treatment they received and the preventative measures needed to be taken to ensure safer running. This research also may provide relevant information to the DUT Chiropractic teaching faculty on the injuries and methods of management that are commonly seen at these events, so they may be adequately addressed in the curriculum.

1.4 Limitations of study

- This retrospective study relied on the knowledge of chiropractic interns, who made subjective observations and objective assessments when recording their patients' details as accurately as possible. This was performed under a supervising clinician utilising the standard clinical protocol in recording and reporting patient information (Chiropractic Day Clinic Manual, 2014); however, the retrospective nature of this study did not allow for the researcher to go back and complete missing data (something which is possible in a prospective design), and this should be taken into account when analysing the accuracy of such information (Mouton, 2006; Mouton, 1996).

- An informed consent (Appendix A) was required from each patient, in the form of a signature, to allow their details to be captured for use in research projects. In some cases, no signature was present, and therefore their details could not be utilised in this study. Although it is expected that the exclusion of these data may have biased the study, it is not possible to have all records fully completed when data mining in retrospective studies and this thus poses an inherent limitation on data analysis from this study design (Mouton, 2006; Mouton, 1996).

- All runners that were treated were only treated within the scope of practice of a chiropractor(Allied Health Professions Act 63 of 1982 (as amended)).Any runner requiring immediate medical attention, transfer to a hospital and / or emergency procedures, was referred to the medical support unit onsite at the respective marathon for care more appropriate to their presenting condition (e.g. dehydration) or was referred to the nearest hospital for further evaluation (e.g. March fractures) before any treatment would have been administered. These runners may not have had documentation completed in view of their ability or time to complete such. Therefore no inferences were possible on these runners and their presenting condition in this study.

- The management offered at the onsite CTF’s at the selected marathons was free of charge. This could result in an over reporting of injuries, as participants are more likely to seek treatment if the services are offered free of charge than if a fee is attached (Konczak, 2010). However, it should also be considered that if a service fee was included, it could lead to an under reporting of injuries.

1.5 Summary

Very few injury tracking profiles have been conducted on marathon runners with regards to their injuries and treatment received for them. Therefore the aim of this study was to determine a retrospective analysis of the presenting injuries and management of marathon runners that presented to the onsite DUT CTF at selected marathons in the eThekwini and uMgungundlovu municipalities, and whether these runners presented at multiple marathons and sought continued treatment from the same facilities for the same or different conditions.

In this chapter, an introduction to running and a background to the sports and reason for the study is provided. In Chapter Two, a review of running and the common injuries, management, as well as chiropractic care is provided. In Chapter Three, the methods and materials used in this study are discussed and explained. Chapter Four includes the statistical findings, along with tables depicting these findings and a discussion of each result. Chapter Five concludes this research with a summary of the study and benefits, limitations and recommendations of how this study may be improved.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction to running

The public's increasing interest in running has resulted from the growth of research showing the benefits of such exercise. In addition, running has become popular because of its convenience and low cost (Noakes and Granger, 2003; Taunton *et al.,* 2002; Glover *et al.,* 1996; Macera, 1992; Macera *et al.,* 1989). However, as the numbers of athletes increase, so do the number of injuries and injury profiles (Hreljac and Ferber, 2006; Noakes and Granger, 2003; Macera, 1992; Macera et *al.,* 1989). It is estimated that every year, a quarter to a half of all athletes sustain an injury that will alter their performance or ability to participate in running (Lavine, 2010; Renström *et al.,* 1993).

2.2 Normal mechanics of running

2.2.1 Gait cycle

To start, it is probably best to describe the biomechanics of running gait, as the concept of the gait cycle needs to be understood (Hyde and Gengenbach, 2007; Norkin and Levangie, 1992). The gait cycle is the basic unit of measurement in the gait analysis (Brolinson *et al.,* 2003; Gage, 1990), and can be described when one foot makes contact with the ground and ends with that same foot contacting the ground again. The gait cycle is commonly split up into the stance phase and swing phase (Ren *et al.,* 2007). The stance phase is divided into three components: initial contact, mid-stance and propulsion. The gait cycle begins with an initial contact, also known as heel strike, as the heel comes into contact with the ground (Levine *et al.*, 2012) and continues only as long as some portion of the foot is in contact with the ground through mid-stance, until toe off in propulsion. The swing phase begins as soon as toe off is complete, when the same extremity leaves the ground, and ceases just prior to heel strike or contact of the same extremity. Swing phase can be divided into acceleration, mid-swing and deceleration (Levine *et al.*, 2012; Ren *et al.,* 2007; Norkin and Levangie, 1992). The gait cycle is made up of 40% swing phase and 60% stance phase (Levine *et al.*, 2012; Norkin and Levangie, 1992; Subotnick, 1999). Walking and running can be differentiated by the fact that in walking, there is placement of one foot in front of the other and is separated by a period when both feet are in contact with the ground, also known as double limb support (Brukner and Khan, 2012). Double limb support does not occur in running, but instead a period of double float exists, where neither foot is in contact with the ground (Shamus and Shamus, 2001). During slow running over longer distances, the stance phase has a longer duration than the swing phase, and with an increase in pace, as with sprinting, the stance phase decreases until eventually the stance phase is shorter than the swing phase (Brukner and Khan, 2002).

2.2.2 Biomechanics of gait cycle in running

During initial contact of the stance phase, there is rapid flexion of the hip, knee and ankle in order to aid with absorption of the impact of the ground on the leg. From initial contact to mid-stance (also known as the absorption phase), the knee and ankle continue to flex, enabling further energy reduction (Novachek, 1998). Mid-stance is identified as the point in which there is a cessation of joint flexion in energy absorption and the commencement of joint extension in propulsion (Scarfe, 2011; Dicharry, 2010; Novachek, 1998). This is also the point at which the centre of gravity reaches its lowest point above the ground. During toe off, the hip, knee and ankle extend to their greatest point in the gait cycle and allow for forward propulsion (Scarfe, 2011; Dicharry, 2010; Novachek, 1998). The end of toe-off leads to the swing phase, in which the hip and knee flex to clear the ground. Eventually the hip begins extension again to position the ipsilateral foot beneath the centre of gravity of the body, at initial contact (Scarfe, 2011; Dicharry, 2010; Novachek, 1998).

Two important concepts to discuss when dealing with running biomechanics are the kinetic chain and the ground reaction force (GRF) (Shamus and Shamus, 2001). The kinetic chain is the sequencing of individual body segments and joints (referred to as links) in an order that will allow for efficient accomplishment of athletic tasks (Brukner and Khan, 2002). The activation of sequencing of the kinetic chain, leads to a generation of force and energy in these links, resulting in an efficient transfer to the terminal link (Brukner and Khan, 2002).

The GRF is the reactive force generated in response to the impact force of the foot on the ground (Shamus and Shamus, 2001). This generated force is transferred from the foot to other parts of the body in order to accomplish the athletic task concerned (Watkins, 1996). The spine plays an important role in all sports (Watkins, 1996). In running, when the feet contact the ground, the lower extremities transfer this force into the pelvis and spine. The back transmits this energy to the upper extremities and shoulders, and along back down the spine into the pelvis and lower extremities, through the thoraco-lumbar fascia, resulting in greater speed and efficiency of performance of the athletic task (Watkins, 1996).

2.2.3 Biomechanics of long distance marathon running

Running requires a repetitive motion by the body, and in marathon running particularly, this repetition is for a long period of time, leading to fatigue and musculoskeletal pain (Coetzee, 2013). Fatigue in turn may cause the alteration of muscle recruitment patterns, which can modify the distribution of forces across soft tissues related to a joint (Murphy *et al.,* 2003) leading to muscular functional deficits which will result in biomechanical changes in sports performance, leading to pain and dysfunction (Kruse and Lemmen, 2009).

2.3 The link between running and injuries

Despite the wealth of literature regarding the biomechanics of running, the relationship between the mechanics and injuries is not well understood (DeLeo *et al.,* 2004; Noakes and Granger, 2003). Renström *et al.* (2003) hypothesised that the prevalence of injuries in runners is due to the repetitive stress on the lower extremity. Renström *et al.* (2003) also showed that the ground reaction force at mid-stance in the gait cycle is equal to a vertical force of 1.5 to 5 times the body weight. When this force is applied repetitively over long distances or for an extended period of time, the body is continuously supporting a heavy load for what could be many hours (Noakes and Granger, 2003). Taking this into account, even a small biomechanical abnormality could result in a significant concentration of stress within a particular structure, which may in turn cause an injury (Hyde and Gengenbach, 2007; van Gent *et al.,* 2007; Lun *et al.,* 2004; Andrews *et al.,* 1997; Meeuwisse, 1994). For example, runners with an abnormal quadriceps femoris angle seem to sustain more knee injuries (such as patellofemoral pain syndrome) than runners with a normal quadriceps femoris angles (Puckree *et al.,* 2007).

2.4 Epidemiology of running injuries

The most common structures injured, in order of most prevalent to least prevalent are: muscle and fascia, tendon and muscle insertion, joint surfaces, tendons, bursae, bones and nerves (Hyde and Gengenbach, 2007; Renström *et al.,* 2003). The most common anatomical site of injury is usually the knee (Ellapen *et al.,* 2013; Chang *et al,* 2012; van Gent *et al.,* 2007; Puckree *et al.,* 2007; van Middelkoop *et al.,* 2007; Hreljac and Ferber, 2006; Noakes, 2003; Renström *et al.,* 2003; Taunton *et al.,* 2003; Taunton *et al.,* 2002; Steinacker *et al.,* 2001; Jeffers, 1999; Nobel, 1997;Satterthwaite *et al,* 1993;van Mechelen, 1992; Jakobsen *et al.,* 1989; Macera *et al.,* 1989; Walter *et al.,* 1989; Bates *et al.,* 1978). This is followed by the lower leg, foot, hips, upper leg/thigh and low back (Ellapen *et al.*, 2013; Renström *et al.*, 2003).Certain studies found the shin and / or calf and lower leg to be either the most common anatomical site of injury (van Middelkoop *et al.,* 2007*;* Satterthwaite *et al.,* 1999; Wen *et al.,* 1998; Bovens *et al.,* 1989) or the second most common anatomical site of injury (Ellapen *et al.,* 2013; van Middelkoop *et al.,* 2007; Taunton *et al.,* 2003). The majority of studies found that injuries affecting the lower limb were the most common injuries in runners (Chang *et al.,* 2012; Lun *et al.,* 2004; Taunton *et al.,* 2003; Macera *et al.,* 1992; Wen *et al.,* 1998; Macera *et al.,* 1989).

Previous research has highlighted that the most common diagnoses (associated with running), irrespective of the anatomical region of injury, are medial tibial stress syndrome (MTSS), Achilles tendinopathy, plantar fasciitis (PF), patellofemoral pain syndrome (PFPS), runners' knee or chondromalacia, patella-tracking syndrome, iliotibial band friction syndrome (ITBS), metatarsal stress syndrome and low back pain (e.g. SI syndrome) (Hamstra-Wright and Preish, 2014; Hyde and Gengenbach, 2007; Puckree *et al.,* 2007; Egermann *et al.,* 2003;Renström*et al.,* 2003; Messier *et al.,* 1991; Lysholm and Wiklander, 1987).Taunton *et al.* (2002) showed that when evaluating 2002 runners, PFPS was the most common diagnosis (16.5%), followed by ITBS (8.4%) and PF (7.9%). Lopes *et al.* (2012) showed in a systematic review of running injuries that MTSS, Achilles tendinopathy and PF were the most common diagnoses, with a prevalence of 5.2% - 17.5%. This concurs with the 14.5% attributed to the most common diagnosis (MTSS) by Lysholm and Wiklander (1987).

In a study on running injuries, Malisoux *et al.* (2014) found that the majority of running related injuries affected muscles. Therefore, whether it is trigger points in MFPS or strains, muscular functional deficits will result in biomechanical changes in sports performance leading to pain and dysfunction (Kruse and Lemmen, 2009). Muscle strain is a term that is frequently used to describe muscle injury. However, the definition may be unclear and highly variable (Meuller-Wohlfahrt *et al.,* 2012). Without details on the severity of such muscle injuries, the diagnosis remains slightly vague. The diagnosis of a MFTP is precise and has a clinical presentation of a "discrete, focal, hyperirritable knot located in a tight band of skeletal muscle" (Dommerholt *et al.,* 2006; Chaitow and DeLany, 2000; Travell and Simons, 1999). Regardless of the lack of agreement in the literature with regards to the definition of this term (Meuller-Wohlfahrt *et al.,* 2012); it is important to note the clinical importance to further investigate muscular injuries sustained in runners during marathons. This is also important so as to be able to determine the influence of muscular injuries on future injury, and therefore the usefulness of this current study (Finch and Cook, 2014; Junge *et al.,* 2008).

2.5 Risk factors associated with running injuries

Research has shown that the common causes of running injuries are usually multi-factorial and could be intrinsic (athlete related) or extrinsic (environmental)in nature(Hyde and Gengenbach, 2007; Wen, 2007; Renström *et al.,* 2003; Noakes *et al.,* 2003;James, 1995; van Mechelen, 1992; Powell, 1986).

Meeuwisse (1994) developed a model accounting for all the risk factors involved in sports injuries, and although injury may result after a single inciting event, it is more likely that there is a complex relationship between intrinsic and extrinsic risk factors that result in athletic injury. Meeuwisse (1994) suggests that intrinsic factors predispose an athlete to injury (these may include age, gender, previous history of injury and flexibility). Once the athlete is predisposed, a number of extrinsic factors could act upon them from the environment (weather condition, playing surface and equipment). These extrinsic factors are considered enabling factors, and they can aid in the manifestation of disease in the athlete. Meeuwisse (1994) suggests that both intrinsic and extrinsic risk factors may be present, but are still not significant enough to allow for injury to occur. The final link in this model is an inciting event which is related directly to the injury. Meeuwisse (1994) stresses the importance of health care providers not focusing on this inciting event alone, but rather on the intrinsic and enabling factors in conjunction with the inciting event, when treating athletes.

Meeuwisse (1994) goes on to describe this model in relation to a runner. Running usually stems from overuse injuries (Hamstra-Wright and Preish, 2013; Wen, 2007; Hreljac and Ferber, 2006; *Jakobsen *et al.,* 1989; Lysholm and Wiklander, 1987). Intrinsic risk factors (such as age and biomechanical alignment) generally have a greater causal relationship in overuse injuries like running, predisposing a runner to injury. The use of worn shoes and rough terrain may be the enabling extrinsic factors which make the runner more susceptible to injury. The increased mileage of a marathon is considered the inciting event, and on its own could possibly not cause injury, but when combined with the relationship of the intrinsic and enabling extrinsic factors, could be the "straw that breaks the proverbial camel's back" (Meeuwisse, 1994).

2.5.1 Intrinsic risk factors

Intrinsic risk factors are an important element to understand when considering the treatment and management of injuries in long distance runners. According to Meeuwisse (1994), predisposing factors (intrinsic risk factors) contribute to the injuries seen in runners. The literature relating to intrinsic risk factors is relevant to this literature review as it can provide a better understanding for the possible causes of injuries seen in this study. The literature may also provide a relevant point of comparison when regarding the data generated in this current study (Chapter Four).

2.5.1.1 Demographics

2.5.1.1.1 <u>Age</u>

Age has been shown to be a relative risk factor for runners and athletes in certain studies (Burns *et al.,* 2003; Riddle *et al.,* 2003; Taunton *et al.,* 2002; Wainwright *et al.,* 1995; DeMaio, 1993; Shaibani *et al.,* 1993). Taunton *et al.* (2002) found that age is a relative risk factor for some running related injuries. Being younger than 34 years (average 32.2 years of age) was reported as a risk factor for PFPS in both females and males, whereas younger males were more at risk of developing ITBS, patellar tendinopathy and tibial stress syndrome. Older age was shown to be a relative risk factor in runners with Achilles tendinopathy, plantar fasciitis (41-50 years of age (Riddle *et al.,* 2003); 55.6 years of age Wainwright *et al.,* 1995)) and meniscal injuries (Riddle *et al.,* 2003; Wainwright *et al.,* 1995; Shaibani *et al.,* 1993). DeMaio (1993) suggested that Achilles tendinopathy was more likely to be found in older runners (over 40 years of age) as a result of the increased stiffness / decreased elasticity and energy absorption capacity of load bearing structures in running (Maffulli *et al.,* 2006) that occurs with an increased age (DeMaio, 1993). Taunton *et al.* (2002) suggests that some runners may acquire a running injury relating to the musculoskeletal decay associated with age, which is in line with the study by Taunton *et al.* (2003), who also showed a significant trend for injury with increasing age.

Marti *et al.* (1988) and van Mechelen (1992) suggest that older age is a protective factor against injuries. A possible reason for this could be due to a longer history of previous running (Section 2.5.1.3). These authors also suggest a 'healthy runner effect' whereby runners who remain free of injury continue to run, leading to an older population of injury free runners, as well as runners being able to 'listen to the language of their body' (Macera *et al.,* 1989), knowing when to train and when to seek treatment. This conflicting evidence in age related injuries is also apparent in the literature review by van Gent *et al.* (2007) and the study by Longo *et al.* (2009). It would however seem that runners that do not acquire injuries are less likely to develop low back pain when older, whereas those that have developed injuries over time are more likely to develop low back as they age.

2.5.1.1.2 Age and low back pain

Age related changes to the spinal column may also have a significant impact on running related injuries. In the third decade, moderate adaptive changes occur on the iliac side of the SI joint. There is also an increase in size and number of elevations and depressions within the joint, which may be an adaption to gravitational stress (Brolinson *et al.*, 2003). During the sixth and seventh decade there are even further advancements in these adaptive changes, as well as thickening of the joint capsule and erosions – exposing the subchondral bone – resulting in degenerative joint disease. The capsule also becomes more collagenous and less cellular, thickened and fibrous (Brolinson *et al.,* 2003). This shows that in later stages of life, the SI joint becomes less mobile. Hypomobility of the SI joint is common both in SI dysfunction and low back pain. This indicates that with an increase in age and the adaptive changes of the spine, the SI joint and low back will be affected in the older population of runners. This will ultimately lead to a common diagnosis of SI syndrome and lumbar facet syndrome, as the runner gets older.

These changes (Brolinson *et al.,* 2003) are supported by the theory of three phases of spinal degeneration proposed by Kirkaldy-Willis and Burton (1992). These authors explain that the first phase of degeneration is dysfunction, followed by the unstable phase and lastly stabilization phase. In this context the patient gradually passes from one phase to the next, and if the patient experiences a recurrent episode of trauma, the passage between phases may be facilitated (Kirkaldy-Willis and Burton, 1992). It is reasonable to propose that runners present with altered joint mechanics over time and distance run as well as injuries incurred over their running career (Kaufmann *et al.,* 2000). This facilitates a move from the dysfunctional phase of joints to the unstable phase (usually associated with increased numbers of injuries in the mid-to-later running career) and later the stabilisation phase (towards the end of the runner's career). This latter stabilisation phase is associated with decreased flexibility / increased stiffness leading to a decrease in the spine's ability to effectively transmit shock absorption from the lower extremity (Decker *et al.,* 2003). This could therefore predispose the spine and pelvis to increased forces and thus injuries. This is particularly true as the SI joint serves as a transfer link for force between the lower extremities and the torso (Brolinson *et al.,* 2003).In this context, SI injuries could have an impact on the kinetic chain of the spinal column and could impact the thoracic and cervical spine if not treated correctly (Watkins, 1996).

Lumbar facet syndrome likely includes a large spectrum of facet disorders, including osteoarthritis, capsular ligamentous tears, synovial cysts, articular cartilage injury/degeneration and soft tissue injury of the multifidus muscle (Beresford *et al.,* 2010). Facet pain has been shown to account for 15%-40% of low back pain (Schwarzer *et al.,* 1994(a), Schwarzer *et al.,* 1994(b)). According to Beresford *et al.* (2010), most epidemiological sports research indicates that low back pain accounts for 6%-10% of all injuries, with SI syndrome as a common differential diagnosis for low back pain (Beresford *et al.,* 2010; Bono, 2004). In a study conducted by Jackson *et al.* (1988), seven factors that correlated significantly with facet pain in runners were identified; one of these factors was an older age in the runner.

2.5.1.1.3 <u>Gender</u>

Van Gent *et al.* (2007), Egermann *et al.* (2003) and Taunton *et al.* (2002) show that gender may also be a risk factor when considering certain types of running injuries. The literature indicates that females are more likely to suffer from hip related injuries and males are more likely to suffer from lower limb related injuries (van Gent *et al.,* 2007).It was shown that SI injuries were found to be more common in women (91%) than in men (9%) (Taunton *et al.,* 2002). In addition, Taunton *et al.'s* (2002) study found that PFPS, ITBS and gluteus medius injuries were significantly more prevalent in females, whereas PF, meniscal injuries, patellar tendinopathy, gastrocnemius injuries, adductor injuries and osteoarthritis of the knee were more common in males. MacIntyre *et al.* (1991) also found that females were more likely to develop PFPS than their male counterparts. The studies by Taunton *et al.* (2002) and MacIntyre *et al.* (1991) were conducted prospectively over a two and four year period respectively. The means of data collection were significantly different to this current study, resulting in a difference of chronicity, history of injury and injury profiling.

Brown *et al.* (2014) indicated that women were also at a greater risk of developing thoracic, cervical and shoulder musculoskeletal injuries due to their inappropriate use of breast support (Brown *et al.,* 2014; Chen *et al.,* 2011; White *et al.,* 2009; Travell and Simons, 1999). White *et al.* (2009) indicated that breast support may alter the kinetics and kinematics of running, and hence have an impact on female running performance. Poorly fitted bras may also lead to muscle fatigue (Chen *et al.,* 2011; McGhee and Steele, 2010; Wood *et al.,* 2008; Pechter, 1998) and referral pain to the thorax, neck and shoulder may result (Travell and Simons, 1999).Taunton *et al.* (2002) reported that there was a 51% / 49% ratio of males to females respectively suffering from spinal injuries. However, these spinal injuries are not specific to the thorax and neck and so an adequate literature comparison cannot be made.

2.5.1.1.4 Pain tolerance and gender

When considering the diagnosis of delayed-onset muscle stiffness / soreness (DOMS), a study by Dannecker *et al.* (2003) confirmed the diagnosis by a decrease in pressure threshold and an increase in pain intensity after eccentric contractions. The study showed that females reported lower muscle pain intensity than males when tested for DOMS, but no difference in pressure threshold. This study analysed pain intensity by taking the patients' arm through a full range of active movement 48 hours after eccentric muscle exercises and assessed by means of a visual analogue scale. Pain threshold was measured with a dolorimeter. This finding was supported by Poudevigne *et al.* (2002) and Cook *et al.* (1998) who reported lower muscle pain ratings in female endurance athletes. MacIntyre *et al.* (2000) found that when observing females 24 hours after maximal eccentric contractions, their pain intensity increased, while males reported an increase in pain immediately after their eccentric contractions. Other researchers have found there to be no significant gender difference when observing athletes for DOMS (Rinard *et al.,* 2000; Evans *et al.,* 1998; High *et al.,* 1989; Newham *et al.,* 1987). As pointed out by Dannecker *et al.* (2003), these studies vary in methodology, dependant variables, and different time periods of data collection and so cannot be compared adequately.

2.5.1.1.5 Laxity and gender

It has been hypothesised that oestrogen may have an effect on human connective tissue, decreasing its collagen content and reducing the amount of force required for tendon failure

(Deie *et al.,* 2002), and that at various stages of their menstrual cycle a woman's risk for ACL ruptures increases (Deie *et al.,* 2002; Heitz *et al.,* 1999). There is a significant amount of literature on ACL ruptures and knee ligament laxity prevalence in women (Beynnon *et al.,* 2005; Deie *et al.,* 2002; Heitz *et al.,* 1999), but not on ankle ligament laxity. Beynonn *et al.* (2005) showed that when compared to men, women had greater knee and ankle ligament laxity values (Deie *et al.,* 2002; Heitz *et al.,* 1999). Lax ligaments could possibly result in joint instability, and will ultimately lead to joint sprains.

Decker *et al.* (2003) and Lun *et al.* (2004) found that female runners suffer from ankle and / or foot injuries more so than men (26.8% / 18.8%). Decker *et al.* (2003) suggest that the reason for previous literature showing a greater disposition to knee injuries occurring in women may be as a result of the foot and ankle failing to provide absorption, being injured and / or being unable to compensate, thus leading to increased absorption of ground reactive forces by the knee and thus knee complaints. It is therefore important to consider the impact of previous injury or trauma to the foot and ankle in females. Decker *et al.* (2003) also found that males generally absorb the impact of running in the muscles of the thigh, as compared to females who tend to absorb much of the ground reactive force in the foot and ankle complex (or leg) and its surrounding musculature. This agrees in part with the study by Lun *et al.* (2004), in which male runners were seen with knee (thigh and extensor mechanism dysfunction commonly occur together (Suter *et al.,* 2000)) and lower leg injuries, followed by hip / groin and foot injuries. Often, thigh extensor dysfunction is associated with either lateral knee pain or pain on the upper tibia, where the infrapatellar ligament and the ITB insert.

2.5.1.1.6 Cultural influences and gender

From the literature it can be seen that through the 1980's there is a significant predominance of males either competing in marathons, or presenting in injury profiles when compared to females (Macera *et al.,* 1991; Bovens *et al.,* 1989; Walter *et al.,* 1989; Kretsch *et al.,* 1984; Maughan and Miller, 1983; Nicholl and Williams, 1982(a); Nicholl and Williams, 1982(b)).

Table 2.1: Table depicting the supporting numbers of these above mentioned studies and the context in which there were conducted.

Author	Context	Total Participants	Males	Females
Macera *et al.,* 1991	Habitual runners at a running club in South Carolina, USA	583	485 with 52% reporting an injury	98 with 48% reporting and injury
Bovens *et al.,* 1989	Marathon training program in the Netherlands	115	83	32
Walter *et al.,* 1989;	Cohort study in Ontario of road runners participating in events and followed over 12 months	1281	980 with 26,8% reporting an injury	301 with 23.3% reporting an injury
Kretsch *et al.,* 1984	Participants in the Melbourne 1980 Big M Marathon	5423	5155	268
Maughan and Miller, 1983	Participants of Aberdeen Milk Marathon	497	472	25
Nicholl and Williams, 1982(a)	Participants of the 1982 Sheffield Marathon	4559	4277	282
Nicholl and Williams, 1982(b)	Participants of the 1982 Sheffield Marathon	554	461	93

Bruening (2005) explains that certain cultural and societal norms at the time could influence the gender participation. The majority of the data from the later 1990s and into the 2000s show a similar ratio of males to females, with four studies in which males slightly predominate (Ellapen *et al.,* 2013; Lun *et al.,* 2004; Steinacker *et al.,* 2001; Bennell *et al.,* 1996) and three studies in which females slightly predominate (Taunton *et al.,* 2003; Taunton *et al.,* 2002; Wen *et al.,* 1998). This suggests that females have become increasingly active in marathons in the late 1990s and into the 2000s, with little restriction placed on them by cultural and or societal norms or economic access restrictions (although this is not true of all the studies (Chang *et al.,* 2012; Satterthwaite *et al.,* 1996)).

2.5.1.1.6 <u>Ethnicity</u>

The risk factor of ethnicity and running related injuries has not been well documented in previous literature. Ellapen *et al.* (2013) conducted a study on half-marathon runners in Kwa-Zulu Natal and found the participants to be 50% White, 33% Indian, 12% Black and 6% Coloured. In a study conducted by The Department of Sport and Recreation of South Africa (2005), it was found that the proportions of population groups participating in sport was 36.6% White, 25% Black, 24.4% Indian / other and 15.2% Coloured,

Black runners have been shown to participate predominantly in long distance running (Cribari *et al.,* 2013; Scott *et al.,* 2005; Hamilton, 2000; Coetzer *et al.,* 1993), and have been shown to have certain advantageous factors such as physiological attributes (Hamilton, 2000) and a better running economy (Onywera *et al.,* 2006; Larsen, 2003; Weston *et al.,* 2000; Saltin *et al.,* 1995). This could possibly indicate a greater percentage of Black runners participating in the selected marathon races in this study, and hence a greater percentage of Black runners possibly presenting with injuries at the onsite CTF. However, this may also be an attributed to lack of access to medical services, as poverty and unemployment are major problems in most African countries (Onywera, 2009; Onywera *et al.,* 2006), and the unavailability of close accessible, adequate medical services may pose an issue.

Mahomed (2007) showed that the typical patient presenting to a chiropractor in the private sector in South Africa was White. This could be because the White population understand the scope of chiropractic better than those of another ethnic background, and so are more likely to present as a patient (Korporaal and Talmage, 2008). This trend found in Mahomed's (2007) study could also be underpinned by the fact that chiropractic services are geographically (Rattan, 2007; Gaumer *et al.,* 2002) limited to 'out of pocket' or medical aid carrier contributions (Onywera, 2009; Onywera *et al.,* 2006), and only to those who have a knowledge of the profession (Korporaal and Talmage, 2008; Dreyer, 2004).

2.5.1.2 History of previous injury and/or trauma

A history of previous injury in terms of this study can be defined as any musculoskeletal complaint incurred during competition and / or training which received medical attention regardless of the consequences with regards to absence of competition or training (Junge *et al.,* 2008). A history of previous trauma in terms of this study can be defined as any complaint that resulted from injury, damage, hurt, wound, bruise, cut, laceration, abrasion or contusion that required medical assistance (Oxford Dictionary, 2015). A history of previous injury and / or trauma has been associated with risk of athletic injury (Korkia *et al.,* 1994).

Once an initial injury or trauma takes place, the static and dynamic stabilisers of the joints involved are compromised and a de-afferentation of the joint occurs (Murphy *et al.,* 2003). An example of this would be that when the anterior cruciate ligament (ACL) of the knee is disrupted there is resultant anterior knee laxity ('giving way' of the knee) and deterioration of knee joint proprioception (Beynnon *et al.,* 1999) due to arthrogenic muscle inhibition (Hopkins *et al.,* 2001; Hopkins and Ingersoll, 2000). With a previous injury, there is muscular weakness and imbalance (Suter *et al.,* 2000; Suter *et al.,* 1999), impairment of ligaments, and psychological factors such as fear of re-injury (Vlaeyen and Linton, 2000). All these factors may contribute to the runner possibly engaging altered or compensatory movement patterns, placing themselves at further risk of injury (Beynnon *et al.,* 1999). In a review of literature by Wen *et al.* (2007), it was shown that a number of studies have reported that previous injuries place the athlete at a greater risk of suffering a secondary injury (van Gent *et al.,* 2007; Taunton *et al.,* 2003; Wen *et al.,* 1998; Jones *et al.,* 1993; Macera *et al.,* 1989; Walter *et al.,* 1989; Marti *et al.,* 1988). Hamstra-Wright and Preish (2013) showed a 46% probability that any randomly selected runner from that population would have a history of previous injury. Chang *et al.* (2012) showed that 44.4% of the runners in their study had a history of previous injury, and Lun *et al.* (2004) showed that 29% of the runners in their study had a recurrence of a previous injury. All these studies concur with Taunton *et al.'s* (2002) suggestion that a runner with a history of previous injury may be prone to re-injury due to certain factors. Suggested causes of re-injury include the original cause remaining; the repaired tissue not functioning properly or being less protective; or the injury not healing completely (re-introduction to sport too soon or inadequate rehabilitation) (Hyde and Gengenbach, 2007; Subotnick, 1999; Reid, 1992). This emphasizes the need for establishing previous history of injury. This history taking will also ensure correct treatment and adequate rehabilitation measures when managing running injuries, as a runner with previous history of injury or a pre-existing injury is at higher risk for re-injury. This highlights the importance of this particular study, as an injury profile and management analysis of long distance runners will provide health care practitioners with relevant information on these intrinsic factors and aid in the treatment, management and rehabilitations of such running related injuries.

The question of history of previous injury and trauma were both subjective questions asked by the chiropractic interns to the runners presenting to the onsite CTF. However, Scollen and Scollen (1995) showed that in regions where language barriers exist, it may be difficult to accurately collect data. Other difficulties when considering subjective questionnaire's and data capture is recall bias (Burns *et al.,* 2003) and memory decay (Mouton, 1996). This is further complicated by the runners' interpretation of injury and injury site, despite guidance from the chiropractic intern (Burns *et al.,* 2003). Therefore, a standardised method for reporting history of previous injury is necessary in order to compare the rate and risk of injury (Finch and Mitchell, 2002), and inclusion of such information is vital in injury profiling, as knowing an athletes' injury history can aid in the prevention of future injuries (Gabbe and Finch, 2001).

2.5.1.3 History of running

Being running active for less than 8.5 years was associated with a risk for tibial stress syndrome in both sexes and high weekly hours of activity (more than five hours a week) was reported as a risk factor for PFPS (Taunton, *et al.,* 2002). However, other factors may influence these outcomes, such as training errors or participation in another activity. Van Mechelen (1992) also showed in a literature review that increasing weekly mileage and a lack of running experience are two of the strongest risk factors for running related injuries, which agrees with the literature review by van Gent *et al.* (2007), although this was only found as a risk factor in males in the latter study.

A high weekly running mileage was not found to be a significant contributing factor to running injury in the study by Ellapen *et al.* (2013), and other studies have showed that an increased number of years spent running was negatively associated with running injuries (Macera *et al.,* 1989;Marti *et al.,* 1988). This has been suggested to be due to the 'healthy runner effect' and the ability of runners to 'listen to their body language' as they get older (Section 2.5.1.1).

2.5.1.4 Anthropometry

Anthropometric factors are considered to be an intrinsic risk factor when considering athletic injury (Vleck and Garbutt, 1998). Body Mass Index (BMI) was shown to be a relative risk factor in a study by Taunton *et al.* (2002), and was seen to be related to women having a BMI under 21 kg/m^2 suffering from tibial stress fractures and spinal injuries. This study further suggested that runners with a low BMI and body fat are prone to developing conditions such as amenorrhoea and low oestrogen levels, which could lead to osteoporosis and reduced collagen elasticity, increasing their risk of injury further (Taunton et al., 2002). Marti *et al.* (1988) also suggests a low BMI (<19.5 kg/m^2) and a high BMI (27 kg/m^2 <) runner were equally at (greater) risk of developing running related injuries.

In Taunton *et al.'s* (2002) study, it was also found that women with a weight of below 60kg were at a reduced risk of developing PF, which Taunton *et al.* (2002) suggests could be attributed to the reduced stress / force placed on the foot musculature with a lower body weight. Taunton *et al.* (2002) suggests that taller or heavier runners may arguably be more at risk of developing injuries to ligamentous structures such as the PF, as there are greater forces acting on their bones, muscles, joints and connective tissues.

Women of below average height(less than 157cm) were considered to be at risk of developing PFPS and men with a below average height were found to have a greater risk of developing PF (Taunton *et al.,* 2002). However, van Gent *et al.* (2007) found in his literature review that taller men were associated with a greater risk of developing running injuries (which may have been as a result of a relative increase in weight (although this was not considered as a co-variate in his review)).

However, older studies by Macera *et al.* (1989) and Walter *et al.* (1989) show that there is no significant correlation between height and weight in running injuries.

2.5.1.5 Skill of runner

Calibre can be defined as the quality of someone's level of ability or skill (Oxford Dictionary, 2014) and can be found to be a relative risk factor when considering athletic injury (Villavicencio *et al.,* 2006). The classification of a skilled (or high calibre) runner according to Cavanagh *et al.* (1977) is generally used to classify an athlete on the basis of an average running velocity over a certain distance. Most studies reviewed in this literature review refer to a high calibre runner as one who competes at a provincial, national or international level, and a lower calibre runner as one who competes locally or recreationally (Taunton *et al.,* 2002). Taunton *et al.* (2002) showed that a low calibre female runner is at risk of developing PFPS. Certain authors suggest that runners of a higher calibre run, train and compete at a higher intensity, over a greater weekly distance and have a history of previous injury, thereby predisposing them to further injury (Murphy *et al.,* 2003; Macera *et al.,* 1992; Macera *et al.,* 1989; Marti *et al.,* 1988; Lysholm and Wiklander, 1987). However, Macera *et al.* (1989) also argues that high calibre runners would generally have more running experience and a greater ability to 'listen to the language of their body', which would reduce their risk of developing running injuries. Therefore the literature is conflicting.

2.5.1.6 Biomechanical and structural abnormalities

Abnormal structures can change the biomechanics of the lower extremity, increasing the likelihood of joint sprains and muscle strains (Chang *et al.,*2012; Decker *et al.,* 2011; Gosling *et al.,* 2008;van Gent *et al.,*2007; Puckree *et al.,*2007; van Middelkoop *et al.,*2007; Hreljac and Ferber, 2006; Noakes, 2003; Renström *et al.*, 2003; Taunton *et al*.,2003; Taunton *et al.*,2002; Steinacker *et al*.,2001;Jeffers, 1999;Nobel, 1997; Satterthwaite *et al.,*1996; van Mechelen, 1992; Jakobsen *et al.,* 1989; Macera *et al.,*1989; Walter *et al.,*1989; Bates *et al.,* 1978) and could have an impact on the amount and type of injuries suffered in runners (Section 2.3).

These structural changes and biomechanical factors may include amongst other things: joint laxity, muscle characteristics, postural stability and anatomical alignment (Murphy *et al.,* 2003). These abnormal structures and biomechanical changes may have links to the runner's age, gender (Section 2.5.1.1) or history of previous injury or trauma (Section 2.5.1.2).

Abnormal anatomical alignment has been shown to be a risk factor for lower limb injury in runners (Ellapen *et al.,* 2013; Puckree *et al.,* 2007; van Gent *et al.,* 2007; Taunton *et al.,* 2002). Various factors such as pelvic obliquity (Ellapen *et al.,* 2013), leg length discrepancies (van Gent *et al.,* 2007), knee alignment and Q-angle changes (Ellapen *et al.,* 2013; Puckree *et al.,* 2007) and rear foot position anomalies (Ellapen *et al.,* 2013; Stergiou *et al.*, 1999) have been studied as potential contributors to alignment variations in lower limb injury sufferers (Brantingham *et al.,* 2012; Brantingham *et al.,* 2009).

Taunton *et al.* (2002) records that there were 17% more subjective observations of pes planus in patients with patellar tendinopathy than in runners with meniscal injuries, and 20% more leg length inequalities for gluteus medius injuries than for tibial stress syndrome. Thus

Taunton *et al.* (2002) suggest that there may be associations with limb alignment changes and injuries, although the literature seems contradictory.

It has also been shown that a deviant quadriceps femoris angle (Q-angle) predisposes male runners to injury (Ellapen *et al.,* 2013; Puckree *et al.,* 2007). The Q-angle is an indicator of quadriceps femoris muscle symmetry surrounding the knee, and a large Q-angle results in an increase in both compressive force on the lateral patellar facet, and tensile force on the medial patellar restraint, resulting in musculoskeletal pain and discomfort (Puckree *et al.,* 2007). When the medial patellar restraint undergoes repetitive and prolonged stressing, it reduces its effectiveness of the lateral patellar restraint traction forces, resulting in lateral patellar tracking and an abnormal Q-angle (Puckree *et al.,* 2007). The male runners observed in Puckree *et al.'s* (2007) study were shown to have a greater risk of knee injuries. This was supported by Ellapen *et al.* (2013). Ellapen *et al.* (2013) also showed that female runners who sustained knee injuries had a greater left Q-angle than their non-injured counterparts, suggesting the injured athletes had a stronger vastus lateralis than vastus medialis. Other factors may have also played a part in the results of Ellapen *et al.'s* (2013) study, such as camber of the road. Runners typically run on the side of oncoming traffic and as these studies were conducted in Kwa-Zulu Natal, South Africa, the runners would be running with the traffic on their left side. This could possibly result in more strain on the vastus lateralis (edge of pavement) and an abnormal Q-angle.

Ellapen *et al.'s* (2013) study shows that the tibia and fibula was the second most common anatomical site of injury. Stergiou *et al.* (1999) postulate that excessive pronation of the subtalar joint during running produces torsional forces up the lower limb. The ground reactive force (Shamus and Shamus, 2001; Watkins, 1996) transfers to the plantar surface of the foot and changes the rear foot angle, resulting in excessive pronation of the subtalar joint and an increased torsional force in the tibia and fibula. This in turn, is thought to lead to further risk of injuries at these anatomical sites (Ellapen *et al.,* 2013).

Low back and hip injuries were a unique finding in runners in the study by Ellapen *et al.* (2013). This study found that runners suffering from low back pain had a greater hip flexion angle than the uninjured runners, and that female runners suffering from low back or hip injuries had a significant difference in their hip flexion angles than their non-injured counterparts. Ellapen *et al.* (2013) postulated that tight hip flexors may produce a posterior pelvic tilt, resulting in an abnormal relationship between the posterior hip rotators and extensors and the anterior hip rotators and flexors (Norkin and Levangie, 1992).

Furthermore, continuous and prolonged anterior pelvic tilt will lead to a shortened iliopsoas and an elongated gluteus muscle, creating an abnormal asymmetrical relationship that can contribute to hip flexor muscle spasm and hip extensor strain, resulting in dull aching pain (Ellapen *et al.,* 2013).

In the literature review by van Gent *et al.* (2007), it was shown that there was a positive association between lower limb running injuries and lower leg length difference, greater left tubercle-sulcus angle and greater knee varus. However, even with the aforementioned studies showing a relationship between abnormal anatomical alignment and structural abnormalities, there is no apparent agreement in the literature regarding the definition, characterisation or correct means of measurement when considering abnormal alignment, therefore making it an important, but difficult aspect of injury management and prevention.

Thus, there is evidence that seems to suggest that if changes in the physiological, biochemical and biomechanical systems are present, the likelihood for injury increases. It is therefore important for health care professionals to understand these risk factors in order to adequately manage and treat athletes(Finch and Cook, 2014; Junge *et al.,* 2008).

2.5.1.7 Nutrition

Optimal nutritional health should be maintained during long distance races, in the form of drinks with carbohydrates and electrolytes (von Duvillard *et al.,* 2004; Burke, 2001), especially during hot weather. If dehydration and inadequate nutrition supplementation occurs, this could further impact the electrolyte metabolism and its indirect effects on the renal system (see Section 2.5.2.1).

2.5.2 Extrinsic risk factors

2.5.2.1 Training errors and environmental factors

Running terrain has been shown to have an effect on lower extremity injuries and kinematics, in particular the ankle / foot complex (Chang *et al.,* 2012; Lun *et al.,* 2004; Korkia *et al.,* 1994; Macera *et al.,* 1989). Chang *et al.* (2012) found that runners training on synthetic tracks developed ankle pain. Macera *et al.* (1989) showed a higher odds ratio for lower extremity injuries in male runners training on concrete surfaces. Lun *et al.* (2004)

showed that runners training on synthetic tracks have more effective shock absorption when compared to runners who train on concrete surfaces or asphalt roads.

However, Taunton *et al.* (2003) conversely found that running terrain does not play an important role in running injuries, which is supported by the findings by James (1995), who also found no association of hard surface running and increased injury risk after the weekly distance was controlled. It is generally considered that given the right combination of intrinsic and extrinsic factors, running terrain may predispose to injury (Hyde and Gengenbach, 2007). Additionally one needs to consider the impact of the various intrinsic and extrinsic factors unique to individual runners in order to more conclusively determine the role of any one factor (McBean, 2015;Coetzee, 2013; Meeuwisse, 1994).

The marathons selected in this study were all run within the first quarter of the year, all in Kwa-Zulu Natal. The environmental temperature during this time of the year is sub-tropical, hot and humid. It has been suggested that warm weather during marathons will have an effect on runners (Cheuvront and Haymes, 2001). According to Havenith (2001), the metabolic production of heat is 10 times higher during physical activity than at rest. Febbraio *et al.* (1994) tested endurance athletes training in 40 degrees Celsius temperature with 20% humidity compared to athletes training in 20 degrees Celsius with 20% humidity. He found that the athletes in the warmer weather had lower levels of creatine phosphate and higher levels of creatine and ammonia in their muscles post exercise. This means that the runners, particularly those participating in the 42 km and 21 km marathons would have been predisposed to adverse environmental conditions with a resultant increase in the likelihood of dehydration (Paluska, 2005; von Duvillard *et al.*, 2004).The resultant dehydration-mediated changes in blood volume and blood flow would compromise exercise heat loss and increase thermal strain (Cheuvront and Haymes, 2012; von Duvillard *et al.*, 2004). This further impacts electrolyte metabolism and its indirect effects on the renal system (von Duvillard *et al.*, 2004) and then the musculoskeletal system (Bergeron, 2003),causing the runner to present with fine fasciculations in muscles or muscle groups (von Duvillard *et al.*, 2004), which may lead to medical consequences (cerebral, cardiac and renal) if not managed properly (von Duvillard *et al.*, 2004).

In addition, it has been shown that exercising in a fatigued state can result in stress, strain, shear and impact forces within the lower extremity (Dierks *et al.,* 2010). A reduction in body weight due to water loss (by as little as 1%) may also cause undue stress on the cardiovascular system. This in turn could lead to an increase in heart rate, inadequate heat transfer to the skin and the environment, increased plasma volume, and may affect the body's electrolyte balance (von Duvillard *et al.,* 2004). An increased heart rate and changes in the cardiovascular system may have an impact on muscle function and ultimately lead to an increase in muscular type injuries (Paluska, 2005; von Duvillard *et al.,* 2004). This could ultimately lead to an increase in muscular fatigue type conditions in this current study.

Duration of training has been shown to have an association with hip and foot and / or ankle pain (Chang *et al.,* 2012; Vleck and Garbutt, 1998; Massimino *et al.,* 1988), as well as intensity of training(van Middelkoop *et al.,* 2008; Satterthwaite *et al.,* 1999; Manninen and Kallinen, 1996; O'Toole *et al.,* 1989). Chang *et al.* (2012) suggest that a high training duration could overload and fatigue muscles thereby predisposing them to further injury. This argument is also supported by authors suggesting that a high calibre runner is predisposed to running injuries (see Section 2.5.1.5).

2.5.2.2 Shoe type and age

MacIntyre *et al.* (1991) suggest that small changes in shoe construction, such as medial posts or varus wedges may alter the alignment of the skeletal structures and lead to running injuries. In a study by Taunton *et al.* (2003), there were inconclusive results with regards to the age of shoes and the risk of running injuries. In Taunton *et al.'s* (2002) study it was suggested that newer shoes may be a protective factor in lower limb running injuries due to their cushioning and support qualities. However, Taunton *et al.* (2002) also show that newer shoes are a risk factor when considering running related injuries. Taunton *et al.* (2003) suggest that when considering age of running shoes, it is important to take into account history of previous injury, running experience and weekly mileage. In the literature review by van Gent *et al.* (2007), the evidence showed that shoe age of four to six months was a protective factor for men with lower limb injuries, but a risk factor in female runners. This shows that further research is needed to understand the effect of shoe construction, shoe age, inserts and orthotics in running related injuries.

There is much variance in the literature when comparing the aetiology of injuries, the type of injuries and the classification of injuries. This may be related to the incompatibility of terms utilised by different studies at different points in time as well as at different points in the pathogenesis of a condition. Thus the next section will briefly discuss this debate.

2.6 Variability between injury profiles

Mechanism of injury has a varying definition and yet is widely used in medical literature to describe the inciting event of an injury in biomechanical terms (Bahr and Krosshaug, 2005). There are many classification systems for identifying the mechanism of injury in the literature (Bahr and Krosshaug, 2005). The classification system used in this study is a simple one, allowing ease of application and understanding by the clinical staff and athlete respectively, enabling more accurate collection of data (Korporaal, 2002). A simpler system is necessary particularly in regions where language (Scollen and Scollen, 1995) make it almost impossible to accurately collect data. This is based on the National Research Council (US) Committee on Trauma Research (National Research Council,1985) and Bahr and Krosshaug (2005) classifications. The following three mechanisms of injury were utilised in this study: Trauma, Overuse and Idiopathic.

A traumatic injury can be defined as any complaint that resulted from injury, damage, hurt, wound, bruise, cut, laceration, abrasion or contusion that required medical assistance (Oxford Dictionary, 2014). An overuse injury can be defined as an injury of the musculoskeletal system resulting from the combined fatigue effect over a period of time beyond the capabilities of the specific structure that is being stressed (Elliot, 1990; Stanish, 1984). The injury itself results when a large number of repetitive forces act on a structure, resulting in microtrauma, and the combined force over a period of time is greater than that which the structure can handle. It is an injury that occurs without a single identifiable event responsible (Bahr, 2009). These events or actions can be repetitive, like long distance running (Clarsen *et al.,* 2013). Idiopathic is related to or denoting any disease or condition which arises spontaneously or for which the cause is unknown (Oxford Dictionary, 2014).

In the literature review by van Gent *et al.* (2007), it can be seen that there is a varied definition of the term ‘injury’. This lack of a standard definition has resulted in a varied comparison of literature, including injury categories such as fatigue, hydration and headaches (van Gent *et al.,* 2007). This suggests that the term injury is also vague and needs to be defined as a standard for future injury profiles.

According to Scollen and Scollen (1995), it can be expected that in areas where language barriers exist, terms of injury, trauma and clinical impressions (acute, chronic, sub-acute and acute on chronic) may not be distinguished adequately. This, combined with recall bias

(Burns *et al.,* 2003) and memory decay (Mouton, 1996) may lead to misunderstanding, misinterpretation and inadequate data capture (Egermann *et al.,* 2003).

2.7 The role of the health care provider

The role of the health care provider is important when identifying and managing current injuries, preventing re-injury, as well as limiting future injuries (Finch and Cook, 2014; Junge *et al.,* 2008; Finch and Mitchell, 2002; Gabbe and Finch, 2001; Finch *et al.*, 1999). To achieve this, practitioners should have a good understanding of intrinsic and extrinsic risk factors, and how these can be modified by the actions of the athlete and practitioner, the coaches and managers, as well as medical conditions of the athletes and medications (McBean, 2015). From a health care management perspective, risk factors can be further divided into modifiable (strength, balance and flexibility) and non-modifiable factors (gender and age) (van Mechelen *et al.,*1992). It is then important for the health care provider to understand which risk factors could be managed adequately and modified to reduce the risk of further injury. This may best be achieved by a combination of multi-faceted, multi-disciplinary, multi-layered approaches to treating and managing the athlete (McBean, 2015; Bahr and Krosshaug, 2005).It is also important for health care providers to take note of the various measures of injury incidence, including injury prevalence and injury risk (proportion of athletes injured in a given time period), injury rate (number of injuries per unit of exposure time), odds of injury (probability injury will occur divided by probability injury will not occur), injury hazard (instantaneous or mean proportion injured per unit of time) and mean number of playing exposures to injury (Hopkins *et al.,* 2007).

There are four potential domains (Table 2.2) in which risk factors may combine in order to cause an injury to an athlete. The purpose of studies such as this one is to highlight which factors in each of the given domains can be modified by the health care professional in order to reduce injury and prevent the athlete from an inability to compete.

Table 2.2: Classification of risk factors (McBean, 2015)

		Source of injury	
		Internal	External
Factors	Modifiable	Injury risk may be ameliorated to a degree but may not be removed entirely	Injury risk may be reduced significantly
	Non-modifiable	Injury risk is not modifiable at all	Injury risk may be ameliorated to a degree but may not be removed entirely

It can be seen from the discussion above that without adequate information on injury risks and profiles, the health care provider is at a disadvantage when trying to adequately treat and manage runners (World Health Organisation, 2001). With appropriate and immediate access to injury profiles, health care providers will be better equipped and be more effective when dealing with the treatment, management and rehabilitation of runners. These injury profiles may also aid in benefiting future event organisers and managers of these events, allowing better understanding of the types of injuries most affecting these runners, thereby ensuring adequate facilities (hydration and nutritional facilities), as well as appropriate medical care (Finch and Cook, 2014; Junge *et al.,* 2008).

In the context of this current study, it is important to understand the role of the chiropractor and the treatment and scope in which they practice and how it can be related to sports injuries. The following paragraphs provide insight as to why the DUT Chiropractic department make their services available at the onsite CTF at sporting events, in particular, marathon events.

The role of the sports chiropractor has seen significant growth over the past decade (Mootz and McCarthy, 1999), with sports chiropractors being involved in many world leading national and international sports events, such as the Olympics and World Games (Sports Chiropractic, 2013). Whether working with amateur teams or as volunteers in the community, sports chiropractors have a broad diagnostic and therapeutic role (The Chiropractic Report, 2008), which is consistent with their education and general chiropractic practice (Allied Health Professions Act 63 of 1982 as amended).

Diagnostic skills are an important technique taught in the chiropractic profession (Chiropractic Hand Book, 2014). Other manual therapists are not taught diagnostic skills, and this may be what sets the chiropractic profession apart. The anatomy, pathology and treatment of myofascial syndromes are also covered in the chiropractic course in South

Africa (Chiropractic Handbook, 2014) over a period of three years. This includes academic and practical experience in the Chiropractic Day Clinic (Chiropractic Clinic Manual, 2014). This shows that chiropractic is a form of health care in which the chiropractic professionals can holistically diagnose and treat a patient, and are able to refer and triage patients as necessary. Chiropractors therefore play a vital role in managing injuries and conditions associated with athletes in sports teams, at sports events and in multi-disciplinary practices.

The role of a sports chiropractor includes the assessment of injury, the function of the neuromuscular and musculoskeletal systems, diagnosis of injury / conditions manual treatments, the prescription and supervision of exercises, use of physical therapy and electro-modalities, taping, the prescription of orthotics and other supports, advice on nutrition and counselling and education (The Chiropractic Report, 2008; Allied Health Professions Act 63 of 1982 as amended).

Chiropractic treatment of an acute running injury should include protection, rest, ice, compression, elevation and pain relief medication (Hyde and Gengenbach, 2007; Bahr and Maehlum, 2004; Noakes and Granger, 2003;Renström*et al*., 2003; Juhn, 1999; Subotnick, 1991). Treatment for chronic running injuries should include the restoration of the normal kinematic chain by manipulation, mobilising, stretching, strengthening and soft tissue work (Renström, 1993).

The chiropractic manipulation or adjustment can be utilised to treat a wide variety of conditions (Brantingham *et al.,* 2012; Dagenais and Haldeman, 2012; Brantingham *et al.,* 2009; Hurwitz *et al.,* 2002; Giles, 1998) and has been shown to improve spinal stability and can aid in optimal muscle functioning through improved contraction (Conradie, 2013). This modality is the most utilised treatment protocol in the scope of chiropractic, and is what makes chiropractors unique compared to other soft tissue therapists, such as physiotherapists (Julian *et al.,* 2010).

Stretching is a common procedure used to treat numerous conditions and injuries (Renström, 1993).PNF stretching is a procedure that is based on a neuro-physiological concept involving the stretch reflex and involves a contract-relax-antagonist-contract stretch technique (Berry, 2006). Static stretching is a passive technique in which an extreme stretched position is slowly reached and then held, increasing the range of movement but not eliciting the stretch reflex, which would counteract the attempted muscle lengthening (Dictionary of Sport and Exercise Science and Medicine, 2008). Both MacDougall (1999) and Berry (2006) showed that PNF stretching is more clinically effective than static stretching, especially in treating MFTP (MacDougall, 1999) and when treating athletes (Berry, 2006).

Massage is widely utilised in the treatment of soft tissue and has many favourable results (Hyde and Gengenbach, 2007; Chaitow and DeLany, 2000; Travell and Simons, 1999). Massage has been shown to assist with the regulation and movement of fluid in the body, as well as aiding in drainage and restoring of normal muscle function in areas of muscle reactivity (injuries) (Hyde and Gengenbach, 2007; Cheung *et al.,* 2003). Other soft tissue therapies include ischaemic compression and dry needling (Simons *et al.,* 1999).

Pluim *et al.* (2009) shows that athletes have an expectation of the organisers of sporting events to arrange for health care providers to be present at said events. As stated before, Sports Chiropractic is growing rapidly with athletes now more frequently seeking chiropractic treatment for their injuries (Sports Chiropractic, 2013; Dagenais and Haldeman, 2012; Hyde and Gengenbach, 2007;Haldeman*et al.,* 1996). The students at the DUT Chiropractic Clinic provide onsite chiropractic treatment in the form of satellite clinics at selected marathons and sporting events in the greater Kwa-Zulu Natal area.

With regards to treatment and management of a runner, it is vital to identify the cause of injury (e.g. whether it is extrinsic or intrinsic, modifiable or non-modifiable) and correct the cause through offering advice and management. Most literature states that prevention is better than cure in relation to running injuries (Noakes and Granger, 2003; Renström *et al.,* 2003; Andrews *et al.,* 1997; Subotnick, 1991). Due to this current study being a retrospective analysis of CSSA forms of runners presenting to onsite CTFs at marathons, it is difficult to 'manage' a runner in terms of recovery, rehabilitation and their return to sport performance (Hyde and Gengenbach, 2007). This difficulty lies in the fact the chiropractic interns were treating the runners for the one marathon in which they were currently presenting, and had no control over the future injury management of the runner. This again shows the importance of an injury profile in order to educate health care providers on important educational modifiable risk factors. If prevention is better than cure, this study could possibly lead to more chiropractors offering periodic talks at relevant sports clubs to highlight how injuries may come about, thereby limiting the amount of future injuries and aiding in the future management of these runners.

2.8 Conclusion

In conclusion, it can be seen from the literature that there has been a large increase in the participation of marathon running (Noakes and Granger, 2003; Taunton *et al.,* 2002; Glover *et al.,* 1996; Macera, 1992; Macera *et al.,* 1989), and as a result a greater increase in the injuries associated with running (Lavine, 2010; Hreljac and Ferber, 2006; Noakes and Granger, 2003; Renström *et al.,* 1993; Macera, 1992; Macera *et al.,* 1989). These injuries can be intrinsic or extrinsic in nature (Hyde and Gengenbach, 2007; Wen, 2007; Renström *et al.,* 2003; Noakes *et al.,* 2003;James, 1995; van Mechelen, 1992; Powell, 1986) and modifiable or non-modifiable (van Mechelen *et al.,*1992). It can be seen that it is an advantage for health care providers to understand injury risk factors in order to adequately treat and manage an injury (Hopkins *et al.,* 2007; Bahr and Krosshaug, 2005). One way of doing this is by conducting an injury profile (Finch and Cook, 2014;Junge*et al.,* 2008; Finch and Mitchell, 2002; Gabbe and Finch, 2001) as this study aims to do.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter discusses the research methods, materials, data collection and statistical analysis used in this study.

3.2 Study Design

This study was a quantitative, retrospective, descriptive, cohort analysis of data already gathered from selected marathons during 2014. The data was gathered by the Chiropractic Students Sports Association (CSSA) form (Korporaal, 2002) which was obtained from the active runners at these marathons (Appendix A). The questionnaire had already been validated (Korporaal, 2002).

Based on this design, the research was approved by the Faculty of Health Sciences Research and Ethics Committee at the Durban University of Technology (Appendix D). This approval implied that the research complies with the requirements of the Declarations of Belmont, Nuremberg and Helsinki of 1975.

3.3 Population and sample

3.3.1 Population

The study population consisted of all individuals at the selected marathons (Sydenham Marathon, Stella Marathon, Hillcrest Marathon, Pietermaritzburg (PMB) Expo and Helpers Race, PMB Marathon, Umgeni Marathon and Dick King Marathon) who utilised the onsite DUT CTF. There was no discrimination in terms of ethnicity, gender or age.

3.3.2 Sample

All people who presented themselves at the onsite CTF were treated, but for the purposes of this study, one of the exclusion criteria was that participants had to be a runner in that particular marathon, and not just a race official or other member of the public present at the marathon. Marathon runners presented themselves of their own free will to the onsite CTF at the selected marathons throughout eThekwini and uMgungundlovu municipalities. This was a free of charge service run by the DUT Chiropractic Day Clinic and runners were not coerced into being assessed or receiving treatment. After a runner presented himself/herself to the onsite CTF and identified themselves as a runner seeking an assessment and treatment, a DUT chiropractic intern would obtain personal data from the runner and begin to conduct an assessment. Before the chiropractic intern discussed the assessment with the onsite clinician and followed through with the treatment process, the runner was asked if he/she agreed to have their data collected in respect of his/her condition as documented at the event for use in research analysis, without disclosing his/her name or identifying details. If the runner agreed to this, then he/she was asked to sign the CSSA form in respect of this. However, if the runner did not agree to having their data utilised in future research studies, then he/she was still treated for his/her condition without any discrimination, but the data obtained on that CSSA form was excluded from any future studies. Thus, the sample consisted of all marathon runners who presented to the onsite CTF and signed the consent form.

3.4 Data Collection Procedure

3.4.1 Background to the Process and Procedure at the events

Based on an agreement with the DUT Chiropractic Day Clinic at Durban University of Technology and the individual responsible for the proceedings at a certain sporting event, a DUT Chiropractic Treatment Facility is made available to all athletes, managers, medical personnel and general public supporting the event. Marathons are examples of such events.

This CTF normally consists of six to twenty portable chiropractic beds and all the consumables and equipment the chiropractic intern needs in order to treat the presenting runners adequately. When a runner presents to the onsite CTF with a specific complaint, he/she is treated under the scope of practice of a chiropractor, and as defined in Act 63 of the Government Gazette (1982 (as amended)). If the runner's complaint does not fall within the scope of practice of a chiropractor, then he/she is referred to another medical professional for appropriate medical care.

Each onsite CTF at the relevant marathons was available to every marathon runner. There were no limitations or prerequisites to the use or entering the CTF (e.g. payment for use of the facility). Each individual runner presenting voluntarily to the CTF was required to give informed consent to be assessed and treated at the onsite facility. They were also required to complete and sign the CSSA questionnaire (Appendix A). At this point any runner was able to decline signing the CSSA form, thereby disallowing the DUT or its agents to utilise their information for any research related activities. No runner was persuaded to be treated by the chiropractic interns and no runner was coerced into signing the informed consent section of the CSSA form. It was also explained to each runner that the CCSA questionnaire is a tool utilised by the Department of Chiropractic interns to record the runners' treatment, for legal reasons. The intern then took a brief case history and performed a clinical assessment of the runner and presented the case to an onsite clinical supervisor (a qualified chiropractor) for discussion and approval of treatment. The intern then carried out an agreed upon treatment protocol. This procedure was based on the standard practice in the Chiropractic Day Clinic at the DUT Chiropractic Day Clinic (Chiropractic Day Clinic Manual, 2014; Government Gazette, Act 63 of 1982 (as amended)).

The information collected at the DUT CTF was then stored in a locked safe within the Chiropractic Day Clinic's Head Office.

The above procedure occurred at any sporting event, irrespective of whether the data was collected for research purposes or not, as the athlete's data was still required to be kept on record for purposes of the athletes' protection, institutional risk management and as a record that contributes to the clinical experience that the chiropractic intern gains whilst completing their qualification. Therefore this current study retrospectively analysed the clinical data generated through the activities provided by the Chiropractic Day Clinic at particular marathons within the first quarter of 2014.

3.4.2 Measurement Tool

The measurement tool utilised in gathering data at the CTF was the Chiropractic Students Sports Association (CSSA) form (Appendix A) (Korporaal, 2002). This is the standard document used by the DUT chiropractic interns to record athletes' assessment, treatment and management at all onsite satellite CTF's.

3.4.3 Development of the CSSA Form

The CSSA form was developed by Korporaal (2002). This form was utilised as a tool for gathering data at various sports related events. It has subsequently been used in research projects at the DUT, such as those conducted by Murgatroyd (2009); McBean (2015), McAlery (2015) and Da Silva (2015).

The original questionnaire was developed by Korporaal (2002) as follows:

- The CSSA questionnaire was developed by means of both a focus group (Morgan, 1997; Silverman, 1997) and a pilot study. This focus group (which consisted of members of the hockey fraternity, health care providers, researchers and statisticians) allowed for the development of face validity as well as construct validity (Bernard, 2000).This technique allowed for the development of ideas, understanding and insight into the research topic (Greenbaum, 2000; Morgan, 1996). Mouton (1996) showed that the minimum requirement for validity and reliability of a questionnaire can be established through the use of a focus group.
- The CSSA questionnaire then underwent a pilot study (Fink and Kosekoff, 1985), which looked at its suitability for the purposes of collecting data. A pilot study includes two or more individuals who complete the questionnaire as though they were an intended patient at a CTF. These patients critically analysed the questionnaire, bringing forth any type of technical and grammatical errors. The researcher was then required to address the concerns from both the focus group and pilot study, and thus validation was successfully achieved. This resulted in functional changes and adaptations for ease of use, without changing the face and construct validity of the CSSA questionnaire, as obtained in the focus group.
- Thereafter the researcher collected data from 994 runners in her study (Korporaal, 2002). This data was then analysed and subjected to a post study focus group, which consisted mostly of coaches, managers, players and health care providers, who then analysed the results based on the original CSSA questionnaire to determine whether the information was valid, useful and accurate and to see whether the CSSA questionnaire was able to capture the experiences of the hockey fraternity easily and simply. This validated the original construct and face validity and determined the accuracy and effectiveness of the CSSA questionnaire.

- This lead to minor adaptations to the CSSA questionnaire and its final version. The questionnaire was then permitted to be used in the research study (Korporaal, 2002).

The document included an informed consent section, requesting runners to identify if they wish for their information to be utilised for research purposes. The CSSA form also included sections such as patient details, region of complaint, and mechanism of injury, clinical impressions, treatment and continuation of participation. Each CSSA form (Appendix A) (Korporaal, 2002) that was included in this study was signed by the patient, chiropractic intern and clinician.

Questionnaires have frequently been utilised in research processes and are one of the most popular and widely used methods of data collection (Parajuli, 2004). In a retrospective cohort analysis, the questionnaires completed by the runners constitute the data required for future research questionnaires (Annum, 2015).

3.4.4 The Methodology for this Study

Data: CSSA Forms

All data was previously collected as part of standard clinical operations through the DUT Chiropractic Day Clinic (Chiropractic Day Clinic Manual, 2014) and its CTFs at various marathons, prior to this research being approved. This data was then stored in a locked safe within the Chiropractic Day Clinic's Head Office.

Access to the records and extraction of clinical data and data analysis was only conducted once the Institutional Research and Ethics Committee granted approval for access and data analysis based on the clinical records that were previously generated (Appendix D). This meant that the population was not limited to marathon runners only, but to everyone that signed a consent form. However, according to the exclusion criteria (see section 3.5.2.1.2); runners who were not participating marathon runners were not included in this study. Thus, the sample consisted of participating marathon runners only. This can be seen under the 'Position: Athlete (state type), Manager, Medt (Medical), Other' section in Appendix A.

3.5 Sampling

3.5.1 Sample size

The sample size was 689 marathon runners who were active runners (Korporaal, 2015 with 741 CSSA forms collected. A purposive sampling method was used for this study (Mouton, 1996) to include records based on the following inclusion and exclusion criteria.

3.5.2 Sample Allocation and Method

3.5.2.1 Sample Characteristics

3.5.2.1.1 Inclusion criteria

- Only CSSA forms which were signed by the runner, clinician and chiropractic intern.
- Only CSSA forms obtained from Sydenham, Stella, Hillcrest, PMB Expo and Helpers Race, PMB, Umgeni and Dick King Marathons in 2014.These marathons were chosen as they represented geographically widely dispersed events, increasing the likelihood of representation of runners generally, and they represented the largest marathons in their geographic regions.
- Incomplete CSSA forms were included. However, they were coded as such.

3.5.2.1.2 Exclusion criteria

- CSSA forms in which the marathon runner did not give consent to treatment or did not wish for their information to be utilised in any research project, was excluded from this research. This was denoted by a missing signature next to the informed consent section in Appendix A.
- CSSA forms in which it was indicated that the patient was either a race official, organiser, manager, medical professional or any other person that was not a participating marathon runner.
- CSSA forms which had a signature missing, whether that of the runner, chiropractic intern or clinician.

3.5.2.2 Procedure of the research process

The CSSA forms collected were released to the researcher for data extraction and statistical analysis, after the researcher had obtained ethics clearance from IREC (Appendix D). For this study, no personal information was captured from the CSSA form. The analysis comprised only the demographics of the runner, an injury profile, treatment profile and a tracking profile.

Thus, this was a record review of the information captured from the CSSA forms that were previously collected at the various CTFs at marathons that took place in the first quarter of 2014 in the greater eThekwini and uMgungundlovu municipalities.

The data contained the demographics, location and treatment of the injury/ies of the active marathon runners that presented to the onsite DUT CTF. The researcher received permission to analyse and interpret the CSSA forms by the Chiropractic Day Clinic Director at Durban University of Technology (See Appendix B). All records were reviewed for purposes of meeting the inclusion and exclusion criteria (see section 3.5.2.1.1 and 3.5.2.2), as approved by the IREC (Appendix D).

3.5.2.3 Statistical Analysis

SPSS version 22 was used for data analysis. Descriptive analysis was used to summarise injury profiles, using frequency tables and percentages for categorical variables. Where associations between variables were sought, cross tabulations between categorical variables were conducted. For continuous variables, summary statistics such as mean and standard deviation were used. No statistical testing was possible due to large numbers of categories, resulting in many cells with zero or low frequencies and invalidating the chi square test. Cross tabulations were examined qualitatively for percentage distributions. Repeat runners were tracked across more than one marathon and their profiles compared between two marathons using paired McNemar's tests, if there were 4 or less paired categories. A p value <0.05 was considered as statistically significant (Esterhuizen, 2015).

3.5.2.4 Ethical Considerations

IREC approval was sought (Appendix D) before the CTF treatment records and data were released to the researcher.

All CSSA forms with the relevant completed signatures were used in data collection, where personal information was omitted and all relevant data was utilized in a coding format to ensure runner confidentiality. Once the forms were released by the Clinic Director from the Chiropractic Day Clinic's Head Office, all data sheets were stored in a safe, locked cabinet and in a secure environment which allowed the researcher's access to the CSSA forms during data capture. Upon completion of data capture, the sheets were returned to the Chiropractic Day Clinic's Head Office to ensure safe-keeping.

3.6 Summary

This chapter outlined the methodology used in this research process. It described the sampling and statistical methods, as well as the measurement tool, the CSSA form which was utilised to capture all the relevant data of the participating marathon runners. The results and discussions of this study will now be presented in Chapter Four.

CHAPTER FOUR: RESULTS AND DISCUSION OF RESULTS

4.1 Introduction

Chapter Four presents the results and discussion. The results were obtained by extracting data from the Chiropractic Students Sports Association (CSSA) forms (Appendix A) (Korporaal, 2002), which were collected via CTFs at the various marathons throughout eThekwini and uMgungundlovu municipalities during the first quarter of 2014. The marathons included Sydenham Marathon, Stella Marathon, Hillcrest Marathon, Pietermaritzburg (PMB) Expo and Helpers Race[1], PMB Marathon, Umgeni Marathon and Dick King Marathon.

4.2 Review of Objectives

1. The first objective was to determine the demographic characteristics of the runners who presented at the onsite DUT CTF.

2. The second objective was to determine an injury profile of runners who presented as a patient at the onsite DUT CTF in terms of injury prevalence and treatment intervention.

3. The third objective was to determine the treatment profile utilised in the management of the runners who presented as a patient at the onsite DUT CTF.

4. The fourth objective was to determine any associations between selected demographics, injury and treatment profiles.

5. The fifth objective was to track repeat runners that presented to the onsite DUT CTF at each selected marathon and to determine any associations between their initial and repeat injury profile.

[1] Helpers Race: A marathon that is organised for the members of the Carbineers Athletic Club who were unable to participate in the PMB marathon, as a result of them having organised the PMB marathon. The word ‘Helpers’ does not imply that the participants were non-runners.

Due to the size of each of the objectives in this study, it was decided that the results and the discussion of the results be completed in one chapter, but with separate subsections. Therefore objective ones' results will be presented along with their discussion, followed by the results relevant to objective two which is then discussed. This sequence will be followed throughout the chapter, with a conclusion at the end of the chapter summarising the different objectives briefly and highlighting any possible links between them. Thereafter Chapter Five will present the conclusion and recommendations that emanated from this study.

4.3 The Data

The information obtained relating to the objectives will now be discussed in terms of primary and secondary data.

4.3.1 Primary data

The primary data utilized in this research process was gathered based on the information on the Chiropractic Students Sports Association (CSSA) questionnaire (Korporaal, 2002). It was collected through a retrospective, epidemiological procedure and based on the quantitative paradigm (Mouton, 1996). This questionnaire was completed by every runner that presented to the onsite CTF at the selected marathons throughout eThekwini and uMgungundlovu municipalities during the first quarter of 2014. The marathons included Sydenham Marathon, Stella Marathon, Hillcrest Marathon, PMB Expo and Helpers Race, PMB Marathon, Umgeni Marathon and Dick King Marathon.

4.3.2 Secondary data

The secondary data collected for this research was collected through many sources including journal articles, online blogs, websites and articles, books and personal communications with relevant people in the field of sports medicine and long distance running. This data was then utilised to discuss the findings of this study.

4.4 Response Rate Methodological Flow Diagram

Table 4.1 below outlines the collection and analysis of the data utilized in this research study. There were a total of 689 individuals that presented to the onsite DUT CTF at 741 visits (CSSA forms). Most athletes presented at one marathon only (93.2%) but 42 (6.1%) had consultations at 2 marathons and 5 (0.7%) had consultations at 3 marathons. However, all 689 marathon runners were captured as new patients.

Table 4.1: Number of Marathons with Consultations per Person

		Frequency	Percent
Number of Marathons	1	642	93.2%
	2	42	6.1%
	3	5	0.7%
Total		689	100.0

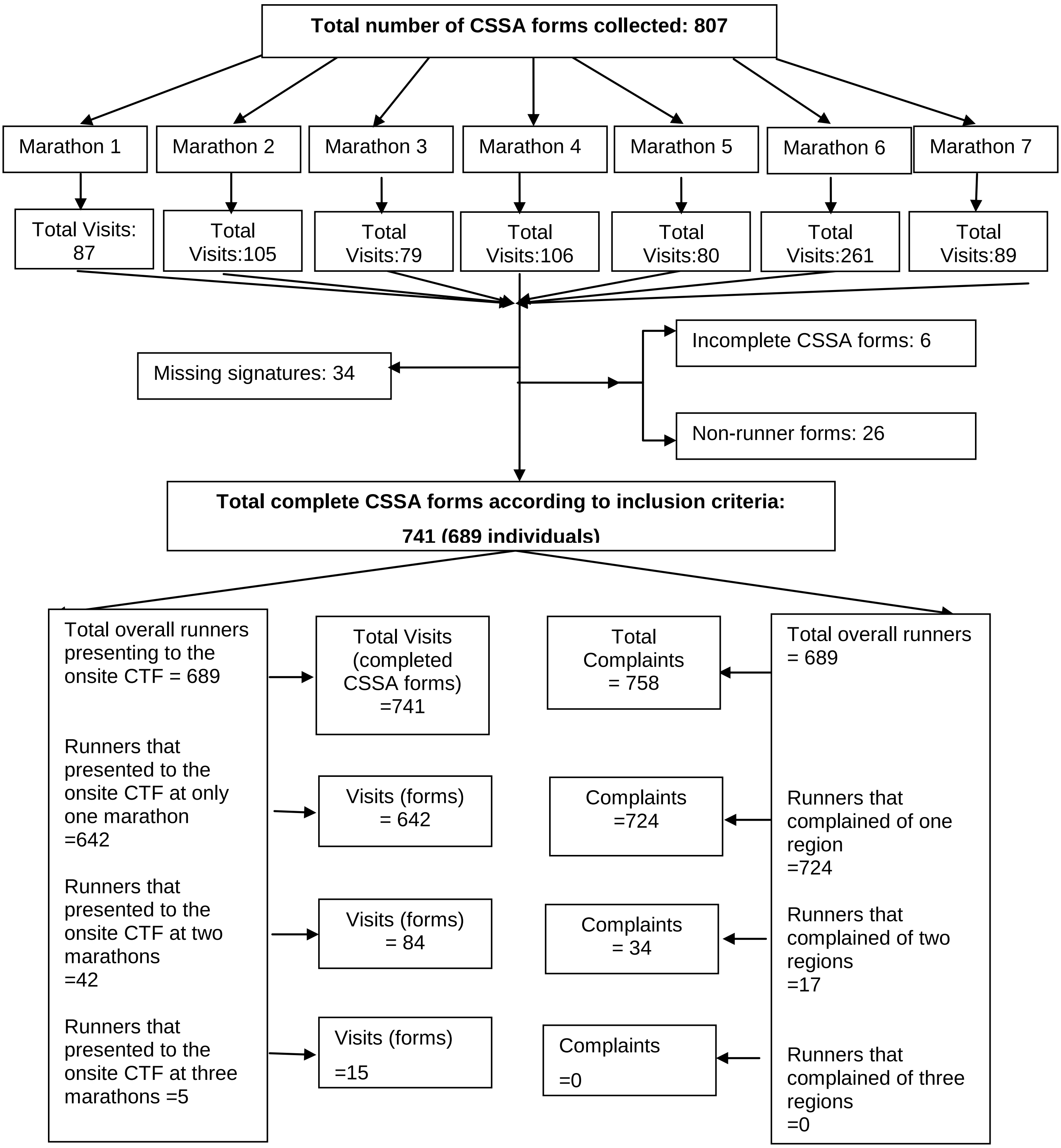

Figure 4.1: Response Rate Methodological Flow Diagram

Table 4.2: Rate of Response per Marathon

Marathon	Marathon Number	Total Data	Missing Signature	Missing Data	Non Athlete	**Total**
Sparksport (Sydenham)	1	87	1	0	1	89
PMB EXPO + Helpers Race	2	67	10	1	1	79
PMB Marathon	3	246	6	3	6	261
Umgeni	4	86	11	0	9	106
Dick King	5	68	4	1	7	80
Hillcrest	6	105	0	0	0	105
Stella	7	82	2	1	2	87
Total		741	34	6	26	807

Table 4.2 shows that the PMB Marathon was the event with the most marathon runners presenting to the onsite CTF (261 CSSA forms). Only 246 CSSA forms were captured due to missing data (three CSSA forms), missing signatures (six CSSA forms) or being a non-athlete (six CSSA forms). The PMB Expo and Helpers Race was the most poorly attended in terms of marathon runners' presenting to the onsite CTF, with only 79 total CSSA forms, of which 10 were missing signatures, one was missing data and one was a non-athlete. This left 67 CSSA forms from which data could be captured. Korporaal (personal communication 2015) noted that there was an estimated 5000 marathon runners at the PMB Marathon compared to 150 marathon runners at the PMB Expo and Helpers Race. This demonstrates how the number of participants in a race affects the relative number of runners that could have visited the onsite CTF. Thus, the 79 forms from the PMB Expo and Helpers Race it shows a response rate of ≈ 52.6%, whereas the 246 forms of the PMB Marathon shows a response rate of ≈ 4.9%.

The response rate of ≈ 52.6% at the PMB Expo and Helpers Race might lead to an over reporting of data. This may be because this race was significantly smaller than some of the other races, with an estimated 150 runners. These runners may have utilised the onsite CTF not because of acute injury, but rather due to convenience, with shorter lines and the possibility of acquiring a free assessment and treatment. On the other hand, the PMB Marathon had a response rate of ≈ 4.9% and could therefore have accounted for some under reporting. As there was an estimate of 5000 runners at this event, the queues for treatment at the onsite CTF may have been long and inconvenient for runners to seek treatment, even those suffering from acute injuries.

As can be seen from the data provided, there may have been cases of over reporting or under reporting. It can be seen from the two examples provided that there were cases of both extremes. It is therefore expected that the variability of over reporting in some marathons and under reporting in other marathons may lead to an average reported norm when considering the selected marathons as a whole. It is therefore anticipated that the results in this study would concur with the average norms reported in the literature, with respect to musculoskeletal injuries in runners.

4.5 Results and Discussion

4.5.1 Results of Objective One

The first objective was to determine the demographic characteristics of the runners who presented at the onsite DUT CTF. The three main demographic characteristics considered in this study were age, gender and ethnic profiles of participation.

4.5.1.1 Age Distribution

Table 4.3: Age Distribution

Mean	39.62
Standard Deviation	10.82
Minimum	11
Maximum	78

Five runners with missing information for age

Table 4.3 indicates that of the 689 CSSA forms collected, 684 were valid, with an average runners' age of 39.6±10.8 years. The oldest marathon runner to present to the onsite CTF was 78 years of age with the youngest being 11 years, participating in the 10km Stella Run. It should be noted that with respect to age, half marathons and full marathons require that an athlete be a minimum 16 years of age for a standard half marathon (Athletics South Africa, 2015). This may produce an unnatural floor / basement effect (Wang *et al*., 2009) with respect to age, as the largest majority of runners would have been 16 years or older in order to legally be allowed to participate. The only two runners that were anomalies and found to be less than 16 years of age (11 years and 14 years of age) are those runners that participated in a 5km event held concurrently with a larger marathon. These runners presented with an 'acute low back' of sudden onset and an acute ankle sprain respectively, with their parents requiring that their children receive immediate medical advice prior to leaving the event premises in order to determine whether further medical assistance would be required for their children.

4.5.1.2 Gender Profile

Table 4.4: Gender Distribution

		Frequency	Valid Percent
Valid	Missing	4	0.6%
	Male	411	59.6%
	Female	274	39.8%
	Total	689	100.0%

Table 4.4 indicates that the majority of the participating marathon runners presenting to the onsite CTF were male (59.6%) and 39.8% were female, with 0.6% as missing data.

4.5.1.3 Ethnic Profile

Figure 4.2: Ethnic Profile of Patients (n=689)

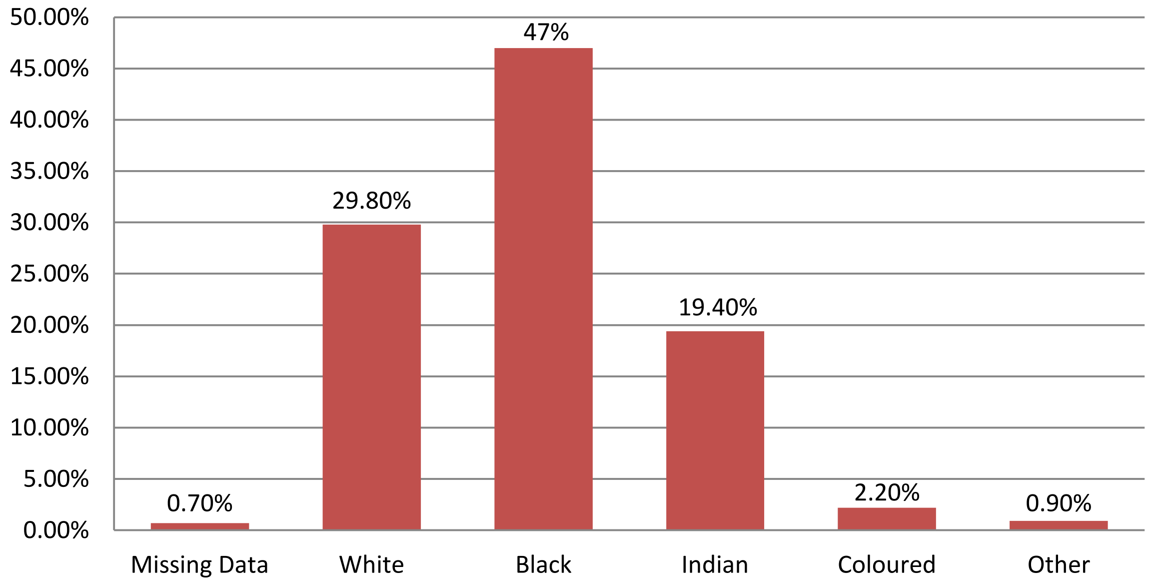

Figure 4.2 indicates that almost half the patients presenting to the CTF were Black (47%), followed by White (29.8%) , Indian (19.4%), Coloured (2.2%) and other (0.9%). 0.7% was recorded as missing data.

4.5.1.4 Summary of Demographics

The demographic profile of the participants that presented to the onsite CTF at the relevant marathons indicated that the average age was 39.6±10.8 years, with the largest proportion of these runners being Black (47%) males (59.6%).

4.5.1.5 Discussion of Objective One

4.5.1.5.1 Response Rate

There were a total of 689 marathon runners that presented to the onsite DUT CTF at the selected marathons throughout eThekwini and uMgungundlovu municipalities with 741 CSSA forms collected.

The literature shows that the following numbers of runners were analysed in their respective studies:

- 200 recreational runners (Ellapen *et al.,* 2013)
- 893 participating marathon runners (Chang *et al.,* 2012)
- 725 runners training for a marathon (van Middelkoop *et al.,* 2007)
- 87 recreational runners(Lun *et al.,*2004)
- 844 recreational runners (Taunton *et al.,*2003)
- 2002 runners presenting with injuries to the Allan McGavin Sports Medicine Centre (AMSMC) (Taunton *et al.,* 2002)
- 42 participating marathon runners (Steinacker *et al.,* 2001)
- 875 participating marathon runners (Satterthwaite *et al.,* 1999)
- 255 runners participating in a training programme for a marathon (Wen *et al.,* 1998)
- 916 participating marathon runners (Satterthwaite *et al.,* 1996)
- 509 runners participating in races (Macera *et al.,*1991)
- 73 runners participating in a training programme for a marathon (Bovens *et al.,* 1989)
- 831 participating half and full marathon runners (Jakobsen *et al.,* 1989)
- 1288 runners participating in short and long distance races (Walter *et al.,* 1989)
- 28 long distance competitive runners (Lysholm and Wiklander, 1987)
- 459 participating marathon runners (Kretsch *et al.,* 1984)
- 449 participating marathon runners (Maughan and Miller, 1983)

- 3462 participating marathon runners (Nicholl and Williams, 1982a)

The average number of runners per study analysed in the literature over the last 33 years is 774.3. This is not dissimilar to this current study, in which 689 runners were analysed for their injuries, providing a total of 741 CSSA forms (equating to 741 visits). In addition, the comparison list above also suggests that there may be inherent differences in the outcomes of each of the above studies based not only on the numbers of runners assessed but also the type of runner (recreational or professional) (Ellapen *et al.,* 2013; Lun *et al.,* 2004; Taunton *et al.,* 2002; Bovens *et al.,* 1989; Jakobsen *et al.,* 1989) and distance run (long distance versus training programme running) (Jakobsen *et al.,* 1989; Walter *et al.,* 1989), versus the location at which the data was taken (onsite at the marathon versus a training centre versus a sports medicine centre) (Chang *et al.,* 2012; Taunton *et al.,* 2002; Bovens *et al.,* 1989; Lysholm and Wiklander, 1987). These factors all impact on whether a runner is likely to sustain an injury, whether the injury is from the running participation, whether the injury is severe enough to report and lastly whether the place at which the data is recorded is convenient for the runner to attend and thus have his/her data recorded.

4.5.1.5.2 Age Distribution

The results of this study show that the average age of the runners presenting to the DUT onsite CTF was 39.6±10.8 years of age. This is in accordance with the literature: 38.8±11.6 years (Chang *et al.,* 2012); 38.0 years (Lun *et al.,* 2004); 38.6±9.8 years (Satterthwaite *et al.,* 1996). However, the following studies showed a younger population and hence an inconsistency with this study: 36.2±4.75 years (Taunton *et al.*, 2002); 34.35±7.3 years (Bovens *et al.,* 1989); 34.6±9.75 years (Jakobsen *et al.,* 1989); 34.5±7.4 years (Lysholm and Wiklander, 1987); 32±8 years (Maughan and Miller, 1983).

The study performed by Taunton *et al.* (2002) shows a younger average age in runners when compared to this study. Taunton *et al.* (2002) extracted data over a two year period from the AMSMC, which is a referral facility situated on the campus of The University of British Columbia. This would provide easy access for collegiate students to present to the AMSMC and could therefore account for the younger average age of injured runners. This is not dissimilar to Lysholm and Wiklander’s (1987) study that used 60 runners from two running clubs who were followed for one month and their injuries reported. This study was conducted on international athletes, as well as top or average district athletes. This could possibly account for the younger age category as younger runners are more likely to be participating internationally and at top level. This study shows that 28 athletes were evaluated for injury, but not all were found with injury. The above however contrasts with Maughan and Miller (1983) who conducted their research in Scotland, Aberdeen on the participants of The Aberdeen Milk Marathon. The data was collected in the form of a questionnaire one week after the marathon and the runners were expected to return these filled out questionnaires. It was suggested that the older generation did not have the time to fill these forms out; as they are more likely to have a family and demanding job, whereas the younger runners would not have had these limitations in filling out the questionnaire. It may also be suggested that one week post-race the reliability of the data captured decreases, as memory decay may occur (Mouton, 1996).

Bovens *et al.* (1989) showed results in which the runners were relatively younger than this current research study. This may be because these volunteers were observed for 18-20 months while training for a marathon and required to keep a 'running diary'. This study was conducted on runners with limited or no running experience, indicating a younger population of runners (Bovens *et al.,* 1989). In the study done by Jakobsen *et al.* (1989) an injury profile was conducted on runners training for the Arhus marathon in 1986. In their study it is shown that the runners sustaining injuries seemed to be younger than the non-injured runners, and this was linked to these runners being men who had lower training tempo and shorter training distances.

Notwithstanding the impact of the research design or its setting, van Gent *et al.* (2007) stated that age may also be a significant protective factor in relation to injury. This was shown in studies by Satterthwaite *et al.,* (1999) and Nicholl and Williams (1982a). The injury profile in the older population of 41.8±10.8 years (Wen *et al.,* 1998), 43.6±12.6 years (Ellapen *et al*., 2013) and 44.55 years (Steinacker *et al.,* 2001), according to van Gent *et al.* (2007) indicates that a greater age is associated with a greater risk for incurring injuries. This assertion is supported by Nicholl and Williams (1982a), Satterthwaite *et al.* (1996) and Taunton *et al.* (2003).

This study shows that the age group of most marathon runners being treated for injuries is between 25-55 years of age, which seems to be consistent with the literature, after taking into account research designs and settings. It would have been interesting to determine whether the sample in this study was a good representation of the overall participants at the seven marathons studied, however the researcher was unable to obtain general participation statistics from the marathon organisers and thus a comparison of age between all runners and the sample in this study could not be completed.

4.5.1.5.3 Gender Profile

The results of this study show that the majority of the participating runners presenting to the onsite CTF were male (59.6%) and 39.8% were female. The remainder (0.6%) was recorded as missing data. This gender representation is similar to the studies conducted by Ellapen *et al.* (2013), Lun *et al.* (2004), Steinacker *et al.* (2001) and Bennell *et al.* (1996).

The following gender proportions were compared to the gender proportions found in this study for males and females respectively:

- 59.4% and 40.5% (Ellapen *et al.,* 2013)
- 93.5% and 6.5% (Chang *et al.,* 2012)
- 50.6% and 49.4% (Lun *et al.,* 2004)
- 24.4% and 75.6% (Taunton *et al.,* 2003)
- 46% and 54% (Taunton *et al.,* 2002)
- 62.1% and 37.9% (Steinacker *et al.,* 2001)
- 42% and 58% (Wen *et al.,* 1998)
- 52.3% and 47.7% (Bennell *et al.,* 1996)
- 80.3% and 19.7% (Satterthwaite *et al.,* 1996)
- 77% and 23% (Macera *et al.,* 1991)
- 79.5% and 20.5% (Bovens *et al.,* 1989)
- 88% and 12% (Jakobsen *et al.,* 1989)
- 76.5% and 23.5% (Walter *et al.,* 1989)
- 75.8% and 24.2% (Kretsch *et al.,* 1984)
- 95% and 5% (Maughan and Miller, 1983)
- 93.8% and 6.2% (Nicholl and Williams, 1982a)
- 83.2% and 16.8% (Nicholl and Williams, 1982b)

It can be seen from the above that from 1982 to 1991, there is a significant predominance of males in the data compared to females (Macera *et al.,* 1991; Bovens *et al.,* 1989; Jakobsen *et al.,* 1989; Walter *et al.,* 1989; Kretsch *et al.,* 1984; Maughan and Miller, 1983; Nicholl and Williams, 1982a; Nicholl and Williams, 1982b). This suggests that there was a greater proportion of males participating in marathons from 1982 to 1991 and that a boom of female participation only came later on in the 1990s. This excludes the studies by Satterthwaite *et al.* (1996) and Chang *et al.* (2012) where there is also a significant difference in male to female comparison. This may be linked to cultural and societal norms (Bruening, 2005) at the time. Bruening(2005) goes further to suggest that there is also an intersection in society between gender and ethnicity that may influence participation; along with access to sport based on economics and societal standing (Burstyn, 1999) in the 1980s and 1990s.The majority of the data from 1996 to 2013 represents the data found in this study, with a similar ratio of males to females, with four studies in which males slightly predominate (Ellapen *et al.,* 2013; Lun *et al.,* 2004; Steinacker *et al.,* 2001; Bennell *et al.,* 1996) and three studies in which females slightly predominate (Taunton *et al.,* 2003; Taunton *et al.,* 2002; Wen *et al.,* 1998). This suggests that females have become increasingly active in marathons in the late 1990s and into the 2000s, with little restriction placed on them by cultural and or societal norms or economic access restrictions (although this is not true of all the studies (Chang *et al.,* 2012)).In addition, the gender statistics in this study seem to be reflective of the ratios of males to females in the South African population generally, according to Statistics South Africa (http://www.statssa.gov.za, 2015)

4.5.1.5.4 Ethnic Distribution

This study shows that the majority of runners presenting to the onsite CTF were Black (47%), followed by White (29.8%), then Indian (19.4%), Coloured (2.2%) and other (0.9%). There was 0.7% recorded as missing data. This is significantly different to the research by Ellapen *et al.* (2013), in which the sample was found to be 50% White, 33% Indian, 12% Black and 6% Coloured. It was also stated by Coetzer *et al.* (1993) that Black athletes currently dominate long-distance running events in South Africa. Further international literature did not include ethnic profiling; therefore it is difficult to compare these results with other studies.

In a study conducted by the Department of Sport and Recreation of South Africa (2005), it was found that the general proportion of population groups participating in sport was 36.6% White, 25% Black, 24.4% Indian/other and 15.2% Coloured, which is dissimilar to the data found in this current research study. Perhaps this could be due to the fact that the 2005 study was performed on individuals performing in sport generally, and was not specific to runners. This current study is performed on runners only, and so a different ethnic profile is not unexpected. The majority of runners presenting to the onsite CTF in this study were Blacks (47%). Cribari *et al.* (2013) found that the top 20 performances of the International Association of Athletics Federation (IAAF) in half marathon and marathon runners were achieved by Black runners. The dominance of African (in particular East African) athletes in long distance running is a well-known trend (Scott *et al.,* 2005; Hamilton, 2000). Certain factors such as advantageous physiological attributes (Hamilton, 2000) and a better running economy (Larson, 2003; Weston *et al.,* 2000; Saltin *et al.,* 1995) have been suggested as the reasons for the success of African runners. There have been some authors (Onywera *et al.,* 2006; Scott *et al.,* 2003) that have postulated the reason that some Blacks dominate in long distance running is that they have had to travel long distances to school every day. These authors have shown that there is an association between the distance travelled to school every day and the performance in long distance running. Anecdotally as suggested by Onywera *et al.* (2006), unique socio-cultural and psychological conditions may be important reasons for African dominance in this sport (Hamilton, 2000; Saltin *et al.,* 1995). Poverty and unemployment are major problems in most African countries (Onywera, 2009; Onywera *et al.,* 2006) and so for some Black runners, competing in long distance races may be their only chance of being successful and making money in order to support their families. Many of the runners may not have access to medical treatment for chronic or acute injuries. In addition, the outcomes of this study may also be linked to the 132% increase in the Black population group between 1996 and 2011 (http://www.statssa.gov.za, 2015) in conjunction with the free of charge onsite CTF treatments, which may have facilitated increased use of the facility by this demographic group.

The study by Mahomed (2007) contrasts with the outcome of this current study, as she showed that the typical patient presenting to a chiropractor in the private sector was White. This could be because the White population group understand the scope of chiropractic better than that of another ethnic background, and so is more likely going to present as a patient (Korporaal and Talmage, 2008). This trend may also be caused by the fact that chiropractic services are geographically (Rattan, 2007; Gaumer *et al.,* 2002) limited to ‘out of pocket’ or medical aid carrier contributions (Onywera, 2009; Onywera *et al.,* 2006), and only to those who have a knowledge of the profession (Korporaal and Talmage, 2008; Dreyer, 2004) (Section 2.5.1.1.6).

4.5.1.6 Summary of objective one

Objective one was to determine the demographic characteristics of the runners who presented to the DUT onsite CTF in terms of age, gender and ethnicity. This study found that the typical runner presenting to the onsite CTF was a Black (47%) male (59.6%) with an average age of 39.6±10.8 years. This is not consistent with the findings in terms of the average patient presenting to a private chiropractor (Mahomed, 2007). However, the findings are consistent with the literature in terms of runners participating in marathons (Ellapen *et al.,* 2013; Chang *et al.,* 2011; Lun *et al.,* 2004; Steinacker *et al.,* 2001; Bennell *et al.,* 1996; Satterthwaite *et al.,* 1996; Coetzer *et al.,* 1993) and consistent with the 2011 data available in terms of the general demographic profile of South Africans (http://www.statssa.gov.za, 2015).

4.5.2 Objective Two

The second objective was to determine an injury profile of the runners who presented as patients at the onsite DUT CTF in terms of injury prevalence and treatment intervention.

4.5.2.1 Injury Profile

4.5.2.1.1 Number of Complaints Reported per Visit

There were 741 CSSA forms analysed and 758 complaints found. Mostly marathon runners presented at each visit with one complaint, but 17 runners had 2 complaints. All 758 complaints were analysed for the injury profile.

4.5.2.1.2 Results and Discussion of Frequency of Injury per Anatomical Site

Table 4.5: Frequency of Injury per Anatomical Site

	Responses		
Treatment	N	Percent of sites	Percent of Cases
Shin and/or Calf	305	21.7%	40.2%
Thigh	303	21.6%	40.0%
Lumbar	226	16.1%	29.8%
Foot and/or Ankle	166	11.8%	21.9%
Knee	127	9.0%	16.8%
Hip	106	7.5%	14.0%
Neck	75	5.3%	9.9%
Thorax	52	3.7%	6.9%
Shoulder	34	2.4%	4.5%
Abdomen	4	0.3%	0.5%
Head	4	0.3%	0.5%
Other	2	0.1%	0.3%
Upper Arm	1	0.1%	0.1%
Wrist and/or Hand	1	0.1%	0.1%
Total	1406	100.0%	185.5%

a. Dichotomy group tabulated at value 1

The total percentage of cases in Table 4.5 indicates that more than one site was reported for many of the complaints. In total there were 1406 reported sites of injury. The most common site of injury was shin and/or calf (40.2% of the cases), followed by thigh (40%) and lumbar spine (29.8%). The least common sites of injury were upper arm (0.1%), wrist and/or hand (0.1%).

This is not consistent with the literature as the findings of previous studies show that the most common structures injured in order of most prevalent to least prevalent are: muscle and fascia, tendon and muscle insertion, joint surfaces, tendons, bursae, bones and nerves (Hyde and Gengenbach, 2007; Renström *et al.,* 2003). This inconsistency may be due to the different manner of reporting injuries in different studies (Meuller-Wohlfahrt *et al.,* 2012). The previous authors often list structures that are injured, as opposed to this current study in which regions of the body are listed as the site of injury. The most common anatomical site of injury is usually the knee (Ellapen *et al.,* 2013; Chang *et al,* 2011; van Gent *et al.,* 2007; Puckree *et al.,* 2007; van Middelkoop *et al.,* 2007; Hreljac and Ferber, 2006; Noakes, 2003; Renström *et al.,* 2003; Taunton *et al.,* 2003; Taunton *et al.,* 2002; Steinacker *et al.,* 2001; Jeffers, 1999; Satterthwaite *et al,* 1996; Nobel, 1997; van Mechelen, 1992; Jakobsen *et al.,* 1989; Macera *et al.,* 1989; Walter *et al.,* 1989;Bates *et al.,* 1978).This is followed by the lower leg, foot, hips, upper leg/thigh and low back (Renström *et al.*, 2003; Ellapen *et al.*, 2002).A small number of studies found the shin and/or calf and lower leg to be the most common anatomical site of injury (van Middelkoop *et al.,* 2007*;* Satterthwaite *et al.,* 1999; Wen *et al.,* 1998; Bovens *et al.,* 1989) and a few studies found the shin and/or calf and lower leg to be the second most common anatomical site of injury (Ellapen *et al.,* 2013; van Middelkoop *et al.,* 2007; Taunton *et al.,* 2003). The majority of the studies found that injuries affecting the lower limb were the most common injuries in runners (Chang *et al.,* 2012; Lun *et al.,* 2004; Taunton *et al.,* 2003; Macera *et al.,* 1991; Wen *et al.,* 1998; Macera *et al.,* 1989), and therefore is consistent with this study.

Some research has shown that running terrain has an impact on the lower extremity kinematics, in particular the ankle/foot complex. Chang *et al.* (2012) found that runners training on synthetic tracks developed ankle pain. Macera *et al.* (1989) also showed a higher odds ratio for lower extremity injuries in male runners training on concrete surfaces. Lun *et al.* (2004) suggested that synthetic tracks have more shock absorption when compared to concrete surfaces or asphalt roads. However, Taunton *et al.* (2003) found that running terrain does not play an important role in running injuries, and James (1995) also found no association between hard surface running and increased injury risk after the weekly distance was controlled. Given the right combination of intrinsic and extrinsic factors, running terrain may predispose to injury (Hyde and Gengenbach, 2007). Additionally one needs to consider the impact of the various intrinsic and extrinsic factors unique to individual runners in order to more conclusively determine the role of any one factor (McBean, 2015; Coetzee, 2013).

Another possible reason for the results in this particular research may be that the scope of chiropractic is unclear to the vast majority of participants presenting to the onsite CTF (Black males (see Section 4.5.4.1.4)). This population group may misunderstand that chiropractors are spinal and joint specialists, and instead may be presenting to the onsite CTF with muscle aches and pains, requesting soft tissue manipulation and a 'massage' after their marathon. By contrast the runners may be presenting to the onsite CTF because they know what a chiropractor is and they understand the benefits of a chiropractic manipulation post-race, or they could be presenting to the CTF purely because it is a tent providing treatment for their aches and pains, regardless of what type of medical professional is providing this treatment. It is therefore unlikely that the provision of chiropractic care specifically would have influenced the outcome of the anatomical sites of injury presenting in this study, as the participating runners are likely to have balanced out between those that came to the facility seeking specific chiropractic care versus those that did not know what chiropractic care entailed.

4.5.2.1.3 Results and Discussion of Frequency of Injury per Diagnosis

Table 4.6: Frequency of Injury Per Diagnosis

	Count	Column N%
Muscle Strain	176	23.2%
SI Syndrome	162	21.4%
Myofascial Pain Syndrome	99	13.1%
Joint Sprain	66	8.7%
DOMS	65	8.6%
Lumbar Facet Syndrome	42	5.5%
Iliotibial Band Syndrome	30	4.0%
Cervical Facet Syndrome	28	3.7%
Thoracic Facet Syndrome	28	3.7%
Tendinitis	26	3.4%
Tendinopathy	12	1.6%
Patellofemoral Pain Syndrome	6	0.8%
Plantar Fasciitis	6	0.8%
Medial Tibial Stress Syndrome	5	0.7%
Missing Data	2	0.3%
Vascular Claudication	2	0.3%
Abrasion	1	0.1%
Contusion	1	0.1%
Metatarsalgia	1	0.1%
Total	758	100.0%

Table 4.6 indicates that the most common diagnosis for the presenting injuries was muscle strain (23.2%), followed by SI Syndrome (21.4%). Abrasion (0.1%), contusions (0.1%) and metatarsalgia (0.1%) were all equal as least common diagnoses.

The results of this study show that muscle strain (23.2%) is the most common diagnosis made in the evaluation of the runners presenting to the onsite CTF, followed by SI Syndrome (21.4%).In a study on running injuries, Malisoux *et al.* (2014) found that the majority of running related injuries affected muscles. However, previous research has highlighted that the most common diagnoses (associated with running), irrespective of the anatomical region of injury, are medial tibial stress syndrome (MTSS), Achilles tendinopathy, plantar fasciitis (PF), patellofemoral pain syndrome (PFPS), runners' knee or chondromalacia, patella-tracking syndrome, iliotibial band friction syndrome (ITBS), metatarsal stress syndrome and low back pain (e.g. SI syndrome) (Hamstra-Wright and Preish, 2014; Hyde and Gengenbach, 2007; Egermann *et al.,* 2003; Renström *et al.,* 2003; Messier *et al.,* 1991; Lysholm and Wiklander, 1987).Taunton *et al.*(2002) showed on evaluating 2002 runners, that PFPS was the most common diagnosis (16.5%), followed by ITBS (8.4%) and PF (7.9%). Lopes *et al,* (2012) showed in a systematic review of running injuries, that MTSS, Achilles tendinopathy and PF were the most common diagnoses with a prevalence of 5.2% - 17.5%. MTSS (14.5%) was found to be the most common diagnosis by Lysholm and Wiklander (1987).

Coetzee (2013) suggested that any repetitive motion required by the body for long periods of time may lead to fatigue and musculoskeletal pain. This may be a possible reason for the vast majority of diagnoses being made as muscular strains at the selected marathons in 2014 in this study. In due course fatigue may cause the alteration of muscle recruitment patterns, which can modify the distribution of forces across soft tissues related to a joint (Murphy *et al.,* 2003). This, along with the knowledge of myofascial trigger points (MFTP) and muscle anatomy of the senior interns at the DUT onsite CTF may have resulted in the high frequency of muscle strains and MFPS diagnoses (13.1%) in this study. Muscle strain is a term that is frequently used to describe muscle injury. However, Meuller-Wohlfahrt *et al.'s* (2012) study showed that the term 'strain' showed the most inconsistencies with regards to variability between practitioners. This may have resulted in other studies diagnosing a 'muscle strain' as something else (e.g. muscle tear). Without details on the severity of such muscle injuries, the diagnosis remains slightly vague. This in turn could lead to discrepancies in the diagnoses of such injuries and should be taken into consideration when analysing this research. The diagnosis of a MFTP is precise and has a clinical presentation of a "discrete, focal, hyperirritable knot located in a tight band of skeletal muscle" (Dommerholt *et al.,* 2006; Chaitow and DeLany, 2002; Travell and Simon's, 1999). In a study on running injuries, Malisoux *et al.* (2014) found that the majority of running related injuries affected muscles. Therefore, whether it be trigger points or strains, muscular functional deficits will result in biomechanical changes in sports performance leading to pain and dysfunction (Kruse and Lemmen, 2009). This could provide another link between the two most common anatomical sites of injury (shin and / or calf and thigh) having a large muscular bulk and the resultant high diagnosis of muscle strains. This shows that it is of clinical importance to further investigate muscular injuries sustained in runners during marathons and their influence on future injury. In contrast, muscle strains may be over diagnosed in this current study. A muscle strain could be classified as an 'umbrella term' to describe an overuse 'mechanism of injury' (Meuller-Wohlfahrt *et al.,* 2012) and may have been over utilised when diagnosing runners due to ease of diagnosis.

The marathons selected in this study were all within the first quarter of the year, all run in Kwa-Zulu Natal. The environmental temperature during this time of the year is sub-tropical, hot and humid. It has been suggested that warm weather during marathons will have an effect on runners (Cheuvront and Haymes, 2001). According to Havenith (2000), the metabolic production of heat is 10 times higher during physical activity than at rest. Febbraio *et al.* (1994) tested endurance athletes training in 40 degrees Celsius temperature with 20% humidity compared to athletes training in 20 degrees Celsius with 20% humidity. He found that the athletes in the warmer weather had lower levels of creatine phosphate and higher levels of creatine and ammonia in their muscles post exercise. This means that the runners, particularly those participating in the 42km and 21 km marathons would have been predisposed to adverse environmental conditions with a resultant increase in the likelihood of dehydration (Paluska, 2005; von Duvillard *et al.*, 2004), with the result that dehydration-mediated changes in blood volume and blood flow would compromise exercise heat loss and increase thermal strain (Cheuvront and Haymes, 2012; von Duvillard *et al.*, 2004). This further impacts electrolyte metabolism and its indirect effects on the renal system (von Duvillard *et al.*, 2004) and then the musculoskeletal system (Bergeron, 2003), causing the runner to present with fine fasciculation's in muscles or muscle groups (von Duvillard *et al.*, 2004), which may lead to medical consequences (cerebral, cardiac and renal) if not managed properly (von Duvillard *et al.*, 2004).

A reduction in body weight due to water loss (by as little as 1%) may cause undue stress on the cardiovascular system. This in turn could lead to an increase in heart rate, inadequate heat transfer to the skin and the environment, increased plasma volume, and may affect the body's electrolyte balance (von Duvillard *et al.,* 2004). An increased heart rate and changes in the cardiovascular system may have an impact on muscle dysfunction and ultimately lead to an increase in muscular type injuries (Paluska, 2005; von Duvillard *et al.,* 2004). This could have been the reason why the diagnoses of muscle strains and MFTP's are so prevalent in this study. Runners may not have been adequately prepared in terms of hydration for the marathons in which they were participating, or the marathon organisers themselves may not have had the correct number of hydration facilities in order to accommodate the amount of runners participating in the events.

In addition, it has been shown that exercising in a fatigued state can result in stress, strain, shear and impact forces within the lower extremity (Dierks *et al.,* 2010). This shows that compensations may occur when an athlete is fatigued (Dierks *et al.,* 2010). The pelvis and the SI joint are a link between the lower extremity and the trunk (Brolinson *et al.,* 2003), therefore, it can be suggested that relevant compensations of lower leg fatigue may include SI syndrome. This may be a reason for the high diagnosis of SI syndromes in this current study. Alternatively, an original diagnosis of SI syndrome may have referral pain into the thigh and occasionally the lower leg (Cohen, 2005). Therefore, a runner with an SI syndrome may come in complaining of thigh and / or leg pain. A chiropractic intern is trained to assess the biomechanical chain (DUT Chiropractic Handbook, 2014), and will look to the SI joint and pelvis for possible issues. Therefore, differences in diagnoses and anatomical region of complaint may occur. This is found in the results of this current study showing that the shin and / or calf and thigh are the top two most common anatomical sites of injury, with the second most common diagnosis being SI syndrome.

4.5.2.1.4 Results and Discussion of Mechanism of Injury

Table 4.7: Mechanism of Injury

	Count	Column N %
Overuse	725	95.6%
Trauma	22	2.9%
Idiopathic	8	1.1%
Missing Data	3	0.4%
Total	758	100.0%

Table 4.7 shows that the most common mechanism of injury is overuse (95.6%), followed by trauma (2.9%), and then idiopathic (0.4%).

Mechanism of injury has a varying definition and yet is widely used in medical literature to describe the inciting event of an injury in biomechanical terms (Bahr and Krosshaug, 2005). There are many classification systems for identifying the mechanism of injury in the literature (Bahr and Krosshaug, 2005). The classification system used in this study is a simple one, allowing ease of application and understanding by the clinical staff and athlete alike, enabling more accurate collection of data (Korporaal, 2002). A simpler system is necessary particularly in regions where language (Scollen and Scollen, 1995) makes it almost impossible to accurately collect data. This is based on the National Research Council (US) Committee on Trauma Research (National Research Council [US], 1985) and Bahr and Krosshaug (2005) classifications. The following three mechanisms of injury were utilised in this study: Trauma, Overuse and Idiopathic.

An overuse injury can be defined as an injury of the musculoskeletal system resulting from the combined fatigue effect over a period of time beyond the capabilities of the specific structure that is being stressed (Elliot, 1990; Stanish, 1984). The injury itself results when a large number of repetitive forces act on a structure, resulting in micro trauma. It is an injury that occurs without a single identifiable event responsible (Bahr, 2009). These events or actions can be repetitive like long distance running (Clarsen *et al.,* 2012).

The most common mechanism of injury in this research was overuse (95.6%). This is consistent with the literature in which Hreljac and Ferber (2006) show in a review article on predicting injury risk in running that 27-70% of recreational and competitive runners are diagnosed with an overuse injury. Hamstra-Wright and Preish (2014) also showed in their evidence based report on common running related injuries that overuse is the most common mechanism of injury, along with Wen (2007),Jakobsen *et al.* (1989) and Lysholm and Wiklander (1987).

4.5.2.1.5 Results and Discussion of History of Previous Injury and/or Trauma and Clinical Impression

Table 4.8:History of Previous Injury and/or Trauma and Clinical Impression

		Count	Column N%
History of Previous Injury	No	558	73.6%
	Yes	197	26.0%
	Missing Data	3	0.4%
	Total	758	100.0%
History of Previous Trauma	No	677	89.3%
	Yes	78	10.3%
	Missing Data	3	0.4%
	Total	758	100.0%
Clinical Impression	Acute	497	65.6%
	Chronic	217	28.6%
	Acute on Chronic	20	2.6%
	Sub-Acute	14	1.8%
	Missing Data	10	1.3%
	Total	758	100.0%

Table 4.8 indicates that 73.6% of the participants that presented to the onsite CTF had no history of previous injury, while 26% did have a history of previous injury. There were 89.3% patient participants

that had a history of previous trauma, while 10.3% did not. Of the 758 complaints, 65.6% were acute, 28.6% were chronic, 2.6 % were acute on chronic and 1.8% was sub-acute.

The results show that 73.6% of the sample reported no history of previous injury and 89.3% reported no history of previous trauma. This is incongruent to the research in which Hamstra-Wright and Preish (2014) showed that there was a 46% probability that any randomly selected runner from that population would have a history of previous injury. Chang *et al.* (2012) showed that 44.4% of the runners in that study had a history of previous injury, and Lun *et al.* (2004) showed that 29% of the runners in the study had a recurrence of injury. In assessing risk factors for overuse injuries in runners, Wen *et al.* (2007) found that a number of studies have reported previous injury as a risk factor for future injuries (Wen *et al.,* 1998; Wen *et al.,* 1997; Jones *et al.,* 1993; Macera *et al.,* 1989; Walter *et al.,* 1989; Marti *et al.,* 1988).

A history of previous injury can be defined as any musculoskeletal complaint incurred during competition and/or training which received medical attention regardless of the consequences with regards to absence of competition or training (Junge *et al.,* 2008). A history of previous trauma can be defined as any complaint that resulted from injury, damage, hurt, wound, bruise, cut, laceration, abrasion or contusion that required medical assistance (Oxford Dictionary, 2014). These were both subjective questions asked by the interns of the runners presenting to the onsite CTF. Scollen and Scollen (1995) show that in regions where language barriers exist, it may be difficult to accurately collect data. The majority of the participants presenting to the onsite CTF were Blacks (47%), and so may have misunderstood the question, misinterpreting and interchanging injury and trauma and hence leading to the dissimilarity in literature.

Here it should be noted that acute is referring to the duration of the condition. The Free Medical Dictionary(2013) states that the definition of ‘acute’ is of abrupt onset, usually describing a condition (disease, disorder or injury) of short duration, rapidly progressive, and in need of urgent care. ‘Acute’ is a measure of the time scale of a disease and is in contrast to ‘sub-acute’ and ‘chronic.’ ‘Sub-acute’ indicates longer duration or less rapid change. ‘Chronic’ indicates indefinite duration or virtually no change (The Free Medical Dictionary, 2013). The data shows that 65.6% of the injuries reported here were acute and 28.6% were chronic. In the previous section however, (4.5.2.1.4 – Mechanism of Injury), it was shown that the majority of injuries were overuse injuries (95.6%). In sports medical literature, overuse injuries are viewed as chronic injuries (Clarsen *et al.,* 2012), which is in contradiction to the results found here in this study. Due to these discrepancies in terms, the acute complaints could perhaps be termed acute on chronic in nature, as this would explain an acute flair up of an already existing chronic, overuse injury. However, as stated above, 73.6% of the sample reported no history of previous injury! This could possibly be due to the fact that these runners were suffering from sub-clinical complaints (those complaints that do not require time off or modification of training) and did not perceive these ‘niggles’ as reportable injuries. Another possible reason for the contradiction found in this study could be that the presenting runners may have feared being excluded from treatment if they had reported a previous injury and / or trauma. This would account for the high percentage of no history of previous injury and / or trauma. The manner of the chiropractic interns’ questioning may have also lead to a discrepancy of high acute injuries and yet high overuse injuries (Jamison, 2001).

4.5.2.1.6 Results and Discussion of Ability to Continue Participation

Table 4.9: Able to Continue Participation

	Count	Column N%
Able to Continue Participation	718	94.7%
Unable to Continue Participation	32	4.2%
Missing Data	8	1.1%
Total	758	100.0%

Table 4.9 shows that of the 758 complaints, 718 (94.7%) were found to have injuries that allowed them to continue participation (‘continued participation’ with regards to this research indicates the runners’ ability to complete the race they are currently particpating in).

Of the 32 cases that were reported in which the runners did not continue participation, diagnoses included: 10muscle strains, five MFPS, four ITBS, four joint sprains, three SI syndrome, two tendinitis and one lumbar facet syndorme, metatarsalgia, PFPS and DOMS each.

The results from this study are similar to the results of a study conductedby van Middelkoop *et al.*(2007), in which runners from the Rotterdam marathon were observed and the incidence and prevalence of lower extremity injuries were studied and documented. The study conductedby van Middelkoop *et al.*(2007) showed that 94.6% of runners were able to continue participation in the marathon and 5.4% did not finish.

It is important to acknowledge here that the runners with conditions severe enough to warrant their discontinuation of participation may have been immediately transported from the road race via emergency personnel at the event. These runners may have gone straight to hospital and therefore not even presented to the onsite CTF. Alternatively, those runners with severe conditions presenting to the onsite CTF may have been referred directly to alternative medical facilities without completing any part of the CSSA form. This should be considered when analysing the total amount of runners who were unable to continue participation in their respective marathons.

4.5.2.2 Summary and Discussionof Injury Profile

There were 741 visits made to the onsite CTF at the selected marathons throughout eThekwini and uMgungundlovu municipalities during the first quarter of 2014. Of these 741 visits, only 17 participants presented with two complaints, making a total of 758 complaints. Of these 758 complaints, 95.6% presented with overuse injuries, 73.6% had no history of previous injury and 89.3% had no history of previous trauma. There were 65.6% patients diagnosed with acute injuries and 94.7% were able to continue participation. The most common anatomical site of injury was the shin and calf (21.7%), followed by the thigh (21.6%) and the lumbar region (16.1%). The most common diagnosis according to the chiropractic interns was muscle strain (23.2%), followed by SI syndrome (21.4%).

Based on these findings, certain treatments should predominate. Muscular strain was documented as the most common diagnosis along with many other muscular complaints. Massage was used due to its effects in assisting with regulation and movement of fluid in the body, and drainage and restoring normal muscle function (Hyde and Gengenbach, 2007; Cheung *et al.,* 2003). Other soft tissue therapy, such as ischaemic compression, dry needling and stretching, are well accepted as treatment protocols for soft tissue injury (Simons *et al.,* 1999) and were used.

SI syndrome was also a common diagnosis (23.2%). This is a common condition seen in private chiropractic practice (Dagenais and Haldeman, 2012). A chiropractic intern is trained to assess the biomechanical chain (DUT Chiropractic Handbook, 2014). As long distance running has an effect on the lower limb mechanics (Dierks *et al.,* 2010), the interns will look to the SI joint, pelvis and other surrounding regions for possible secondary issues. Therefore, differences in diagnoses and anatomical region of complaint may occur. The chiropractic intern would manipulate the fixated joints in order to facilitate the treatment of that specific area, as well as the original area of complaint. This indicates that manipulation is a unique and frequent mode of treatment for chiropractors, and it is the main modality that sets chiropractors apart from other manual therapists, who are traditionally the therapists of choice for athletes seeking treatment (Julian *et al.,* 2010). The chiropractic adjustment or manipulation has been shown to improve spinal stability and can aid in optimal muscle functioning through improved contraction (Conradie, 2014) and can be utilised for conditions such as SI syndrome (Dagenais and Haldeman, 2012; Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Hurwitz *et al.,* 2002; Giles, 1998) as it was on runners in this study.

4.5.3 Objective Three

The third objective was to determine the treatment profile utilised in the management of each runner who presented as a patient at the onsite DUT Chiropractic Treatment Facilities.

4.5.3.1 Treatment Profile

Table 4.10: Frequency of Treatment Protocols Utilised

Treatment	Responses N	Responses Percent	Percent of Cases
Manipulation	624	33.3%	82.8%
Massage	431	23.0%	57.2%
PNF Stretch	253	13.5%	33.6%
Needle	198	10.6%	26.3%
Ischaemic Compression	129	6.9%	17.1%
Static Stretch	114	6.1%	15.1%
Mobilisation	83	4.4%	11.0%
Cross frictions	19	1.0%	2.5%
Ice	11	0.6%	1.5%
Strapping	5	0.3%	0.7%
Other	3	0.2%	0.4%
Referral	3	0.2%	0.4%
Rest	2	0.1%	0.3%
Total	1875	100.0%	248.7%

a. Dichotomy group tabulated at value 1

Table 4.10 shows that of the 758 complaints, 1875 treatments were delivered. The most common treatment was manipulation (82.8%) followed by massage (57.2%) and PNF stretching (33.6%).

4.5.3.2 Cross Tabulations of Diagnosis versus Treatment

Table 4.11: Frequency of Treatment per Diagnosis

Diagnosis	Treatment: Rest	Ice	Manipulation	Mobilisation	Massage	PNF Stretch	Static Stretch	Ischaemic Comp	Strapping	Needle	Cross frictions	Other	Referral	**Total**
Muscle Strain	0	1	139	17	119	71	39	25	0	43	0	1	0	176
SI Syndrome	0	1	156	10	82	47	15	36	0	34	0	0	0	160
Myofascial Pain Syndrome	0	1	78	10	60	34	17	21	0	37	0	0	0	99
Joint Sprain	1	3	54	16	23	15	11	4	3	16	2	0	1	65
DOMS	0	0	40	3	47	31	7	11	0	16	1	0	0	64
Lumbar Facet Syndrome	0	0	37	6	26	8	5	8	0	8	1	0	0	42
Iliotibial Band Syndrome	0	0	24	5	14	14	5	7	0	10	1	0	0	30
Cervical Facet Syndrome	0	0	28	4	11	9	2	4	0	10	0	1	0	28
Thoracic Facet Syndrome	0	0	28	2	17	3	5	2	0	6	0	0	0	28
Tendinitis	0	1	14	7	15	13	4	5	1	10	5	1	0	26
Tendinopathy	0	0	9	1	7	1	0	2	0	2	8	0	0	12
Patellofemoral Pain Syndrome	0	0	4	2	2	2	1	1	0	3	0	0	0	6
Plantar Fasciitis	0	1	5	0	2	2	1	1	0	2	0	0	0	6
Medial Tibial Stress Syndrome	0	1	4	0	3	1	2	2	0	1	1	0	0	5
Missing Diagnoses	0	0	2	0	1	0	0	0	0	0	0	0	0	2
Vascular Claudication	1	1	0	0	0	1	0	0	1	0	0	0	2	2
Abrasion	0	1	1	0	0	0	0	0	0	0	0	0	0	1
Contusion	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Metatarsalgia	0	0	1	0	1	1	0	0	0	0	0	0	0	1
Total	2	11	624	83	431	253	114	129	5	198	19	3	3	754

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

Table 4.11 indicates the frequency of treatment per diagnosis. The most common diagnosis was muscle strain, and of the 176 diagnoses of muscle strain, 139 were treated by manipulation (79%), followed by massage (68%). It can be seen from the table above that sometimes there were multiple treatments per diagnosis. The second most common diagnosis was SI Syndrome, which was treated by manipulation in 156 of the 160 cases (98%), followed by massage in 82 of the cases (51%). Myofascial pain syndrome was the third most common diagnosis, with manipulation being the primary treatment in 78 of the 99 cases (79%), followed again by massage in 60 of the cases (61%).

4.5.3.3 Summary and Discussionof Treatment Profile

Manipulation was used in 82.8% of cases, massage was used in 57.2% of cases and PNF stretching was used in 33.6% of cases. Rest was prescribed least commonly of all in 0.3% of cases. Manipulation was used to treat 97.5% of SI syndrome, 79% of muscle strains and 78.8% of myofascial pain syndrome. Massage was used to treat 67.6% of muscle strains, 51.3% of SI syndrome and 60.6% of myofascial pain syndrome. PNF stretching was used to treat 40.3% of muscle strains, 34.3% of myofascial pain syndrome and 29.4% of SI syndrome.

As suggested above, manipulation (82.8%) was the most common treatment utilised in the management of runners in this study. Possible reasons for the use of manipulation in the treatment of such sporting injuries are as follows:

1. It has a reflex relaxation effect on muscles (Leach, 2004; Korr, 1975). This may aid in the treatment of MFPS. MFTP's are bands of hyperirritable knots located in taut muscles (Travell and Simons, 1999). A reflex relation effect may reduce the tautness in these bands, resulting in a beneficial effect.
2. It has been shown to produce vertebral movement resulting in biomechanical changes (Pickar, 2002). This alteration in biomechanics is thought to correct the previous changes in the abnormal dynamics of the segment being adjusted. These mechanical changes are thought to reduce stress and strain on soft and hard tissues (Triano, 2001). This may have an effect on shifting mechanical loads and reducing the stress on certain common anatomical regions of complaint in this current study.
3. Manipulation has been shown to have an analgesic affect (Wyke, 1968; Melzak and Wall 1965).Pickar (2002) showed that patient's pain threshold increased post adjustment. This is important to consider as the patient's satisfaction has an effect on their ability to heal (Jamison, 2001). An analgesic effect may also aid in the patients' ability to return to play.

These factors show that it is not unexpected that a chiropractic manipulation or adjustment is the most utilised treatment protocol in the scope of chiropractic. It is what makes chiropractors unique compared to other soft tissue therapists, such as physiotherapists (Julian *et al.,* 2010). It can be utilised to treat a wide variety of conditions, both soft tissue and spinal (Dagenais and Haldeman, 2012; Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Hurwitz *et al.,* 2002; Giles, 1998).

Massage therapy was utilised in 57.2% of the cases, which made it the second most utilised treatment modality. According to Sports Medicine Australia (2014), a soft tissue injury is any injury to muscles, tendons, ligaments, fascia, nerves, fibrous tissues, fat, blood vessels and synovial membranes. Taking this into account, the anatomical sites of injury most affected in this study were soft tissue (Table 4.6). It is well documented that massage is widely utilised in the treatment of soft tissue and has many favourable results (Hyde and Gengenbach, 2007; Chaitow and DeLany, 2000).

It is important to note here that massage has been used as an ‘umbrella term’ when considering the context of this study. Massage has been used as a broad application to describe many soft tissue manual therapies in this study, such as Swedish massage, ischaemic compression, cross frictions and Graston technique. It may also be utilised when referring to the application of hot / cold gels such as Voltaren, Arnica Ice, Ice Man and Repel Gel. It is suggested therefore, that in future studies it would be important to distinguish between the different massage techniques. It may even be suggested that the CSSA form be modified in order to include the more specified soft tissue therapies utilised.

PNF stretching was the third most commonly utilised treatment protocol in this study. PNF stretching is a procedure that is based on a neuro-physiological concept involving the stretch reflex and involves a contract-relax-antagonist-contract stretch technique (Berry, 2006).Both MacDougall (1999) and Berry (2006) showed that PNF stretching is more clinically effective than static stretching, especially in treating MFTP (MacDougall, 1999) and when treating athletes (Berry, 2006). This supports the findings found in this study, with PNF being utilised in 33.6% of the cases.

Ice has been shown to be incorporated in the treatment of acute injuries (Hyde and Gengenbach, 2007; Bahr and Maehlum, 2004; Noakes and Granger, 2003; Renström *et al*., 2003; Juhn, 1999; Subotnick, 1991). As there were 65.6% acute cases presented in this current study, it would be logical to assume that ice would be a common treatment modality. This is also true of the high amount of muscular strains (acute area of inflammation) seen in this study. However, it is interesting to note that only 11 cases (0.6%) of presenting runners were treated with ice in this current study. A possible reason for this may be that ice should be applied to an acute inflammatory area for 20 minutes to achieve maximal healing benefits. Under the time constraints at these onsite CTF’s, ice may have been overlooked as a treatment modality in that it required too much treatment time in order to be effective. It may also be considered that the marathons selected for this study were all in the hotter part of the year in Kwa-Zulu Natal. Therefore, ice may be considered an impractical modality of choice as storage units and use of ice became difficult problems to address. Instead, the use of cooling gels may have been used, such as Arnica Ice and Ice Man Ice. This may account for another reason as to why massage was a popular treatment of choice in these marathons (57.2% of cases).

Manipulation was the most common modality of treatment used in 13 out of 19 of the diagnoses. There were only two diagnoses in which massage was utilised more than manipulation, and those were DOMS and tendinitis. There were only two diagnoses in which manipulation was not used, vascular claudication and contusion. This reiterates the versatile use of the chiropractic manipulation. It also suggests that students may be isolating their choice of treatment to adjusting, instead of developing a multimodal approach to treatment as established by Hoskins *et al.* (2006).

4.5.4 Objective Four

The fourth objective was to determine any associations between selected demographics, injury and treatment profiles

4.5.4.1. Demographics versus Injury Profile

4.5.4.1.1 Comparison of Age versus Injury Profile

The following data shows the comparison of age versus anatomical site of injury, diagnosis, mechanism of injury, history of previous injury, history of previous trauma, clinical impression and continuation of participation.

4.5.4.1.1.1 Results and Discussion of Comparison of Age versus Anatomical Site of Injury

Table 4.12:Comparison of Age versus Anatomical Site of Injury

Anatomical Site of Injury	Count	Mean Age	Standard Deviation
Shin and/or Calf	305	39.5	10.1
Thigh	303	38.7	10.1
Lumbar	226	41.2	11.2
Foot and/or Ankle	166	37.7	9.7
Knee	127	38.8	12.3
Hip	106	38.8	10.7
Neck	75	42.3	11.8
Thorax	52	40.8	10.1
Shoulder	34	39.1	11.8
Head	4	41.8	10.6
Abdomen	4	44.3	11.4
Other	2	38.5	6.4
Upper Arm	1	30.0	.
Wrist and/or Hand	1	31.0	.
Total	758	39.7	10.9

Table 4.12 indicates that the participants who presented as patients with the most common anatomical site of injury (shin and/or calf) were 39.5±10.1 years of age. The second most common site of injury was the thigh, with an average age of 38.7±10.1.

From Table 4.12 it can thus be seen that the younger runners seemed to suffer more from lower limb injuries (hip, knee, thigh, shin and/or calf and foot and/or ankle). This is not including those anatomical sites in which only one case was reported (upper arm and wrist and/or hand). Van Mechelen (1992) suggests that younger runners train at higher speeds, also running more kilometres per training session than older runners. It could be deduced from this that younger runners are able to push harder when running marathons (Kraemer *et al.*, 1999; Robergs and Roberts, 1997), and hence incur more acute injuries (Vetter and Symonds, 2010), related particularly to the lower limb. Younger runners seem to incur more injuries to the lower limb, and older runners who seem to have more spinal injuries (Table 4.12).

There could be a twofold reason for this:

1. When looking at the lower limb kinematic chain and its joints, runners present with altered joint mechanics over time and distance run as well as injuries incurred over their running career (Kaufmann *et al.,* 2000). The decreased flexibility / increased stiffness of the lower extremity joints over time prevent the lower limb from acting as a shock absorber (Decker *et al.,* 2003), therefore predisposing the spine and pelvis to increased forces and thus injuries. The SI joint also serves as a transfer link for force between the lower extremities and the torso (Brolinson *et al.,* 2003) and this ability is also compromised in relatively older runners.
2. Conversely in younger runners, the lower extremity is responsible for attenuating the ground reactive forces. This occurs in the joints (Norkin and Levangie, 1992) as well as in the soft tissues of the lower extremity (Decker *et al*., 2003). This burden on the soft tissues increases the likelihood of fatigue (Vetter and Symonds, 2010) and therefore injury (Chang *et al.,* 2012; Lun *et al.,* 2004; Taunton *et al.,* 2003; Macera *et al.,* 1989; Macera *et al.,* 1991; Wen *et al.,* 1998).

It is therefore not unexpected that the younger runners in this study presented with lower limb injuries as compared to the older runners who presented with spinal injuries. It is also evident from the discussion above, that it would be expected that the younger runners present with soft tissue injuries as compared to the older runners, who are more likely to present with mechanical joint injuries. This will be further discussed in Section 4.5.4.1.1.2.

4.5.4.1.1.2 Results and Discussion of Comparison of Age versus Diagnosis

Table 4.13: Comparison of Age versus Diagnosis

Diagnosis	Count	Age Mean	Age Standard
Muscle Strain	176	39.2	10.5
SI syndrome	162	40.2	11.0
Myofascial Pain Syndrome	99	40.1	11.0
Joint Sprain	66	36.8	11.4
DOMS	65	39.1	11.3
Lumbar Facet Syndrome	42	42.3	10.1
Iliotibial Band Syndrome	30	35.3	9.3
Cervical Facet Syndrome	28	43.6	12.1
Thoracic Facet Syndrome	28	40.0	9.8
Tendinitis	26	39.3	10.5
Tendinopathy	12	41.3	10.0
Patellofemoral Pain Syndrome	6	40.3	14.9
Plantar Fasciitis	6	47.2	11.6
Medial Tibial Stress Syndrome	5	41.4	12.5
Missing Diagnoses	2	41.0	2.8
Vascular Claudication	2	43.0	7.1
Abrasion	1	31.0	.
Contusion	1	38.0	.
Metatarsalgia	1	44.0	.
Head	0	.	.
Heat Exhaustion	0	.	.
Laceration	0	.	.

Table 4.13 shows that the runners presenting with the most common diagnoses (muscle strain) were 39.2±10.5 years of age; younger runners suffered from joint sprains and ITBS (36.8±11.4 and 35.3±9.3 years of age respectively). The second most common diagnosis is SI syndrome and this presented in older runners (40.2±11.0 years of age). Older runners were seen to suffer more from spinal diagnoses (such as SI syndrome, lumbar facet syndrome and cervical facet syndrome) (40.2±11, 42.3±10.1 and 43.6±12.1 years of age respectively) than their younger counterparts. This is understood as part of spinal degeneration (Kirkaldy-Willis and Burton, 1992).

Taunton *et al.* (2002) showed that a lower age is a significant risk factor for men with ITBS. They showed that younger men were more likely to be involved in activities that could contribute to the excessive loading on the knee extensor mechanisms (Pickar, 2002; Hopkins and Ingersoll, 2000; Suter *et al.,* 2000), and ultimately have an impact on ITBS (Landrum *et al.,* 2008; Vicenzino *et al.,* 2006; Whitman *et al.,* 2005). This impact is likely due to changes in the biomechanics of the lower extremity, increasing the likelihood of joint sprains and muscle strains (Chang *et al.,*2012; Decker *et al.,* 2011; van Gent *et al.,*2007; Puckree *et al.,*2007; van Middelkoop *et al.,*2007; Hreljac and Ferber, 2006; Noakes, 2003; Renström *et al.*, 2003; Taunton *et al*.,2003; Taunton *et al.*,2002; Steinacker *et al*.,2001;Jeffers, 1999; Satterthwaite *et al.,*1996; Nobel, 1997; van Mechelen, 1992; Jakobsen *et al.,* 1989; Macera *et al.,*1989; Walter *et al.,*1989; Bates *et al.,* 1978).These outcomes are further supported by the fact that MTSS was also shown to have a lower age as a relative risk factor for this injury. This syndrome is usually the result of an inability of the lower extremity to absorb ground reactive forces, with the result that the forces are absorbed at the tenoperiosteal interface (“shin splints”) or within the trabeculae of bone (stress fractures) – both of which are classed as MTSS (Hyde and Gengenbach, 2007; Reid, 1992).

In contrast to the above injuries, a lower age was shown to be a protective factor for Achilles tendinopathy (41.3 ± 10 years). Taunton *et al.*(2002) found that older male runners were more prone to Achilles tendinopathy as a result of increased stiffness / decreased elasticity and energy absorption capacity (DeMaio, 1993) of load bearing structures in running(Maffulli *et al.,* 2006).Yet Longo *et al.* (2009)showed that no correlation was found between age and development of Achilles tendinopathy. According to other research (Maffulli *et al.,* 2000; Maffulli, 1999; Maffulli, 1998; Maffulli, 1996; Maffulli, 1995), this may be influenced by tendon vascularity, gastrocnemius-soleus dysfunction, age and gender. This is supported by the fact that PF (Table 4.13) is shown in the oldest age category (47.2±11.6) in this current study, and is in accordance with literature showing that PF is common in the older population (Riddle *et al.,* 2003; Wainwright *et al.,* 1995; Shaibani *et al.,* 1993).

As already noted, older ages predispose the runner to spinal diagnoses such as SI syndrome, lumbar facet syndrome and cervical facet syndrome (40.2±11, 42.3±10.1 and 43.6±12.1 years of age respectively). Older age also adds to a lack of shock absorption in the lower extremity (Chang *et al.,* 2011; Lun *et al.,* 2004; Taunton *et al.,* 2003; Macera *et al.,* 1991; Wen *et al.,* 1998; Macera *et al.,* 1989) and presents a unique biomechanical load through the pelvis and lumbar spine (Decker *et al.,* 2003).This needs to be addressed by health care professionals that deal with the musculoskeletal sequelae of running, in order to effectively provide the patient with short term and long term pain relief (Finch and Cook, 2014; Junge *et al.,* 2008; Hyde and Gengenbach, 2007).

4.5.4.1.1.3 Results and Discussion of Comparison of Age versus Mechanism of Injury, History of Previous Injury and/or Trauma and Clinical Impression.

Table 4.14: Comparison of Age versus Mechanism of Injury, History of Previous Injury, History of Previous Trauma and Clinical Impression

		Count	Age	
			Mean	Standard Deviation
Mechanism of Injury	Overuse	725	39.6	10.8
	Trauma	22	39.9	12.9
	Idiopathic	8	39.4	9.8
	Missing Data	3	44.0	7.1
History of Previous Injury	No	558	39.6	10.9
	Yes	197	39.8	10.8
	Missing Data	3	44.0	7.1
History of Previous Trauma	No	677	39.5	10.8
	Yes	78	40.6	11.9
	Missing Data	3	44.0	7.1
Clinical Impression	Acute	497	38.8	10.8
	Chronic	217	41.9	10.8
	Acute on Chronic	20	36.1	7.0
	Sub-Acute	14	37.9	12.5
	Missing Data	10	41.9	13.9

Table 4.14 shows that the marathon runners presenting as patients with the most common mechanism of injury (overuse), no history of previous injury, a history of previous injury and no history of previous trauma were 39.5±10.8 years old or there about. Patients diagnosed with an acute clinical impression were 38.8±10.8 as opposed to those diagnosed with a chronic clinical impression (41.9±10.8). The average age of runners for overuse injury (39.6±10.8), traumatic injury (39.9±12.9) and idiopathic mechanism of injury (39.4±9.8) shows that there are no significant differences in the age of runners with regards to their mechanism of injury.

There was no significant age difference (0.2 years of age) between those with a history of previous injury and those without. There is a continuous even age distribution of runners with regards to history of previous injury.

Runners who reported that they had a history of previous trauma, were slightly older (40.6±11.9) than those who reported no history of previous trauma (39.5±10.8). This agrees with Tandogan *et al.* (2004) who found that the likelihood of incurring a traumatic event increases with age.

The majority of runners presented to the onsite CTF with an acute injury (65.6%) and 28.6% were chronic. Runners who presented with an acute injury were younger (38.8±10.8) than those with chronic injuries (41.9±10.8). This concurs with the assertions presented in Sections 4.5.4.1.1.1 and 4.5.4.1.1.2.

4.5.4.1.1.4 Results and Discussion of Comparison of Age versus Continuation of Participation

Table 4.15: Comparison of Age versus Continuation of Participation

		Age	
	Count	Mean	Standard
Able to Continue Play	718	39.7	10.9
Unable to Continue Play	32	38.9	10.3
Missing Data	8	43.3	11.0

Table 4.15 indicates that 718 individuals with an average age of 39.7±10.9 were able to continue participation, 32 marathon runners (38.9±10.3 years old) were unable to continue participation. This concurs with Table 4.14, where it was shown that the younger marathon runners suffered more from acute type injuries and were thus more unlikely to continue running. It would agree with the assertion that older runners had more chronic injuries (Table 4.14) of a less severe nature, that did not impact directly on the biomechanics of the lower extremity (i.e. therefore not limiting their participation to the same degree as a younger runner who may not have been able to run based on the location of their injury in the lower kinematic chain).These collective outcomes seem to support Marti *et al.* (1988) who suggested that there may be significance in the 'long term adaptive process of the musculoskeletal system', explaining that older runners adapt to their chronic injuries due to their increased years of running when compared to a younger runner.

4.5.4.1.2 Comparison of Gender versus Injury Profile

The following data shows the comparison of gender versus anatomical site of injury, diagnosis, mechanism of injury, history of previous injury, history of previous trauma, clinical impression, and continuation of participation.

4.5.4.1.2.1 Results and Discussion of Comparison of Gender versus Anatomical Site of Injury

Table 4.16: Comparison of Gender versus Anatomical Site of Injury

	Gender						**Total**	
	Missing Data		Male		Female			
Anatomical Site of Injury	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Shin and/or Calf	1	25.0%	192	42.5%	112	37.1%	305	40.3%
Thigh	1	25.0%	204	45.1%	97	32.1%	302	39.9%
Lumbar	0	0.0%	128	28.3%	97	32.1%	225	29.7%
Foot and/or Ankle	0	0.0%	85	18.8%	81	26.8%	166	21.9%
Knee	1	25.0%	70	15.5%	56	18.5%	127	16.8%
Hip	1	25.0%	61	13.5%	44	14.6%	106	14.0%
Neck	0	0.0%	35	7.7%	40	13.2%	75	9.9%
Thorax	0	0.0%	28	6.2%	24	7.9%	52	6.9%
Shoulder	0	0.0%	14	3.1%	20	6.6%	34	4.5%
Head	0	0.0%	3	0.7%	1	0.3%	4	0.5%
Abdomen	0	0.0%	3	0.7%	1	0.3%	4	0.5%
Other	0	0.0%	1	0.2%	1	0.3%	2	0.3%
Upper Arm	0	0.0%	0	0.0%	1	0.3%	1	0.1%
Wrist and/or Hand	0	0.0%	1	0.2%	0	0.0%	1	0.1%
Total	4		452		302		758	

Table 4.16 shows that the most common anatomical site of injury overall was the shin and/or calf for both males (42.5%) and females (37.1%). The most common anatomical site of injury amongst males was the thigh (45.1%), followed by the shin and/or calf (42.5%). The most common anatomical site of injury amongst females was the shin and/or calf (37.1%), followed by the thigh and lumbar spine, both at 32.1%.

In this study it can be seen that males suffered from thigh injuries more commonly than females (45.1% / 32.1%). This outcome concurs with the work presented by Decker *et al.* (2003) in which they found that males generally absorbed the impact of running in the muscles of the thigh, as compared to females who tend to absorb much of the ground reactive force in the foot and ankle complex (or leg) and its surrounding musculature. Lun *et al.* (2004) agree – male runners were seen with knee and lower leg injuries, followed by hip/groin and foot injuries. Often thigh extensor dysfunction is associated with either lateral knee pain or pain on the upper tibia, where the infrapatellar ligament and the ITB insert. Decker *et al.* (2003) and Lun *et al.* (2004) found that female runners suffer from ankle and/or foot injuries more frequently than men (26.8% / 18.8%).

However, certain studies have shown that women have a predisposition to ACL rupture and knee ligament laxity (Beynnon *et al.,* 2005; Deie *et al.,* 2002; Heitz *et al.,* 1999), and that at various stages of their menstrual cycle their risk of ACL ruptures increases (Deie *et al.,* 2002; Heitz *et al.,* 1999). This difference Decker *et al.* (2003) suggest may be as a result of the foot and ankle failing to provide absorption, being injured and / or being unable to compensate, thus leading to increased absorption of ground reactive forces by the knee and thus knee complaints. It is therefore important to consider the impact of previous injury or trauma to the foot and ankle in females. In this current study, when one considers that only 25.9% of the sample had a previous injury and that females represented only 39.8%, that less than 10% of female runners had had an injury to the lower extremity, this means that the percentage of females having had an injury specifically to the foot and ankle complex is extremely low. Thus few if any would have reported ligament dysfunction in the knee.

In terms of upper extremity injuries, Table 4.16 shows that females suffered from shoulder and neck injuries significantly more than their male counterparts (6.6% / 3.1% and 13.2% / 7.7% respectively). As this is unlikely to be associated with the absorption of ground reactive forces (Decker *et al.,* 2003), it may be because women wear sports bras. White *et al.* (2009) indicated that breast support may alter the kinetics and kinematics of running, and hence have an impact on female running performance. Poorly fitted bras may also lead to muscle fatigue (Chen *et al.,* 2011; McGhee and Steele, 2010; Wood *et al.,* 2008; Pechter, 1998) and referral pain to the thorax, neck and shoulder may result (Travell and Simons, 1999).

4.5.4.1.2.2 Results and Discussion Comparison of Gender versus Diagnosis

Table 4.17: Comparison of Gender versus Diagnosis

Diagnosis	Missing Data		Gender			
			Male		Female	
	Count	Column N%	Count	Column N%	Count	Column N%
Muscle Strain	1	33.3%	106	23.5%	69	22.8%
SI syndrome	1	33.3%	104	23.0%	56	18.5%
Myofascial Pain Syndrome	1	33.3%	62	13.7%	36	11.9%
DOMS	0	0.0%	48	**10.6%**	17	**5.6%**
Joint Sprain	0	0.0%	32	**7.1%**	34	**11.3%**
Lumbar Facet Syndrome	0	0.0%	27	6.0%	15	5.0%
Iliotibial Band Syndrome	0	0.0%	17	3.8%	13	4.3%
Tendinitis	0	0.0%	15	3.3%	11	3.6%
Cervical Facet Syndrome	0	0.0%	12	**2.7%**	16	**5.3%**
Tendinopathy	0	0.0%	9	2.0%	3	1.0%
Thoracic Facet Syndrome	0	0.0%	8	**1.8%**	20	**6.6%**
Patellofemoral Pain Syndrome	0	0.0%	6	**1.3%**	0	**0.0%**
Medial Tibial Stress Syndrome	0	0.0%	3	0.7%	2	0.7%
Plantar Fasciitis	0	0.0%	2	0.4%	4	1.3%
Contusion	0	0.0%	1	0.2%	0	0.0%
Missing Data	0	0.0%	0	0.0%	2	0.7%
Head	0	0.0%	0	0.0%	0	0.0%
Heat Exhaustion	0	0.0%	0	0.0%	0	0.0%
Abrasion	0	0.0%	0	0.0%	1	0.3%
Laceration	0	0.0%	0	0.0%	0	0.0%
Metatarsalgia	0	0.0%	0	0.0%	1	0.3%
Vascular Claudication	0	0.0%	0	0.0%	2	0.7%

Table 4.17 shows that 23.5% of males and 22.8% of females were diagnosed with muscle strain (thigh versus leg respectively); in addition 23% of males were diagnosed with SI syndrome and 18.5% of

females. The findings show that 13.7% of males and 11.9% of females were diagnosed with MFPS and there is a slightly greater difference in the gender distribution of DOMS (10.6% of males and 5.6% of females); joint sprain (7.1% of males and 11.3% of females); cervical facet syndrome (2.7% of males and 5.3% of females); thoracic facet syndrome (1.8% of males and 6.6% of females) and PFPS (1.3% of males and 0% of females). All other comparisons only varied by a slight ±1% difference.

These outcomes support the previous assertions:

- Males are more likely to suffer with soft tissue injury of the thigh and extensor mechanism dysfunction (PFPS) than females and thus would be more likely to suffer from DOMS and MFPS (see Section 4.5.4.1.1.2).
- Females are more likely to suffer with joint sprains particularly associated with the leg, foot and ankle (see Section 4.5.4.1.2.1), (Decker *et al.,* 2003) and
- Increased spinal pain in females may be related to their bra support or lack thereof.

4.5.4.1.2.3 Results and Discussion of Comparison of Gender versus Mechanism of Injury, History of Previous Injury, History of Previous Trauma and Clinical Impression

Table 4.18: Comparison of Gender versus Mechanism of Injury, History of Previous Injury and/ or Trauma and Clinical Impression

		Missing Data		Gender: Male		Gender: Female	
		Count	Column N %	Count	Column N %	Count	Column N %
Mechanism of Injury	Overuse	2	66.7%	434	96.0%	288	95.4%
	Trauma	0	0.0%	13	2.9%	9	3.0%
	Idiopathic	0	0.0%	4	0.9%	4	1.3%
	Missing Data	1	33.3%	1	0.2%	1	0.3%
History of Previous Injury	No	1	33.3%	337	74.6%	220	72.8%
	Yes	1	33.3%	114	**25.2%**	81	**26.8%**
	Missing Data	1	33.3%	1	0.2%	1	0.3%
History of Previous Trauma	No	1	33.3%	411	90.9%	265	87.7%
	Yes	1	33.3%	40	**8.8%**	36	**11.9%**
	Missing Data	1	33.3%	1	0.2%	1	0.3%
Clinical Impression	Acute	0	0.0%	304	67.3%	193	63.9%
	Chronic	1	33.3%	122	**27.0%**	93	**30.8%**
	Acute on Chronic	1	33.3%	12	2.7%	7	2.3%
	Sub-Acute	0	0.0%	11	2.4%	3	1.0%
	Missing Data	1	33.3%	3	0.7%	6	2.0%

Table 4.18 shows that overuse is the most common mechanism of injury (96% in males) with2.9% being traumatic injuries. Ninety five point four percent of women had overuse injuries and 3% were traumatic. In addition, 74.6% of males had no history of previous injury and 90.9% had no history of previous trauma, whereas 72.8% of the females had no history of previous injury and 87.7% had no history of previous trauma. Lastly, 67.3% of the males were diagnosed with acute conditions and 27% were chronic. 63.9% of the females were diagnosed with acute conditions and 30.8% were chronic.

A history of previous injury or trauma has been shown to be a risk factor when evaluating injuries in runners (van Gent *et al.,* 2007; Wen *et al.,* 2007; Macera *et al.,* 1991; Wen *et al.,* 1998;Macera*et* *al.,*1989; Walter *et al.,* 1989). The outcomes of this study therefore seem to agree with the possible reasons provided in Section 4.5.4.1.1.3 and 4.5.4.1.1.4. An interesting observation is that the females seem to be the runners that have an increased likelihood for chronic injuries that seem to be of spinal origin. They're the older runners in this study, which are more likely to not be prevented from continued running as a result of their injury (Table 4.19). By contrast the males seem to be the group that are characterised by being younger, more likely to have an acute injury of their soft tissues of the lower extremity that prevents them from participating in continued running (Table 4.19).

4.5.4.1.2.4 Results and Discussion of Comparison of Gender versus Continuation of Participation

Table 4.19: Comparison of Gender versus Continuation of Participation

	Missing Data		Gender: Male		Gender: Female	
	Count	Column N%	Count	Column N%	Count	Column N%
Able to Continue Participation	2	66.7%	424	93.8%	291	96.4%
Unable to Continue Participation	0	0.0%	24	**5.3%**	8	**2.6%**
Missing Data	1	33.3%	4	0.9%	3	1.0%

Table 4.19 shows that 93.8% of males were able to continue running and 5.3% were not able to continue. Females were more likely to continue running (96.4%) and 2.6% were unable to. These results concur with the discussion presented in Section 4.5.4.1.1.4 and 4.5.1.2.2.

4.5.4.1.3 Comparison of Ethnicity versus Injury Profile

The following data shows the comparison of ethnicity versus anatomical site of injury, diagnosis, mechanism of injury, history of previous injury, history of previous trauma, clinical impression and continuation of participation.

4.5.4.1.3.1 Results and Discussion of Comparison of Ethnicity versus Anatomical Site of injury

Table 4.20: Comparison of Ethnicity versus Anatomical Site of Injury

	Ethnicity											
	Missing Data		White		Black		Indian		Other		Total	
Anatomical Site of Injury	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Shin and/or Calf	1	20.0%	78	35.3%	154	43.3%	63	41.2%	2	33.3%	298	40.2%
Thigh	3	60.0%	64	29.0%	169	47.5%	58	37.9%	2	33.3%	296	39.9%
Lumbar	0	0.0%	69	31.2%	87	24.4%	58	37.9%	5	83.3%	219	29.6%
Foot and/or Ankle	1	20.0%	47	21.3%	92	25.8%	20	13.1%	0	0.0%	160	21.6%
Knee	2	40.0%	38	17.2%	67	18.8%	17	11.1%	0	0.0%	124	16.7%
Hip	2	40.0%	26	11.8%	59	16.6%	16	10.5%	0	0.0%	103	13.9%
Neck	0	0.0%	25	11.3%	23	6.5%	26	17.0%	0	0.0%	74	10.0%
Thorax	0	0.0%	18	8.1%	25	7.0%	8	5.2%	1	16.7%	52	7.0%
Shoulder	0	0.0%	9	4.1%	14	3.9%	11	7.2%	0	0.0%	34	4.6%
Head	0	0.0%	1	0.5%	0	0.0%	3	2.0%	0	0.0%	4	0.5%
Abdomen	0	0.0%	0	0.0%	2	0.6%	2	1.3%	0	0.0%	4	0.5%
Other	0	0.0%	1	0.5%	1	0.3%	0	0.0%	0	0.0%	2	0.3%
Upper Arm	0	0.0%	0	0.0%	1	0.3%	0	0.0%	0	0.0%	1	0.1%
Wrist and/or Hand	0	0.0%	1	0.5%	0	0.0%	0	0.0%	0	0.0%	1	0.1%
Total	5	100.0%	221	100.0%	356	100.0%	153	100.0%	6	100.0%	741	100.0%

Table 4.20 indicates that the anatomical site of injury that the White participants complained most about was shin and/or calf (35.3%), followed by the lumbar spine at 31.2% and thigh at 29%. The Black participants complained most about their thigh (47.5%), followed by shin and/or calf (43.3%) and foot and/or ankle (25.8%). The Indian participants complained most about their shin and/or calf (41.2%), followed by their thigh (37.9%) and lumbar spine (39.7%) equally. The category of 'other' includes a majority of Coloureds, as well as Asians. The most common complaint here was the lumbar spine (83.3%), followed by shin and/or calf (33.3%) and thigh (33.3%) equally.

There is a paucity of literature on ethnicity as documented in injury profiles, thus it is not possible to compare these data with the available literature. A comparison can therefore only be made with the gender / anatomical region cross tabulation. It can be seen from Table 4.20 that Black participants suffered mainly from thigh, shin and/or calf and foot and/or ankle problems. This would seem to suggest that the greater proportion of participating Blacks were likely to be male, based on their predominance of lower limb injuries and the relative proportion of these injuries to one another. This agrees with the presentation among Indian participants, who also presented predominantly with lower limb injuries, indicating that there seemed to be a predominance of male Indian participants. By contrast the White participants complained most about their shin and/or calf, lumbar spine and thigh, which suggests a fairly equitable spread of male and female participants in this ethnic group. These conclusions support the initial data presented in Sections 4.5.1.5.3 and 4.5.1.5.4 where it can be seen that the majority of participants were male (gender analysis) and that the ethnic analysis indicated that the majority of participants were Black, followed by White, Indian and Coloured, with Asian making up the smallest ethnic subgroup. Therefore in the context of the results for this section, it is plausible that with Indians and Blacks having a predominance of males with Whites being equitable in their male: female ratio, in terms of their presenting anatomical regions of complaint, that this would concur with the overall race demographics. These results support the suggestions by Decker *et al.* (2003) that gender running style may be more significant in terms of runners than their respective ethnicities.

When comparing the anatomical regions of complaint between the race groups to determine who is most likely to have a particular injury, it would seem that the Blacks are most likely to have lower extremity complaints, the Indians most likely to have upper spinal complaints, the Asians and Coloureds most likely to have thoracic and lumbar spine complaints. White participants did not have as many complaints as the other ethnic groups, which seem to suggest that perhaps:

1. The White runners have access to medical care on a continuous basis to treat and rehabilitate injuries more adequately.
2. The Black runners do not have access to medical facilities as readily as other runners.
3. The Black runners are more likely to be running as a means of living than recreationally (as the White runners may do).
4. The running styles between the runners may be inherently different, based on their training, coaching or access to such.
5. The level of education on running and the requirements for running either through levels of literacy and / or exposure to information may be limited for different ethnic groups, therefore predisposing them to injuries more generally –particularly as relates to such topics as hydration and nutrition. This latter point may explain the high number of particularly soft tissue injuries in Black runners. This may be due to their lack of education (Onywera, 2009; Onywera *et al.,* 2006) on adequate hydration and nutrition leading to musculoskeletal sequelae (See section 2.5.2.1 and 4.5.2.1.3).

These speculations are however just that and would require further, more in depth investigation in order to confirm or refute the trend seen in this study, therefore it is suggested that these speculations be tested through either questionnaire or interview studies of runners on the eastern seaboard of South Africa.

The last observation in this section is in relation particularly to the Indian participants, who seemed to complain the most about neck and shoulder issues. It was previously shown by Omar *et al.* (1994) that South African Indians have a high prevalence of non-insulin-dependent diabetes mellitus (DM), which a number of studies have indicated, shows a significant correlation with shoulder pain, stiffness, periarthritis and 'frozen shoulder' or adhesive capsulitis (Cole *et al.,* 2009; Thomas *et al.,* 2007; Balci *et al.,* 1999; Bridgman, 1972). It also stands to reason that neck pain and shoulder pain are related to one another (Travell and Simons, 1999). Thus, these results of high prevalence of neck and shoulder pain in Indian runners could be due to DM, as upper extremity injuries are unlikely to be a result of the absorption of ground reactive forces as previously discussed (Section 4.5.4.1.2.1).

4.5.4.1.3.2 Results and Discussion of Comparison of Ethnicity versus Diagnosis

Table 4.21: Comparison of Ethnicity versus Diagnosis

Diagnosis	Ethnicity									
	Missing Data		White		Black		Indian		Other	
	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Muscle Strain	1	20.0%	38	17.2%	**95**	**26.7%**	35	22.9%	1	16.7%
SI syndrome	3	60.0%	**51**	**23.1%**	73	20.5%	33	21.6%	0	0.0%
Myofascial Pain Syndrome	1	20.0%	36	16.3%	43	12.1%	16	10.5%	**1**	**16.7%**
Joint Sprain	0	0.0%	21	9.5%	**36**	**10.1%**	7	4.6%	0	0.0%
DOMS	0	0.0%	14	6.3%	**34**	**9.6%**	14	9.2%	2	33.3%
Lumbar Facet Syndrome	0	0.0%	6	2.7%	17	4.8%	**17**	**11.1%**	2	33.3%
Thoracic Facet Syndrome	0	0.0%	9	4.1%	12	3.4%	**7**	**4.6%**	0	0.0%
Tendinitis	0	0.0%	**10**	**4.5%**	13	3.7%	2	1.3%	0	0.0%
Iliotibial Band Syndrome	0	0.0%	**11**	**5.0%**	15	4.2%	2	1.3%	0	0.0%
Patellofemoral Pain Syndrome	0	0.0%	**2**	**0.9%**	3	0.8%	1	0.7%	0	0.0%
Cervical Facet Syndrome	0	0.0%	7	3.2%	6	1.7%	**15**	**9.8%**	0	0.0%
Medial Tibial Stress Syndrome	0	0.0%	**2**	**0.9%**	2	0.6%	1	0.7%	0	0.0%
Tendinopathy	0	0.0%	**9**	**4.1%**	2	0.6%	1	0.7%	0	0.0%
Plantar Fasciitis	0	0.0%	**2**	**0.9%**	2	0.6%	1	0.7%	0	0.0%
Laceration	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Missing Data	0	0.0%	**1**	**0.5%**	1	0.3%	0	0.0%	0	0.0%
Heat Exhaustion	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Abrasion	0	0.0%	0	0.0%	**1**	**0.3%**	0	0.0%	0	0.0%
Metatarsalgia	0	0.0%	0	0.0%	**1**	**0.3%**	0	0.0%	0	0.0%
Head	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Contusion	0	0.0%	**1**	**0.5%**	0	0.0%	0	0.0%	0	0.0%
Vascular Claudication	0	0.0%	1	0.5%	0	0.0%	**1**	**0.7%**	0	0.0%

Table 4.21 shows specifically in the White runners that the most common diagnoses were SI syndrome (23.1%), followed by muscle strain (17.2%) and then MFPS (16.3%). This is not unlike the most common diagnoses found in the Black runners, which was muscle strain (26.7%), followed by SI syndrome (20.5%) and then MFPS (12.1%). In the Indian runners the most common diagnoses found were muscle strain (22.9%), followed by SI syndrome (21.6%) and then MFPS (10.5%). Coloureds and Asians made up the runners in the 'other' category, and were found to have DOMS (33.3%) and lumbar facet syndrome (33.3%) equally prevalent, followed by muscle strain (16.7%) and MFPS (16.7%) equally.

These findings suggest that all the ethnic groups in their own right presented with injuries that are typically associated with running (Hamstra-Wright and Preish, 2014; Ellapen *et al.,* 2013; Chang *et al.,* 2012; Hyde and Gengenbach, 2007; van Middelkoop *et al.,* 2007*;* Lun *et al.,* 2004; Egermann *et al.,* 2003; Renström *et al.,* 2003; Taunton *et al.,* 2003; Satterthwaite *et al.,* 1999; Wen *et al.,* 1998;Macera *et al.,* 1991; Messier *et al.,* 1991; Bovens *et al.,* 1989; Macera *et al.,* 1989; Lysholm and Wiklander, 1987). However, when comparing the ethnic groups to each other and their relative percentages of injuries sustained, one finds that according to Table 4.21:

- Soft tissue injury (muscle strains, MFPS and DOMS) are most prevalent amongst Black runners. This is in line with the findings in Table 4.20, in which areas with large soft tissue surfaces were complained of as the most common sites of injury (thigh and shin and/or calf). It is however unusual to find a high soft tissue injury load in this population group, when only a small number of complaints regarding lumbar spine were reported in comparison to the other ethnic groups. This seems to indicate that the Black runner does not associate back discomfort / pain with the possible injuries in these soft tissues. However, chiropractic interns would have assessed both low back muscular and soft tissue regions along with thigh complaints, as these regions are linked by the pelvis in the kinematic chain. This may lead to the large number of Black runners that were diagnosed with SI syndrome (22.5%).
- The White participants were diagnosed with SI syndrome as the second most common diagnosis. This is in accordance with the findings in Table 4.20, where lumbar spine pain was reported as the second most common anatomical site of pain. This agrees with the previous conclusions (discussed in Section 4.5.4.1.2.3) that the White participants were more likely to be older, female and have more chronic conditions (e.g. tendinopathies, plantar fasciitis, ITB's and PFPS).

- Indians had a relatively high diagnosis of lumbar facet syndrome when compared to other ethnic groups. This is in relation to the findings in Table 4.20 in which Indians complained predominantly of lumbar spine pain. The diagnosis of cervical facet syndrome correlates to the findings in Table 4.20 in which there were a high number of neck complaints.

In the category of 'other', there were five complaints of lumbar spine pain as their anatomical site of injury, yet only two complaints were diagnosed as lumbar facet syndrome; the other complaints were diagnosed as muscle strain, MFPS and DOMS, all soft tissue related injuries.

It therefore seems that the outcome of the region of anatomical complaint and the ultimate diagnoses for each of the runners seems to be limited by:

- Runner understanding(refer to Section4.5.4.1.3.1);
- Stage of the pathogenesis of the running injuries and the degree to which the biomechanics of the runner have changed in order to allow for continued running; and
- The fact that the interns assessing the patients were chiropractic interns and likely that they looked for and diagnosed joint dysfunctions at a higher rate than another health care professional.

These assumptions require further investigation. It is recommended that an injury profile from an integrated health care team may be able to address the last possibility, whereas the other two may be investigated through interviews, questionnaires or both, so as to gain a greater understanding of the runners' history and understanding of their sport and its related injuries.

4.5.4.1.3.3 Results and Discussion of Comparison of Ethnicity versus Mechanism of Injury, History of Previous Injury and/or Trauma and Clinical Impression.

Table 4.22: Comparison of Ethnicity versus Mechanism of Injury, History of Previous Injury and/or Trauma and Clinical Impression

		Ethnicity									
		Missing Data		White		Black		Indian		Other	
		Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Mechanism of Injury	Overuse	4	80.0%	207	93.7%	344	96.6%	147	96.1%	6	100.0%
	Trauma	0	0.0%	10	**4.5%**	10	2.8%	2	1.3%	0	0.0%
	Idiopathic	0	0.0%	3	1.4%	2	0.6%	3	2.0%	0	0.0%
	Missing Data	1	20.0%	1	0.5%	0	0.0%	1	0.7%	0	0.0%
History of previous Injury	No	3	60.0%	150	67.9%	276	**77.5%**	111	72.5%	4	66.7%
	Yes	1	20.0%	70	**31.7%**	80	22.5%	41	26.8%	2	**33.3%**
	Missing Data	1	20.0%	1	0.5%	0	0.0%	1	0.7%	0	0.0%
History of Previous Trauma	No	3	60.0%	181	81.9%	331	**93.0%**	140	91.5%	5	83.3%
	Yes	1	20.0%	39	**17.6%**	25	7.0%	12	7.8%	1	16.7%
	Missing Data	1	20.0%	1	0.5%	0	0.0%	1	0.7%	0	0.0%
Clinical Impression	Acute	2	40.0%	139	62.9%	245	**68.8%**	96	62.7%	4	66.7%
	Chronic	1	20.0%	66	**29.9%**	94	26.4%	50	**32.7%**	1	16.7%
	Acute on Chronic	1	20.0%	10	4.5%	7	2.0%	2	1.3%	0	0.0%
	Sub Acute	0	0.0%	4	1.8%	6	1.7%	3	2.0%	0	0.0%
	Missing Data	1	20.0%	2	0.9%	4	1.1%	2	1.3%	1	16.7%

Table 4.22 indicates that the mechanism of injury most common in all ethnic groups was overuse (White 93.7%, Black 96.6%, Indian 96.1% and 'other' 100 %.). This is in keeping with the running literature (Hamstra-Wright and Preish, 2013; Wen, 2007; Hreljac and Ferber, 2006; Jakobsen *et al.,* 1989; Lysholm and Wiklander, 1987).

There was no history of previous injury in 77.5% of the Black runners, 72.5% of the Indian runners, 67.9% of the White runners and 66.7% of the 'other' runners. There was no history of previous trauma found in 93% of the Black runners, 91.5% of the Indian runners, 83.3% of the 'other' runners and 81.8% of the White runners. From these results it suggests that the majority of Black runners had no prior complaint that they associated with running. The White runners had the highest rate of previous injury or trauma. This could indicate two things: that the White runners are older and therefore are more likely to have sustained injuries / trauma in their running careers; and that the White runners were more likely to have appropriate access to medical care, (see Section 4.5.4.1.2.3 and 4.5.4.1.3.1) allowing them to run for longer without injury preventing their participation. The converse would be true of the Black runner. This would be supported by previous studies showing that a history of previous injuries and/or trauma is a risk factor for developing running injuries(van Gent *et al.,* 2007; Wen *et al.,* 2007; Macera *et al.,* 1991; Wen *et al.,* 1998;Macera*et al.,* 1989; Walter *et al.,* 1989). The only limitation of these studies is that they did not show if the later running injuries are acute or chronic in nature and therefore the link to acute and chronic presentations could not be made conclusively.

The assertions made in the previous paragraph concur with the results that 68.8% of the conditions reported by the Black runners were acute and 26.4 were chronic. Additionally, it supports the statistic that 62.9% of White runners had acute conditions and 29.9% were found to have chronic conditions. It also concurs with the statistic that 32.7% of Indian runners who were found to have acute conditions and 32.7% chronic conditions.

4.5.4.1.3.4 Results and Discussion of Comparison of Ethnicity versus Continuation of Participation

Table 4.23: Comparison of Ethnicity versus Continuation of Participation

	Ethnicity									
	Missing Data		White		Black		Indian		Other	
	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Able to Continue Participation	4	80.0%	208	94.1%	341	**95.8%**	142	92.8%	6	100.0%
Unable to Continue Participation	0	0.0%	10	4.5%	15	4.2%	7	**4.6%**	0	0.0%
Missing Data	1	20.0%	3	1.4%	0	0.0%	4	2.6%	0	0.0%

Table 4.23 shows that:

- 94.1% of the White runners were able to continue running while 4.5% could not continue.95.8% of the Black runners were able to continue running and 4.2% were not able to.
- 92.8% of the Indian runners were able to continue running and 4.6% were not
- 100% of the Coloured and Asian runners were able to continue running.

These findings are interesting to note, as previously when looking at a comparison of gender and ability to continue to run (Table 4.19), it was shown that males were more likely to suffer from acute conditions (Table 4.18), and were more likely to not be able to continue the marathon they were participating in. The findings when comparing ability to continue running and ethnic groups indicates dissimilarity. The Black runners were more likely to suffer from acute conditions (Table 4.22), yet were more likely to be able to continue running (Table 4.23). These findings do not agree with the previous findings in this study discussed in Section 4.5.4.1.1.4.

Possible reasons for this dissimilarity could be because:

- Some Black runners may be competing in long distance races in order to make money to support their families, as poverty and unemployment are major problems in most African countries (Onywera, 2009; Onywera *et al.,* 2006). For this reason, they may be driven to not pull out of the marathons despite injuries, but rather compete and finish with a chance of making money.
- Language barriers may lead to misinterpretation of the terms injury and trauma (Scollen and Scollen, 1995), resulting in no history of previous injury and/or trauma being recorded when in fact there could possibly have been. This is particularly true as the manner in which an injury is usually defined is either by whether the person is actually able to continue with the activity, with activities of daily living or whether it requires hospital (emergency room) admission or a visit to the general practitioner. Without the Black runner necessarily having access to medical care, the scope for defining previous trauma or injury would be different than when compared to the other ethnic groups. Conversely if the White runners only define an injury when medical care is required, they are likely to underreport their injuries relative to the other ethnic groups (Burns *et al.,* 2006; Egermann *et al.,* 2003; Mouton, 1996).
- The high rate of poverty and unemployment amongst the Black ethnic group (Onywera, 2009; Onywera *et al.,* 2006) which may result in runners from this

ethnic group not receiving medical attention for injuries, and hence not having a previous diagnosis of any type of injury. This could lead to the perception that if a runner has not been previously diagnosed with an injury, they would not necessarily report a history of previous injury and/or trauma, as they would have not been previously diagnosed or treated for anything.

It is therefore difficult to associate the reported history of injuries and trauma to the profile that has been discussed up to this point. Therefore, it is suggested that the reporting of injuries and trauma by athletes be investigated to develop an understanding of the athletes' perception of the terms and thus the effect on reporting. Additionally once the definition has been outlined, this definition should be used as a standard term, so that all research in this field is comparable on a shared understanding (Burns *et al.,* 2006; Egermann *et al.,* 2003*;* Mouton, 1996).

Thus, from the comparison of the ethnicity versus the injury profile, it could be stated that the older White female runner is more likely to suffer from chronic injuries that are related to the pelvis and spine and that stem from a past injury (although this may be modified by access to medical care), compared to the younger White male runner that is likely to suffer from acute injuries that are related to injuries on site with no history of chronicity. This contrasts to the Black runners that are more likely to be younger males, with lower extremity injuries that are acute, with a limited link to past injury or trauma (the latter limited by the issues of language and understanding). With the smaller group of Black female runners, there is a likelihood that the injuries will be acute, related to the lower extremity (the foot and ankle predominantly), with little relationship to previous injury or trauma. By contrast the Indian runners seem to fall outside of the mould as the majority seem to be male, with spinal injuries being noted as overuse / chronic and of the upper back, neck, head and shoulder regions. A possible modifier for this presentation (which was discussed in Section4.5.4.1.3.1) is the high prevalence of diabetes mellitus on the eastern seaboard of South Africa. This however requires further investigation in order to determine both the causal link as well as the physiological association between the two conditions.

4.5.4.2. Demographics versus Treatment Profile

4.5.4.2.1 Results and Discussion of Comparison of Age versus Treatment Profile

Table 4.24: Comparison of Age versus Treatment

Treatment	Count	Mean Age	Standard Deviation
Manipulation	624	40.0	11.1
Massage	431	39.8	10.6
PNF Stretch	253	40.2	11.1
Needle	198	40.7	10.6
Ischaemic Compression	129	41.1	10.9
Static Stretch	114	37.4	10.6
Mobilisation	83	40.0	10.2
Cross Frictions	19	**43.1**	11.2
Ice	11	38.3	12.5
Strapping	5	33.6	5.9
Other	3	**58.0**	15.6
Referral	3	41.0	6.1
Rest	2	**31.5**	9.2
Total	754	39.7	10.9

Table 4.24 shows that the relative ages of all participants receiving the three most common treatments were very close. The mean age of the participants receiving manipulation was 40±11.1 years, massage was 39.8±10.6 years of age and PNF stretching was 40.2±11.1 years old. This outcome may be as a result of the fact that these ages of the runners would regress to the mean, based on the fact that the majority of runners would have been manipulated (if joint dysfunction was found). This is highly likely when one considers that the lower limb kinematic chain itself has multiple joints (Brukner and Khan, 2002) that could be treated by manipulation and that runners utilise these joints repetitively in their sport (Dagenais and Haldeman, 2012; Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Hurwitz *et al.,* 2002; Giles, 1998; Renström, 1993).

The results from this current study show that the younger generation suffered more from soft tissue type injuries (Table 4.12 and 4.13).This would therefore concur with massage being commonly utilised, particularly for the younger runners with soft tissue injuries, as massage has been shown to effectively reduce and alleviate symptoms of soft tissue injuries (Hyde and Gengenbach, 2007; Zainuddin *et al.,* 2005; Chaitow and DeLany, 2000; Travell and Simons, 1999). Static stretching has also been shown to have great benefits when treating soft tissue injuries (Hammer, 2007). These findings of massage and static stretching as a treatment protocol for the younger runners (39.8±10.6) are in accordance with the findings and literature relevant to this study (See Section 4.5.3.3).

From Table 4.24 it can be shown that the older runners were more commonly treated using manipulation and mobilisations. This could possibly be due to the fact that the older generation of runners in this study suffer more from chronic (Table 4.14) and spinal injuries (Table 4.13) than their younger counterparts. In keeping with the theory by Kirkaldy-Willis and Burton (1992) and the three phases of degeneration, older runners are more likely to suffer from stiff joints, leading to a greater utilization of treatment protocols known to treat joints (Brantingham *et al.,* 2012; Hoskins *et al.,* 2006). This would concur with the use of manipulations, mobilisations and cross frictions (the latter could be collectively labelled soft tissue mobilisations if combined with massage or grip and rip) and were found to be the treatment protocol utilised for the older runners with soft tissue injuries (e.g. tendinitis, tendinopathy and plantar fasciitis). Table 4.11 showed that cross frictions were utilized most commonly as a treatment for tendinitis (19.2%) and tendinopathies (66.7%). Out of the 19 times that cross frictions were used as a treatment protocol, 13(68.4%) were utilised to treat the diagnoses of tendinitis and tendinopathies, which is consistent with the literature (Cook *et al.,* 2001; Gehlsen *et al.,* 1999). In Table 4.13 it is shown that the age of runners diagnosed with tendinitis and tendinopathies was 39.3±10.5 and 41.3±10 respectively. This only slightly differs with the results found in this Table 4.24 as the age of the runners receiving cross frictions as a treatment protocol is 43.1±11.2. When adding PF into this analysis of soft tissue mobilisations, which is found in runners who are 43.1±11.6 years old (Table 4.13), it arguably modifies this age category slightly. This modified age may also be found due to the fact that cross frictions are not solely used for the treatment of tendinitis or tendinopathy (Table 4.11), and these accumulated conditions may alter this overall age bracket (43.1±11.2). When looking at these age categories there is a difference of about four years in the top seven treatments utilised. The rate of degeneration over four years is negligible over this time. However, when considering the intensity of running over these years (Section 2.5.1.3 and 2.5.1.5), then this intrinsic risk factor may be a modifying agent and may result in higher injury rate and / or degeneration over a shorter period of time.

The runners with the youngest age category were treated with rest. The number of runners treated with rest was only two, making it difficult to use this data as an inference when regarding age. However, when considering diagnosis, the youngest runners were found to suffer from abrasions, ITBS and joint sprains (Table 4.13). Early rest has been shown to have some effect when treating soft tissue injuries such as joint sprains (Accident Compensation Corporation [ACC] Sport Smart, 2002) (but mobilisation has been shown to be more effective) (Tiemstra, 2012). Rest is a commonly utilised treatment modality in acute phases of an injury, especially when there is an inflammatory response (ACC Sport Smart, 2002; Reid, 1992). ITBS may have periods of acute exacerbations that present with an acute inflammatory response in the early stages of the injury (Lavine, 2010), and hence can account for the use of rest is justified in the younger runners. When accounting for the great number of acute injuries, it is interesting to note that rest was not utilised more often, as it has been shown to be an important treatment modality when considering early management of acute injuries (Hyde and Gengenbach, 2007; Bahr and Maehlum, 2004; Noakes and Granger, 2003; Renström *et al*., 2003; Juhn, 1999; Subotnick, 1991). However, when recommending rest, a chiropractic intern may have only considered it as a significant treatment option when active rest was required immediately (when the patient could not get up and walk).

It is also interesting to note that the oldest mean age of 58±15.6 years was seen to receive ‘other’ treatment and the youngest mean age of 31.5±9.2 years was seen to receive rest as a part of their treatment protocol.

‘Other’ treatment modalities may have included less commonly utilised techniques such as grip and rip, active release and the use of heating gels such as Deep Heat or Voltaren. Kirkaldy-Willis and Burton (1992) showed that with age, anatomical areas of dysfunction may slowly progress into the phase of stabilization which results in stiff joints and muscle spasms. Treatments such as grip and rip and active release may aid in the management of runners in the stabilization phase, as these protocols allow for a great movement of soft tissue and joints.

It is therefore evident that for the most part, treatments received by the runners at the events chosen for this analysis, were consistent in terms of the conditions per age group as well as the type of condition.

4.5.4.2.2 Results and Discussion of Comparison of Gender versus Treatment Profile

Table 4.25: Comparison of Gender versus Treatment

	Gender					
	Missing Data		Male		Female	
Treatment	Count	Column N%	Count	Column N%	Count	Column N%
Manipulation	1	50.0%	363	80.8%	259	85.8%
Massage	1	50.0%	257	57.2%	173	57.3%
PNF Stretch	0	0.0%	162	36.1%	91	30.1%
Needle	1	50.0%	135	30.1%	61	20.2%
Ischaemic Compression	0	0.0%	66	14.7%	63	20.9%
Static Stretch	0	0.0%	62	13.8%	52	17.2%
Mobilisation	0	0.0%	45	10.0%	38	12.6%
Cross Frictions	0	0.0%	10	2.2%	9	3.0%
Ice	0	0.0%	5	1.1%	6	2.0%
Other	0	0.0%	3	0.7%	0	0.0%
Strapping	0	0.0%	2	0.4%	3	1.0%
Rest	0	0.0%	1	0.2%	1	0.3%
Referral	0	0.0%	0	0.0%	3	1.0%
Total	2	100.0%	449	100.0%	302	100.0%

Table 4.25 shows that 80.8% of males and 85.8% of females received manipulation as a part of their treatment. This is consistent with the assertion in the Section 4.5.4.1.3.2 which noted that chiropractic interns are likely to have diagnosed joint dysfunction and restriction in most runners and therefore it is likely that irrespective of the gender of the runners, each would have received a high percentage of manipulation (unless there was a contra-indication for such treatment in the patient).An equitable figure of 57.2% and 57.3% in male and female

runners respectively received massage as part of their treatment, and 36.1% of males and 30.1% of females received PNF stretching as part of their treatment protocol.

Therefore collectively, females were more likely to receive treatment such as manipulations, stretching, mobilisations, and cross frictions. It can be seen from Table 4.17 that females were more likely to be diagnosed with cervical and thoracic facet syndrome, in addition to the fact that they are also likely to have been older (see Section 4.5.4.1.2.3). Thus there is congruency between the type of treatment and the type and chronicity of the conditions that females presented with. As previously discussed (Section 4.5.3.3)manipulation is(Julian *et al.,* 2010) used to treat a variety of spinal complaints (Dagenais and Haldeman, 2012; Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Hurwitz *et al.,* 2002; Giles, 1998). This would agree with the findings of females being treated with manipulations.

Females also presented with more joint sprains / dysfunction of the lower extremity than males (Table 4.17). The initial treatment of joint sprains traditionally starts with the PRICE guideline (ACC Sport Smart, 2002) of protection, rest, ice, compression and elevation, followed by gentle mobilisation of the joint (Tiemstra, 2012). This is found to be relevant in this current study, as rest, ice and mobilisations are all more commonly utilised in the treatment of females (Table 4.25).

Males were more likely to be diagnosed with DOMS (Section 4.5.4.1.2.2). It has been shown that massage has an effect of alleviating DOMS by approximately 30% (Zainuddin *et al.,* 2005) and so it is not unexpected that massage is utilised when treating males. Thus there is congruency between the type of treatment and the type and chronicity of the conditions that males presented with.

4.5.4.2.3 Results and Discussion of Comparison of Ethnicity versus Treatment Profile

Table 4.26: Comparison of Ethnicity versus Treatment

	Ethnicity									
	Missing Data		White		Black		Indian		Other	
Treatment	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Manipulation	2	50.0%	168	76.4%	304	85.6%	130	85.5%	5	83.3%
Massage	2	50.0%	121	55.0%	208	58.6%	87	57.2%	3	50.0%
Needle	1	25.0%	71	32.3%	79	22.3%	40	26.3%	4	66.7%
PNF Stretch	0	0.0%	70	31.8%	120	33.8%	52	34.2%	3	50.0%
Ischaemic Compression	0	0.0%	37	16.8%	56	15.8%	29	19.1%	2	33.3%
Static Stretch	1	25.0%	29	13.2%	52	14.6%	25	16.4%	1	16.7%
Mobilisation	0	0.0%	19	8.6%	42	11.8%	18	11.8%	0	0.0%
Cross Frictions	0	0.0%	8	3.6%	8	2.3%	2	1.3%	0	0.0%
Ice	0	0.0%	6	2.7%	4	1.1%	0	0.0%	0	0.0%
Strapping	0	0.0%	3	1.4%	2	0.6%	0	0.0%	0	0.0%
Rest	0	0.0%	2	0.9%	0	0.0%	0	0.0%	0	0.0%
Other	0	0.0%	2	0.9%	0	0.0%	1	0.7%	0	0.0%
Referral	0	0.0%	1	0.5%	1	0.3%	1	0.7%	0	0.0%
Total	4	100.0%	220	100.0%	355	100.0%	152	100.0%	6	100.0%

Table 4.26 shows that 76.5% of the White runners received manipulation as part of their treatment, 55% received massage and 32.3% received needling. The majority of the Black runners (85.6%) received manipulation as part of their treatment protocol, 58.6% received massage and 33.8% received PNF stretching. Similarly, 85.5% of the Indian runners received manipulation as part of their treatment, 57.2% received massage and 34.2% received PNF stretching. The majority (83.3%) of the coloured and Asian runners received manipulation as part of their treatment, 66.7% received needling (larger proportion) and 50% received both massage and PNF stretching.

Manipulation and massage were the two most common modalities utilised in the treatment of Black runners. When considering that muscle strain, SI syndrome and MFPS were the most common diagnoses of this ethnic group (Table 4.21), manipulation and mobilisation would be the expected treatment modalities. Needling would also be an expected treatment modality as it has been shown to be beneficial in the treatment of MFPS (Travell and Simons, 1999). However, with regards to language barriers (Scollen and Scollen, 1995) and cultural perception (Rattan, 2007) of needles it may have been difficult for the interns to obtain consent in the utilisation of this treatment protocol. Section 4.5.4.2.2 discusses the use of a chiropractic manipulation for the treatment of a variety of spinal and extremity injuries. Kirkaldy-Willis and Burton (1992) and Bronfort *et al.* (2004) also showed the benefits of spinal manipulation in the treatment of SI syndrome, low back and neck pain.

Table 4.21 shows that Indians are most likely to suffer from lumbar and thoracic facet syndromes. The treatment of these conditions by a chiropractor is most commonly going to be a manipulation (Section 4.5.4.2.2) (Dagenais and Haldeman, 2012; Brantingham *et al.,* 2012; Julian *et al.,* 2010; Brantingham *et al.,* 2009; Hurwitz *et al.,* 2002; Giles, 1998), and so it is expected that manipulation was utilised as a treatment modality in 85.5% of the complaints made by Indian runners.

It is therefore seen from this section that where ethnicity was compared to the treatment interventions received:

- An older White female runner was more likely to suffer from chronic injuries related to the pelvis and spine that stem from a history of past injury (although this may be modified by access to medical care), and be treated with manipulation, mobilisation, massage, PNF stretching, needling, cross frictions, ischaemic compression and other treatment.

- A younger White male runner was more likely to suffer from acute injuries that are related to injuries on site with no history of chronicity and related to the lower extremity and be treated with manipulation, massage, strapping, static stretching, rest and ice.
- A Black runner was more likely to be a younger male with lower extremity injuries that are acute, with a limited link to past injury or trauma and be treated with manipulation, massage, PNF and static stretching, rest and strapping.
- A Black female runner had an increased likelihood of acute injuries related to the lower extremity (the foot and ankle predominantly), with little relationship to previous injury or trauma and be treated with manipulation, massage, PNF stretching and ischaemic compression.
- Indian runners that seemed to fall outside of the mould, presented with predominantly males who had overuse / chronic spinal injuries of the upper back, neck, head and shoulder regions. Thus these runners were treated with manipulation, massage, and PNF stretching.

4.5.5 Objective Five

The fifth objective was to track repeat patients that presented to the onsite DUT CTF at each selected marathon and to determine any associations between their initial and repeat injury profile.

4.5.5.1 Results and Discussion of Repeat Marathon Runners

Table 4.27:Numberof Repeat Marathon Runners

Revisits	Frequency	Percent %
Repeat participants, more than one marathon	49	6.5%
Only one marathon	709	93.5%
Total	758	100.0%

Table 4.27 shows that in total there were 49 runners who presented for visits at the DUT CTF’s at 2 or more marathons. These runners were further analysed to assess associations between their initial and repeat profiles. For the purposes of comparison, just their first and second marathon visits were compared since there were too few runners with a third

marathon visit. The row and column totals are based on number of runners, not the number of visits.

4.5.5.2 Results and Discussion of Comparison of the Anatomical Site of Injury between the First and Subsequent Marathon

Table 4.28: Cross Tabulation Comparing Anatomical Site of Injury of the First Marathon to the Anatomical Site of Injury of the Subsequent Marathon

First Marathon: Number of Complaints per Anatomical Site of Injury	**Subsequent Marathon**: Number of Complaints per Anatomical Site of Injury											**Total Forms**
	Head.2	Neck.2	Shoulder.2	Thorax.2	Lumbar.2	Abdomen.2	Hip.2	Thigh.2	Knee.2	ShinCalf.2:	FootAnkle.2:	
Neck.1	0	3	0	2	0	0	0	1	0	2	1	5
Shoulder.1	0	2	0	1	0	0	0	1	0	2	1	3
Thorax.1	0	0	0	1	1	0	0	1	1	1	2	2
Lumbar.1	0	2	1	0	**8**	0	1	5	1	5	4	14
Hip.1	0	0	1	1	0	0	1	3	0	3	1	7
Thigh.1	1	1	2	5	3	1	1	**7**	1	**11**	4	18
Knee.1	1	2	1	2	4	0	1	2	2	2	1	8
ShinCalf.1:	0	3	1	3	5	0	1	**7**	3	**9**	6	21
FootAnkle.1	0	2	0	2	2	0	0	4	1	3	3	8
Total Forms	1	8	4	9	14	1	3	17	5	18	11	47

Percentages and totals are based on respondents.

a. Dichotomy group tabulated at value 1.

Table 4.28 shows the data captured from the runners who presented at more than one marathon. This table reveals the anatomical site of injury found in the runners presenting to the onsite CTF at the first marathon that they participated in, and compares it to the anatomical site of injury they presented with at a second marathon. This table shows that the shin and/or calf is the most common anatomical site of injury (44.7%) occurring at the first marathon that the runners participated in, as well as the second marathon (38.3%) (Percentages reflect as a percentage of the total injury record sheets). The thigh was the second most common anatomical site of injury (38.3%) at the first marathon, and was a close second (36.2%) at the second marathon that the runners presented at. The third most common site of injury was the lumbar spine, and this was found to be 29.8% at both the first and second marathons.

Of the 21 runners who presented with shin and/or calf problems at their first marathon, nine complained of shin and/or calf problems at their second marathon. The following anatomical sites of injuries were also documented at their second marathon; six complained of foot and/or ankle problems, three complained of knee problems, seven complained of thigh issues, five complained of lumbar issues, three complained of thorax issues and three complained of neck issues. One runner suffered from a hip problem and one runner indicated they were having trouble with their shoulder. No runners complained of abdominal or head issues. This chain of complaints is consistent with the regions of ground reactive force shock absorption outlined by Decker *et al.* (2003). It suggests that if the patient presented with an inability to utilise the soft tissue structures of the anatomical leg, more pressure would be placed on the foot and ankle With increased mileage, intensity, changes in camber or changes in the type of course being run, there is an increased likelihood for shock absorption at points higher in the kinematic chain over time. Of academic interest would be a follow on study to track athletes over an entire season, to determine whether this change over time does indeed occur. This present study is limited as many of the runners would have been at various points along this hypothesised pathogenesis of running injuries and hence the spread over multiple points of anatomical location.

Of the 18 runners who presented with thigh pain at their first marathon, 11 complained of shin and/or calf pain at their subsequent marathon, seven complained of thigh pain, five complained of thoracic pain, four complained of foot and/or ankle pain, three complained of lumbar pain and two complained of shoulder pain. One runner complained of head issues, one had neck problems, one suffered from an abdominal complaint, one runner had hip issues and one runner had a knee complaint.

Table 4.28 shows that the anatomical sites of injury were seldom the same between the first and second marathon visit, indicating the need for the runner to adapt or compensate in order to achieve the same activity / outcomes (Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Norkin and Levangie, 1992).

4.5.5.3 Results and Discussion of Comparison of the Diagnosis of Injuries between the First and Subsequent Marathon

Table 4.29: Cross Tabulation Comparing Diagnosis of Injuries at the First Marathon to the Diagnosis of Injuries at the Repeat Marathon

First Marathon:		**Repeat Marathon:** Diagnosis.2												
		Joint Sprain	Muscle Strain	Cervical Facet Syndrome	Thoracic Facet Syndrome	SI syndrome	Lumbar Facet Syndrome	Tendinitis	Myofascial Pain Syndrome	Tendinopathy	DOMS	MTSS Stress	ITBS	**Total Forms**
Diagnosis.1	Joint Sprain	0	1	1	0	1	0	0	0	0	0	0	0	3
	Muscle Strain	0	2	0	1	2	0	1	2	0	1	1	1	11
	Patellofemoral Pain Syndrome	0	0	0	0	0	1	0	0	0	0	0	0	1
	Cervical Facet Syndrome	0	0	1	1	0	0	0	0	0	1	0	0	3
	Thoracic Facet Syndrome	0	2	0	0	0	0	0	0	0	0	0	0	2
	SI syndrome	1	2	0	1	2	1	0	2	0	0	0	1	10
	Lumbar Facet Syndrome	0	0	1	0	2	0	0	1	0	0	0	0	4
	Tendonitis	0	0	0	0	0	0	0	0	0	0	0	1	1
	Myofascial Pain Syndrome	3	0	1	0	0	0	0	2	0	1	0	0	7
	Tendinopathy	0	0	0	0	0	0	0	0	1	1	0	0	2
	DOMS	0	1	1	0	0	0	0	1	0	0	0	0	3
Total Forms		4	8	5	3	7	2	1	8	1	4	1	3	47

Table 4.29 shows the diagnosis of the injuries at the first marathon compared to that of the second marathon that the runner participated in. This table shows that the most common diagnoses in the first marathon were muscle strains (23.4%), SI syndromes (21.3%) and MFPS (14.9%), and both muscle strain and MFPS in the second marathon (17%) were equally common, followed by SI syndrome (14.9%) and cervical facet syndrome (10.6%).

Table4.29 also shows that out of the 11 runners presenting with muscle strain in the first marathon, two people were diagnosed with muscle strain in the subsequent marathon, two developed SI syndrome and two developed MFPS. One runner developed thoracic facet syndrome, one developed tendinitis, one developed DOMS, one developed MTSS and one developed ITBS. No runners were diagnosed with joint sprain, cervical or lumbar facet syndrome or tendinopathy.

Of the 10 runners that presented with SI syndrome in the first marathon, two remained with a diagnosis of SI syndrome in the subsequent marathon, two developed muscle strain and two developed MFPS. One runner each developed joint sprain, thoracic facet syndrome, lumbar facet syndrome and ITBS. No runner presented with cervical facet syndrome, tendinitis, tendinopathy, DOMS or MTSS.

Further, Table 4.29 shows that the diagnoses were very seldom the same between the first and subsequent marathons. It is however interesting to note that this chain of diagnoses from the first marathon to the second marathon underpins the argument presented under the anatomical complaints (Section 4.5.5.2), indicating that the developing pathogenesis and the relationship between the diagnoses is consistent with the regions of ground reactive force shock absorption outlined by Decker *et al.* (2003).It could be argued that because the same chiropractic interns often worked at the onsite CTF, it is likely that they saw the runner a second time, therefore anticipating the outcome in line with the literature. This is however not likely, as the chiropractic interns were on a rotation schedule, which did not necessarily match the events that the runners elected to run. It also did not mean that the chiropractic intern was available at the time that the runner actually presented to the CTF for treatment. Thus it is unlikely that the chiropractic interns would have been able to anticipate the data collection and manipulate it. Furthermore, the data in this retrospective study would already have been generated by the time the clinic record analysis was approved. Thus there would have been no reason for the chiropractic interns to note anything other than the clinically relevant information at the time of interacting with the patient.

The argument that runners need to adapt or compensate in order to be able to achieve the same activity / outcomes (Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Norkin and Levangie, 1992) for previous injury exists, and presents real problems, particularly if the runner has no understanding of the relationship between the complaints and no access to medical care. These factors suggest that a runners' career can be significantly shortened if their conditions are not treated and managed effectively by themselves, their coaches and / or the supporting medical personnel (Finch and Cook, 2014; Junge *et al.,* 2008; Finch and Mitchell, 2002; Finch *et al.*, 1999).

4.5.5.4 Results and Discussion of Comparison of the Mechanism of Injury between the First and Subsequent Marathon

Table 4.30: Cross Tabulation Comparing the Mechanism of Injury sustained at the First Marathon to the Mechanism of Injury at the Subsequent Marathon

		Repeat Marathon: Mechanism of Injury	Total
		Overuse	
First Marathon: Mechanism of Injury	Overuse	43	43
	Trauma	1	1
	Idiopathic	2	2
	Missing Data	1	1
Total		47	47

Table 4.30shows that all the mechanisms of injury for the repeat marathon were overuse, therefore no comparison was possible. It does however support the notion that repeated activity leads to the development of chronic injury, partly as a result of overuse and partly as a result of compensatory actions as a result of previous trauma (Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Wen *et al.,* 1998; Jones *et al.,* 1993; Norkin and Levangie, 1992; Macera *et al.,* 1989; Walter *et al.,* 1989; Marti *et al.,* 1988).

4.5.5.5 Results and Discussion of Comparison of History of Previous Injury at the First Marathon and Subsequent Marathon

Table 4.31: Cross Tabulation Comparing History of Previous Injury at the First Marathon to the History of Previous Injury to the Subsequent Marathon

		Subsequent Marathon: History of Previous Injury		**Total**
		Yes	No	
First Marathon: History of Previous Injury	Yes	8	2	10
	No	12	24	36
Total		20	26	46

One runner with missing information for history of previous injury

Table4.31 shows that of the 10 runners reporting a history of previous injury at their first marathon, eight reported a history of previous injury at their subsequent marathon and two reported no history of previous injury.

Of the 36 runners presenting with no history of previous injury at their first marathon, 12 reported history of previous injury at their subsequent marathon, and 24 reported no history of previous injury at that marathon.

It is shown from this table that there was a significant difference (McNemar's p=0.013) in history of previous injury between the first and subsequent marathon (they were more likely to report a history of previous injury at their subsequent marathon visit).

The outcomes of this analysis reveal that there may have been an inconsistent understanding of the term "injury". This has previously been discussed in several sections (Section 4.5.1.3.4 being the most relevant).In the context of Table 4.31, it is evident with the significant difference between the first and the second visit that the runner now understands what is meant by having had a previous injury (viz. they have spoken to the chiropractic interns at visit one) and thus are better able to answer the question compared to visit one. This implies that one of three things is possible:

- the patient under reported injury history at visit one
- they reported an injury at visit two, because they utilised the CTF at a prior event (potentially over reporting)
- Or a combination of the two options above.

It is therefore re-iterated that a future study should track runners over the course of a season, utilising a common set of definitions and terms in order to validate the outcomes of this study and determine the effect of the factors influencing the reporting of injury.

4.5.5.6 Results and Discussion of Comparison of the History of Previous Trauma between the First and Subsequent Marathon

Table 4.32: Cross Tabulation Comparing the History of Previous Trauma at the First Marathon to the History of Previous Trauma at the Subsequent Marathon

		Subsequent Marathon: History of Previous Trauma		**Total**
		Yes	No	
First Marathon: History of Previous Trauma	Yes	5	2	7
	No	0	39	39
Total		5	41	46

Table 4.32 shows that there was no difference between the first and second marathons regarding history of previous trauma (McNemar's p=0.500). Of the seven runners reporting a history of previous trauma at their first marathon, five reported a history of previous trauma at their second marathon and two reported no history of previous trauma. Of the 39 runners who reported no history of previous trauma at their first marathon, no runners reported a history of previous trauma at their second marathon, and all 39 runners maintained their report of no history of previous trauma at their subsequent marathon. These results seem internally congruent and less prone to the issues of definition and understanding associated with the term "injury" in Section 4.5.5.5.

4.5.5.7 Results and Discussion of Comparison of the Clinical Impression of Injury between the First and Subsequent Marathon

Table 4.33: Cross Tabulation Comparing the Clinical Impression of the Injury at the First Marathon to the Clinical Impression of the Injury at the Subsequent Marathon

		Subsequent Marathon: Clinical Impression				**Total**
		Acute	Chronic	Sub-Acute	Acute on Chronic	
First Marathon: Clinical Impression	Acute	19	10	0	0	29
	Chronic	7	4	1	1	13
	Sub-Acute	1	1	0	0	2
	Acute on Chronic	1	1	0	0	2
Total		28	16	1	1	46

Table 4.33 shows that there was no significant difference in clinical impression between the first and second marathon visit (McNemar's p=0.722).Of the 29 runners that presented with an acute condition at the first marathon, 19 presented with an acute condition at their second marathon, 10 presented with a chronic condition and no runners presented with a sub-acute or acute on chronic condition. Of the 13 runners that presented to the onsite CTF with chronic conditions at their first marathon, seven presented with acute conditions at their second marathon, four presented with chronic conditions, one runner presented with a sub-acute condition and one runner presented with an acute on chronic condition.

This outcome suggests (as have the outcomes in Section 4.5.5.5 and 4.5.5.6) that acute injuries are often a precursor for later more chronic injuries related to altered biomechanics (Hyde and Gengenbach, 2007);and that chronic conditions (unless attended to regularly) provide a nidus for continued problems, with acute exacerbations of the chronic condition (Morris, 2006). It is therefore crucial that runners are adequately able to maintain fitness, hydration and nutrition (Cheuvront and Haymes, 2012; Dierks *et al.,* 2010; Paluska, 2005; von Duvillard *et al.*, 2004; Bergeron, 2003) and that they seek adequate and appropriate care when injured (Hyde and Gengenbach, 2007). It would then also become the domain of the health care professional to understand not only the current condition, but also its effect on the biomechanics of running (Ellapen *et al.,* 2013; Puckree *et al.,* 2007; van Gent *et al.,* 2007; Murphy *et al.,* 2003;Taunton *et al.,* 2002), the possible development of compensations as sequelae (Brantingham *et al.,* 2012; Brantingham *et al.,* 2009; Norkin and Levangie, 1992) as well as to educate the runner on the most appropriate home care (Noakes and Granger, 2003; Renström *et al.,* 2003; Andrews *et al.,* 1997; Subotnick, 1991)and training protocol (Hyde and Gengenbach, 2007; Wen, 2007; Renström *et al.,* 2003; Noakes *et al.,* 2003; James, 1995; Meeuwisse, 1994; Van Mechelen, 1992; Powell, 1986) that they should employ to ensure that the injury does not cause chronic sequelae and hinder their athletic career (Finch and Cook, 2014; Junge *et al.,* 2008; Finch and Mitchell, 2002; Finch *et al.*, 1999).

4.5.5.8 Results and Discussion of Comparison of the Ability to Continue Participation between the First and Subsequent Marathon

Table 4.34:Cross Tabulation Comparing the Ability to Continue Participation at the First Marathon to the Ability to Continue Participation at the Subsequent Marathon

		Subsequent Marathon: Able to Continue Participation		**Total**
		Yes	No	
First Marathon: Able to Continue Participation	Yes	41	2	43
	No	3	0	3
Total		44	2	46

Table 4.34 shows that there was no difference in continued participation between the first and second marathon visits (McNemar's p=1.000).Of the 43 runners who were able to continue participation at their first marathon, 41 were able to continue participation at their second marathon and two were unable to continue participation. All three of the athletes who were unable to continue participation in their first marathon, were all able to continue participation in their second marathon. The outcomes of this analysis indicate that the majority of injuries in running are not those that require immediate medical attention and are not significant enough to prevent participation for the majority of runners. It is therefore important that more of these types of studies are performed, as they capture information that is not available in studies that are conducted at training centres(van Middelkoop *et al.,* 2007; Taunton *et al.,* 2003; Wen *et al.,* 1998; Bovens *et al.,* 1989) or medical facilities (Taunton *et al.,* 2002)where access is usually predetermined by the athletes' level of performance (Taunton *et al.,* 2002; Macera *et al.,* 1992; Macera *et al.,* 1989; Marti *et al.,* 1988; Lysholm and Wiklander, 1987), or the athletes' access to medical care (Onywera, 2009; Onywera *et al.,* 2006), or by their perceived need in terms of the severity of the injury (Burns *et al.,* 2006; Egermann *et al.,* 2003; Mouton, 1996).

4.6 Conclusion

From this study, it was seen that the following characteristics were determined from the data gathered from the runners that presented to the Chiropractic Treatment Facilities (CTF) and the manner in which they were treated:

- The older White female runner was more likely to suffer from chronic injuries related to the pelvis and spine, stemming from a history of past injury (although this may be modified by access to medical care). Examples of such injuries were SI syndrome, lumbar facet syndrome, MFPS, tendinitis, tendinopathies and joint sprains; and were thus treated with manipulation, mobilisation, massage, PNF stretching, needling, cross frictions, ischaemic compression and ‘other’ treatment such as grip and rip, active release and heating gels.
- The younger White male runner was more likely to suffer from acute injuries that were related to injuries on site with no history of chronicity, and related to the lower extremities. Examples of such injuries were muscle strains, joint sprains, SI syndrome and ITBS; and were thus treated with manipulation, massage, strapping, static stretching, rest and ice.
- The Black runner was more likely to be a younger male with lower extremity injuries that were acute with a limited link to past injury or trauma. Examples of such injuries were muscle strains, joint sprains and DOMS; and were thus treated with manipulation, massage, PNF and static stretching, rest and strapping.
- The Black female runner had an increased likelihood of acute injuries related to the lower extremity (the foot and ankle predominantly), with little relationship to previous injury or trauma. Examples of such injuries were muscle strain, SI syndrome, MFPS and joint sprain; and were thus treated with manipulation, massage, PNF stretching and ischaemic compression.
- The Indian runners seemed to fall outside of the mould, presenting with predominantly males who had overuse / chronic spinal injuries of the upper back, neck, head and shoulder regions. Examples of such injuries were SI syndrome, cervical, thoracic and lumbar facet syndromes; and were thus treated with manipulation, massage, and PNF stretching.

Collectively, the most common anatomical sites of complaint were: the shin and/or calf (40.2% of the cases) followed by thigh (40%) and lumbar spine (29.8%).

Collectively, the most common diagnoses were: muscle strain (23.2%), followed by SI syndrome (21.4%) and MFTP (13.1%).

Collectively, the most common treatments were: manipulation (82.8%), followed bymassage (57.2%)and PNF stretching (33.6%).

In addition it was found that in runners who had repeat visits:

- A history of injury was likely to increase the chances of a subsequent injury / presenting to the CTF.
- A history of trauma was not likely to increase the chances of a subsequent injury / presenting to the CTF.
- Acute injuries were likely to lead to chronic injuries or would present as acute exacerbations of chronic injuries.

Broadly considered, the data from this study suggests that the average recreational running population on the eastern seaboard of South Africa conform collectively to the data that has been presented in the previous literature (Ellapen *et al.,* 2013; Chang *et al.,* 2012; van Middelkoop *et al.,* 2007*;* Lun *et al.,* 2004; Taunton *et al.,* 2003; Satterthwaite *et al.,* 1999; Wen *et al.,* 1998; Macera *et al.,* 1991; Wen *et al.,* 1998; Bovens *et al.,* 1989; Macera *et al.,* 1989).However, on analysing the data more closely, there are selected groups defined along age, gender and ethnic lines that seem to have a predisposition to particular types of injuries that are unique to that group (viz. the Indian runner (see Section 4.5.4.1.3.1)). It is therefore suggested that these differences are further explored in future research.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Running has become popular because of its convenience, proposed health benefits and low cost (Paluska, 2005), but running injuries having increased (Hreljac and Ferber, 2006). This has resulted in a wealth of literature regarding the biomechanics of running, but a paucity of understanding regarding the relationship of running mechanics and injuries associated with running (De Leo *et al*., 2004). Many profiles of running injuries have resulted to inform health care practitioners (e.g. chiropractors) when developing research based and patient centred injury management and injury prevention strategies (Finch and Cook, 2014; Hyde and Gengenbach, 2007). This assists runners in avoiding injury, increasing their lifetime participation in the sport (Movassaghi *et al.,* 2012), reducing their burden of injury and thus decreasing their mortality and morbidity (Dagenais *et al.,* 2008).

This study in the South African context, determined the demographics of runners, their injury patterns and treatment received at selected marathons in the eThekwini and uMgungundlovu municipalities during 2014. Additionally, runners were tracked from event to event to determine whether runners had ongoing problems or new complaints over the marathons included in the study.

The results showed that the following outcomes characterised the runners that presented to the Chiropractic Treatment Facilities (CTF) and the manner in which they were treated:

- Overall, the majority of the runners were Black males of approximately 40 years of age.
- Of the 741 runners, only 17 participants presented with two complaints, making a total of 758 complaints. Of these 758 complaints, 95.6% presented with overuse injuries, 73.6% had no history of previous injury and 89.3% had no history of previous trauma. 94.7% of the runners were able to continue participation.
- The anatomical sites of injury were most commonly the shin and calf (21.7%), followed by the thigh (21.6%) and the lumbar region (16.1%), which reflected the diagnoses, which included muscle strains (23.2%), followed by SI syndrome (21.4%).
- In terms of treatment, manipulation was applied in 82.8% of cases, followed by massage (57.2%) and PNF stretching (33.6%). Manipulation was used to treat

97.5% of SI syndrome, 79% of muscle strains and 78.8% of myofascial pain syndrome. Massage was used to treat 67.6% of muscle strains, 51.3% of SI syndrome and 60.6% of myofascial pain syndrome. PNF stretching was used to treat 40.3% of muscle strains, 34.3% of myofascial pain syndrome and 29.4% of SI syndrome.

In terms of the associations between the runners, their injuries and the treatment they received, it was evident that

- The Black younger male runners tended to present with acute lower extremity injuries (e.g. muscle strains, joint sprains and DOMS), which were not related to past injury or trauma. They most often received manipulation, massage, PNF and static stretching, rest and strapping as treatment.
- The Black female runners (irrespective of age), also had an increased likelihood of acute lower extremity injuries (muscle strain, SI syndrome, MFPS and joint sprain), and with no relationship to previous injury or trauma. They were treated with manipulation, massage, PNF stretching and ischaemic compression.
- The White male runners were likely to be younger, suffer from acute injuries such as muscle strains, joint sprains, SI syndrome and ITBS, and were treated with manipulation, massage, strapping, static stretching, rest and ice.
- In general, the White female runners were more likely to be older, suffer from chronic injuries of the pelvis and spine that stemmed from a history of past injury; and thus be treated with manipulation, mobilisation, massage, PNF stretching, needling, cross frictions, ischaemic compression and ‘other’ treatment such as grip and rip, active release and heating gels.
- The Indian runners seemed to fall outside of the mould, presenting with predominantly males who had overuse / chronic spinal injuries of the upper back, neck, head and shoulder regions such as SI syndrome, lumbar facet, cervical and thoracic facet syndromes. Thus these runners were treated with manipulation, massage, and PNF stretching. Too few Indian females were included in the study, so no trends were detectable.

In those runners who had repeat visits, it was found that a history of injury was likely to increase the chances of a subsequent injury / presenting to the CTF whereas a history of trauma was not likely to increase the chances of a subsequent injury / presenting to the CTF, and acute injuries were likely to lead to chronic injuries or would present as acute exacerbations of chronic injuries.

Thus broadly considered, the outcomes of this study suggest that the average recreational runners on the eastern seaboard of South Africa collectively conform to the literature (Ellapen *et al.,* 2013; Chang *et al.,* 2012; van Middelkoop *et al.,* 2007; Lun *et al.,* 2004; Taunton *et al.,* 2003). It has however become evident that selected groups defined by age, gender and ethnic lines seem to have a predisposition to particular types of injuries that are unique to that group. Practitioners are therefore encouraged to contextualise their patients who participate in recreational running events in a manner that is appropriate for their age, gender, ethnic grouping as well as their biomechanical function, in order to more effectively address their health care concerns.

5.2 Recommendations

5.2.1 Methodological

- It is recommended that a future study with a larger sample size confirm that these composite profiles are indeed characteristic of the male and female running populations in South Africa and particularly on the eastern seaboard.
- It would have been interesting to determine whether the sample in this study was a good representation of the overall population at the seven marathons studied. Therefore in future studies, the demographics of overall participation in events should be noted (easier in prospective studies), to analyse what percentage of the total participants incurred injuries.
- In future injury profile studies, it is also important to utilise a common set of definitions and terms with regard to injury, mechanism of injury, clinical impression of injury and diagnoses in order to validate the outcomes of the study and determine the effect of the factors influencing the reporting of injury.

5.2.2 Future research

- It would be of interest in future studies, to determine how many older runners are female versus male in order to determine the relative impacts of the ground reactive force as the originator of spinal pain versus the bra fit (in females only) as an originator of spinal pain and / or whether these factors act synergistically to increase / decrease the likelihood of spinal pain in females.
- It would be interesting if a follow on study were able to track athletes over an entire season to determine whether there was a trend in observing injuries higher

up the kinematic chain with an increase in time. This present study is limited as many of the runners would have been at various points along the hypothesised pathogenesis of running injuries and hence the spread over multiple points of anatomical location.

- When observing the data from this current study, it can be seen that selected groups (age, gender and ethnicity) seem to have a predisposition to particular types of injuries (as well as regions of injuries) that are unique to that group (viz. the Indian). It is therefore suggested that these differences be further explored in future research.
- It would be interesting if a follow up study were to contact runners (who presented to the onsite CTF) one week post-race to assess the results of the treatment they received and if in their subjective view the treatment has benefited them or not. It would also be interesting to conduct research on the patient satisfaction of the onsite DUT CTF's post-race, and understand what the runners' subjective view of their treatment is. A descriptive study, such as this current one, is not able to adequately identify why each treatment was utilised or in what context it was used. Therefore, a qualitative study is needed in future research. This may help to understand the appropriateness of each treatment in its context and why it was used and in conjunction with what.
- In future studies, the CSSA form should be more specific to predisposing factors related to running injuries such as years of running, distance completed in the race, hours per week of training per/Km per week, pregnancy of females, height and weight and training surface. The CSSA form could also specify what type of massage / soft tissue techniques have been utilised (e.g. Swedish massage, ischaemic compression, cross frictions, Graston technique, heating / cooling gels).

5.2.3 Pragmatic suggestions for practitioners

- It can be seen from this study that health care providers should be aware of the various intrinsic and extrinsic factors predisposing runners to injuries when considering a treatment protocol for said patients. For example, when planning a treatment and management strategy for Indian runners, the cardiovascular risks of diabetes mellitus should be taken into consideration, as this may alter the type of treatment a health care provider may want to employ, as well as affecting the speed of recovery of the patient. This should also be taken into consideration when educating chiropractic interns at the DUT Chiropractic teaching faculty.

REFERENCES

Accident Compensation Corporation (ACC) Sport Smart. 2002. ACC think safe: managing your sports injury (brochure). Auckland, New Zealand: Accident Compensation Corporation. http://www.acc.co.nz/publications/index.htm.

Allied Health Professions Act 63, 1982. See Republic of South Africa.

Andrews, J.R., Clancy, W.G., and Whiteside, J. A. eds. 1997. *On-field evaluation and treatment of common athletic injuries*. St Louis, MO.: Mosby.

Annum, G. 2015. *Research instrument for data collection* (online). Available: http://campus.educadium.com/newmediart/file.php/1/giilmadstore/UgradResearch/ThesisWrit4all/files/notes/resInstr.pdf (Accessed 30/06/2015).

Athletics South Africa. 2015. Athletics South Africa Rules and Regulations (policy document). Available: http://www.athletics.org.za/ (Accessed 30/06/2015)

Bahr, R. and Maehlum, S. 2004. *Clinical guide to sports injuries.* Champaign, IL.: Human Kinetics.

Bahr, R. 2009. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *British Journal of Sports Medicine*, 43(13): 966-972.

Bahr, R. and Krosshaug, T. 2005. Understanding injury mechanisms: a key component of preventing injuries in sport. *British Journal of Sports Medicine*, 39(6): 324-329.

Balci, N., Balci, M.K. and Tüzüner, S. 1999.Shoulder adhesive capsulitis and shoulder range of motion in type II diabetes mellitus: association with diabetic complications. *Journal of Diabetes and its Complications,*13(3): 135-140.

Banwell, H. A., Mackintosh, S. And Thewlis, D. 2014. Foot orthoses for adults with flexible pes planus: a systematic review. *Journal of Foot and Ankle Research,* 7(23): 1-18.

Bates, B.T., James, S.L. and Osternig, L.R. 1978. Foot function during the support phase of running. *Running,* 3(4): 24-31.

Bennell, K., Malcolm, S.A., Thomas, S.A., Wark, J.D. and Brukner, P.D. 1996. The incidence and distribution of stress fractures in competitive track and field athletes: a twelve-month prospective study. *The American Journal of Sports Medicine,* 24(2): 211-217.

Beresford, Z.M., Kendall, R.W. and Willick, S. E. 2010. Lumbar facet syndromes. *Current Sports Medicine Reports,* 9(1): 50-56.

Bergeron, M.F. 2003. Heat cramps: fluid and electrolyte challenges during tennis in the heat. *Journal of Science and Medicine in Sport,* 6(1): 19-27.

Bernard, H. R. 2000. *Social research methods: qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

Berry, J. 2006. The relative effectiveness of myofascial trigger point manipulation as compared to proprioceptive neuromuscular facilitative stretching in the treatment of active myofascial trigger points: a pilot clinical investigation. M.Tech., dissertation, Durban University of Technology.

Beynnon, B. D., Bernstein, I. M., Belisle, A., Brattbakk, B., Devanny, P., Risinger, R. and Durant, D. 2005. The effect of estradiol and progesterone on knee and ankle joint laxity. *The American Journal of Sports Medicine,* 33(9): 1298-1304.

Beynnon, B.D., Ryder, S.H., Konradsen, L., Johnson, R.J., Johnson, K. and Renstrom, P.A. 1999. The effect of anterior cruciate ligament trauma and bracing on knee proprioception. *American Journal of Sports Medicine*, 27(2): 150-155.

Bono, C., M. 2004. Low-back pain in athletes. *Journal of Bone and Joint Surgery American,* 86(2): 382-396.

Boon, H.S. and Kachan, N. 2008. Integrative medicine: a tale of two clinics. *BMC Complementary and Alternative Medicine*, 8(1):32.

Bovens, A.M., Janssen, G.M., Vermeer, H.G., Hoeberigs, J. H., Janssen, M.P. and Verstappen, F.T. 1989. Occurrence of running injuries in adults following a supervised training program. *International Journal of Sports Medicine,* 10: S186-S190.

Brantingham, J. W., Bonnefin, D., Perle, S. M., Cassa, T.K., Globe, G., Pribicevic, M., Hicks, M. and Korporaal, C. 2012. Manipulative therapy for lower extremity conditions: update of a literature review. *Journal of Manipulative and Physiological Therapeutics,*35(2): 127-166.

Brantingham, J.W., Globe, G.A., Jensen, M.L., Cassa, T.K., Globe, D.R., Price, J.L., Mayer, S.N. and Lee, F.T. 2009. A feasibility study comparing two chiropractic protocols in the treatment of patellofemoral pain syndrome. *Journal of Manipulative and Physiological Therapeutics*, 32(7): 536-548.

Bridgman, J. 1972. Periarthritis of the shoulder and diabetes mellitus. *Annals of the Rheumatic Diseases,* 31(1): 69-71.

Brolinson, P.G., Kozar, A.J. and Cibor, G. 2003. Sacroiliac joint dysfunction in athletes. *Current Sports Medicine Reports,* 2(1): 47-56.

Bronfort, G., Haas, M., Evans, R. L. and Bouter, L. 2004. Efficacy of spinal manipulation and mobilization for low back pain and neck pain: a systematic review and best evidence synthesis. *The Spine Journal,*4(3): 335-356.

Brown, N., White, J., Brasher, A. and Scur, J. 2014. An investigation into breast support and sports bra use in female runners of the 2012 London Marathon. *Journal of Sports Sciences,*32 (9): 801-809.

Bruening, J. E. 2005. Gender and Racial Analysis in Sport: Are All the Women White and All the Blacks Men? *National Association for Kinesiology and Physical Education in Higher Education,* 57: 330-349.

Brukner, P. and Khan, K. 2012. *Clinical sports medicine*. 4th ed. Australia: McGraw-Hill.

Burke, L.M. 2001. Nutritional needs for exercise in the heat. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*,128 (4): 735-748.

Burns, J., Keenan, A.M. and Redmond, A.C. 2003. Factors associated with triathlon-related overuse injuries. *Journal of Orthopaedic & Sports Physical Therapy,* 33 (4): 177-184.

Burstyn, V. 1999. *The rites of men: manhood, politics and the culture of sport.* Toronto: University of Toronto Press.

Cavanagh, P.R., Pollock, M.L. and Landa, J. 1977. A biomechanical comparison of elite and good distance runners. *Annals of the New York Academy of Sciences,* 301(1): 328-345.

Chaitow, L. and DeLany, J. 2000. *Clinical application of neuromuscular techniques.* Edinburgh: Elsevier.

Chan, O., Del Buono, A., Best, T. M. and Maffulli, N. 2012. Acute muscle strain injuries: a proposed new classification system. *Knee Surgery, Sports Traumatology, Arthroscopy,* 20(11): 2356-2362.

Chang, W.L., Shih, Y.F. and Chen, W.Y. 2012. Running injuries and associated factors in participants of ING Taipei Marathon. *Physical Therapy in Sport*, 13(3): 170-174.

Chen, C.M., LaBat, K. and Bye, E. 2011. Bust prominence related to bra fit problems. *International Journal of Consumer Studies,* 35(6): 695-701.

Cheung, K., Hume, P. A. and Maxwell, L. 2003. Delayed onset muscle soreness: treatment strategies and performance factors. *Sports Medicine*, 33(2): 145-164.

Cheuvront, S.N. and Haymes, E.M. 2001. Thermoregulation and marathon running: biological and environmental influences. *Sports Medicine,* 31(10): 743-762.

Chiropractic Day Clinic Manual. 2014. Chiropractic and Somatology Department, Durban University of Technology.

Chiropractic Handbook. 2014. Chiropractic and Somatology Department. Durban University of Technology.

Clarsen, B., Myklebust, G. and Bahr, R. 2013. Development and validation of a new method for the registration of overuse injuries in sports epidemiology: the Oslo Sports Trauma

Research Centre (OSTRC) overuse injury questionnaire. *British Journal of Sports Medicine,* 47(8): 495-502.

Coetzee, C. W. 2013. An injury profile of amateur and semi-professional KwaZulu-Natal triathletes. M.Tech., dissertation, Durban University of Technology.

Coetzer, P., Noakes, T.D., Sanders, B., Lambert, M., Bosch, A., Wiggins, T. and Dennis, S. 1993. Superior fatigue resistance of elite black South-African distance runners. *Journal of Applied Physiology,* 75(4): 1822-1827.

Cohen, S.P. 2005. Sacroiliac Joint Pain: A Comprehensive Review of Anatomy, Diagnosis and Tretament. *Anaesthesia and Analgesia*, 101:1440-1453.

Cole, A., Gill, T. K., Shanahan, E. M., Phillips, P., Taylor, A. W. and Hill, C. 2009. Is diabetes associated with shoulder pain or stiffness? Results from a population based study. *The Journal of Rheumatology*, 36(2): 371-377.

Colledge, N.R, Walker, B.R. and Ralston. S.H. 2010. *Davidson's principles and practice of medicine.* 21st ed. Edinburgh: Elsevier.

Conradie, E. 2013.The effect of chiropractic adjustments on sprint times and vertical jump height in rugby players. M.Tech., dissertation, University of Johannesburg.

Cook, D.B., O'Connor, P.J., Oliver and S.E., Lee, Y. 1998. Sex differences in naturally occurring leg muscle pain and exertion during maximal cycle ergometry. *International Journal of Neuroscience,* 95(3-4): 183-202.

Cook, J.L., Khan, K. and Purdam, C.R. 2001. Conservative treatment of patellar tendinopathy. *Physical Therapy in Sport,* 2(2): 54-65.

Cribari, M., Rüst, C. A. Rosemann, T., Onywera, V., Lepers, R. and Knechtle, B. 2013. Participation and performance trends of East African runners in Swiss half-marathons and marathons held between 2000 and 2010. *BMC Sports Science, Medicine and Rehabilitation,* 5(1):24.

Da Silva, C. 2015. A profile of injuries among participants at the 2013 Cross Fit Games in Durban. M.Tech., dissertation, Durban University of Technology.

Dagenais, S. and Haldeman, S. 2012. *Evidence-based management of low back pain.* St Louis, MO.:Elsevier.

Dagenais, S., Caro, J. and Haldeman, S. 2008. A systematic review of low back pain cost of illness studies in the United States and internationally. *The Spine Journal,*8(1): 8-20.

Dannecker, E.A., Koltyn, K.F., Riley, J.L. and Robinson, M.E. 2003. Sex differences in delayed onset muscle soreness. *Journal of Sports Medicine and Physical Fitness,*43(1): 78-84.

Decker, M.J., Torry, M.R., Wyland, D.J., Sterett, W.I. and Steadman, J.R. 2003. Gender differences in lower extremity kinematics, kinetics and energy absorption during landing. *Clinical Biomechanics,*18(7): 662-669.

Deie, M., Sakamaki, Y., Sumen, Y., Urabe, Y. and Yoshikazu, I. 2002. Anterior knee laxity in young women varies with their menstrual cycle. *International Orthopaedics,*26(3): 154-156.

DeLeo, A.T., Dierks, T.A., Ferber, R. and Davis, I.S. 2004. Lower extremity joint coupling during running: a current update. *Clinical Biomechanics*, 19(10): 983-991.

DeMaio, M., Paine, R., Mangine, R.E. and Drez, D. 1993. Plantar fasciitis. *Orthopaedics*, 16(10): 1153-1163.

Dicharry, J. 2010. Kinematics and kinetics of gait: from lab to clinic. *Clinics in Sports Medicine,*29(3): 347-364.

Dictionary of Sport and Exercise Science and Medicine. 2008. Edinburgh: Elsevier.

Dierks, T.A., Davis, I.S. and Hamill, J. 2010. The effects of running in an exerted state on lower extremity kinematics and joint timing. *Journal of Biomechanics,* 43(15): 2993-2998.

DiFiori, J.P., Benjamin, H.J., Brenner, J., Gregory, A., Jayanthi, N., Landy, G.L. and Luke, A. 2014. Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *Clinical Journal of Sports Medicine,* 24(1): 3-20.

Dommerholt, J., Bron, C. and Franssen. 2006. Myofascial trigger points: an evidence-informed review. *The Journal of Manual and Manipulative Therapy,*4(14): 73-92.

Dorland's medical dictionary for health care consumers, 2007. St Louis MO.: Elsevier.

Dreyer, N. 2004. South Africa: Traditional Medicine to Fight AIDS, Poverty. Star News paper. [Online] Available from http://www.newmediaexplorer.Org/sepp/2004/02/16/southafricatraditionalmedicinetofightaidspoverty.htm (Accessed 30 June 2015).

Egermann, M., Brocai, D., Lill, C.A. and Schmitt, H. 2003. Analysis of injuries in long distance tri-athletes. *International Journal of Sports Medicine,* 24(4): 271-276.

Ellapen, T.J., Satyendra, S., Morris, J. and van Heerden, H.J. 2013. Common running musculoskeletal injuries among recreational half-marathon runners in KwaZulu-Natal*. South African Journal of Sports Medicine*, 25(2): 39-43.

Elliott, B. 1990. *Adolescent overuse sporting injuries: a biomechanical review*. National Sports Research Centre, Australian Sports Commission. https://secure.ausport.gov.au/__data/assets/pdf_file/0008/380879/No._23_Adolescent_Overuse_Sporting_Injuries.pdf.

Esterhuizen, T. 4/.5/2015. Personal communications with G. v. Niekerk. Durban University of Technology.

Evans G.F., Haller, R.G., Wyrick, P.S., Parkey, R.W. and Fleukenstein, J.L. 1998. Submaximal delayed-onset muscle soreness: correlation between MR imaging findings and clinical measures. *Radiology,*208(3): 815-820.

Febbraio, M. A., Snow, R. J., Stathis, C. G., Hargreaves, M. And Carey, M. F. 1994. Effect of heat stress on muscle energy metabolism during exercise. *Journal of Applied Physiology,* 77(6): 2827-2831.

Finch, C. F. and Cook, J. 2014 Categorising sports injuries in epidemiological studies: the subsequent injury categorisation (SIC) model to address multiple, recurrent and exacerbation of injuries. *British Journal of Sports Medicine,*48(17): 1276-1280.

Finch, C. F. and Mitchell, D. J. 2002. A comparison of two injury surveillance systems within sports medicine clinics. *Journal of Science and Medicine in Sport,* 5(4): 321-335.

Finch, C. F., Valuri, G. and Ozanne-Smith, J. 1999. Injury surveillance during medical coverage of sporting events: development and testing of a standardized data collection form. *Journal of Science and Medicine in Sport*, 2(1):42-56.

Fink, A. and Kosekoff, J. B. 1985. *How to conduct surveys: a step by step guide.* Thousand Oaks, CA.: Sage.

Fischer, A. A. 1987. Pressure algometry over normal muscles. Standard values, validity and reproducibility of pressure threshold. *Pain,* 30: 115-126.

Gabbe, B. and Finch, C. F. 2001. A profile of Australian football injuries presenting to sports medicine clinics. *Journal of Science and Medicine in Sport,*4(4): 386-395.

Gage, J.R. 1990. An overview of normal walking. *AAOS Instructional Course Lectures,* 39:291-303.

Gaumer, G., Koren, A. And Gemmen, E. 2002. Barriers to Expanding Primary Care Roles for Chiropractors: The Role of Chiropractic as Primary Care Gatekeeper. *Journal of Manipulative and Physiological Therapeutics,* 25(7): 427-449.

Gehlsen, G., Ganton, L. and Helfst, R. 1999. Fibroblast responses to variation in soft tissue mobilisation pressure. *Medicine and Science in Sport and Exercise,*31: 531-535.

Giles, L. and Singer, K. 1998. *Clinical anatomy and management of cervical spine pain*. Oxford: Butterworth-Heinemann.

Glover, B., Shepard, J. and Glover, F.S. 1996. *The runner's handbook.* New York: Penguin.

Gosling, C.M., Gabbe, B.J. and Forbes, A.B. 2008. Triathlon related musculoskeletal injuries: the status of injury prevention knowledge. *Journal of Science and Medicine in Sport,*11: 396-406.

Greenbaum, T. L. 2000. *Moderating focus groups [electronic resource]: a practical guide for group facilitation.* Thousand Oaks, CA.: Sage. Doi: http://dx.doi.org/10.4135/9781483328522

Gujarati, D.N. and Porter, D. 2009. *Basic econometrics.* Uttar Pradesh, India: McGraw Hill.

Haldeman, S. and Rubenstein de Koekkoek, T. 1996. Spinal manipulation. In: Watkins, R.G. (ed).*The spine in sports.* St Louis, MO.: Mosby, 303-311.

Hamilton, B. 2000. East African running dominance: what is behind it? *British Journal of Sports Medicine,* 34(5): 391-394.

Hammer, W.I. 2007. *Functional soft tissue examination and treatment by manual methods*. 3rd ed. Sudbury, MA.: Jones and Bartlett.

Hamstra-Wright, K.L. and Preish, M. 2014. Common running-related injuries: methodology and prevention evidence based report. *Athletic Training and Sports Health Care*, 6(1): 46-48.

Havenith, G. 2001. Individualized model of human thermoregulation for the simulation of heat stress response. *Journal Applied Physiology,* 90(5): 1943-1954

Heitz, N.A., Eisenman, P.A., Beck, C.L. and Walker, J.A. 1999. Hormonal changes throughout the menstrual cycle and increased anterior cruciate ligament laxity in females. *Journal of Athletic Training,* 34(2): 144-149.

High, D.M., Howley, E.T. and Franks, B.D. 1989. The effects of static stretching and warm-up on prevention of delayed-onset muscle soreness. *Research Quarterly for Exercise and Sport,* 60(4): 357-361.

Hopkins, J.T. and Ingersoll, C.D. 2000. Arthrogenic muscle inhibition: a limiting factor in joint rehabilitation. *Journal of Sport Rehabilitation*, 9(2): 135-159.

Hopkins, J.T., Ingersoll, C.D., Edwards, J. and Klootwyk, T.E. 2001. Cryotherapy and transcutaneous electric neuromuscular stimulation decrease arthrogenic muscle inhibition of the vastus medialis after knee joint effusion. *Journal of Athletic Training*, 37(1): 25-31.

Hopkins, W.G., Marshall, S.W., Quarrie, K.L. and Hume, P.A. 2007. Risk factors and risk statistics for sports injuries. *Clinical Journal of Sport Medicine*, 17(3): 208-210.

Hoskins, W., McHardy, A., Pollard, H., Windsham, R., Onley, R. 2006. Chiropractic treatment of lower extremity conditions: a literature review. *Journal of Manipulative and Physiological Therapeutics,* 29(8): 658-671.

Hreljac, A. and Ferber, R. 2006. A biomechanical perspective of predicting injury risk in running. *International SportsMed Journal,* 7(2): 98-108.

Hurwitz, E.L., Morgenstern, H., Harber, P.,Kominski, G.F.,Yu, F. andAdams, A.H. 2002. A randomized trial of chiropractic manipulation and mobilization for patients with neck pain: clinical outcomes from the UCLA neck-pain study. *American Journal of Public Health,* 92(10): 1634-1641.

Hyde, T.E. and Gengenbach, M.S. 2007. *Conservative management of sports injuries.* Sudbury, MA.: Jones and Bartlett.

Jackson, R.P., Jacobs, R.R. and Montesano, P.X. 1988. Facet joint injection in low-back pain: a prospective statistical study. *Spine,* 13(9): 966-971.

Jakobsen, B. W., Krøner, K., Schmidt S. A.and Jensen, J. 1989. Løbeskader ved motions marathon. Registrering af skadehyppighead og skadetyper ved Århus Marathon 1986 (Running injuries sustained in a marathon race. Registration of the occurrence and types on injuries in the 1986 Arhus Marathon.) *Ugeskr Laeger,* 28: 2189-21.

James, S.L. 1995. Running injuries to the knee. *Journal of the American Academy of Orthopaedic Surgeons,* 3(6):309-18.

Jamison, J. R. 2001. Reflections on Chiropractic's Patient-Centered Care. *Journal of Manipulative and Physiological Therapeutics,* 24(7): 483-486.

Jeffers, K. 1999. Common running injuries. *Journal of the American Chiropractic Association*, 36(4): 26.

Jones, B.H., Cowan, D.N., Tomlinson, J.P., Robinson, J.R., Polly, D.W. and Frykman, P.N. 1993. Epidemiology of injuries associated with physical training among young men in the army. *Medicine and science in sports and exercise,* 25(2): 197-203.

Juhn, M.S. 1999. Patellofemoral pain syndrome: A review and guidelines for treatment. *American Family Physician,* 60(7):2012-2022.

Julian, C; Hoskins, W and Vitiello, A. 2010. Sports chiropractic management at the World Ice Hockey Championships. *Chiropractic & Manual Therapies*, 18(1): 1-9.

Junge, A., Engebretsen, L., Alonso, J.M., Renstrom, P., Mountjoy, M., Aubry, M. and Dvorak J. 2008. Injury surveillance in multi-sport events: the International Olympic Committee approach. *British Journal of Sports Medicine*, 42(6): 413-421.

Kaufmann, K., Brodine, S. and Shaffer, R. 2000. Military training-related injuries: surveillance research and prevention. *American Journal of Preventative Medicine,*18(3S): 54-63.

Kirkaldy-Willis, W.H. and Burton, C.V. 1992. *Managing low back pain.* New York: Churchill Livingstone Inc.

Konczak, C. 2010. Chiropractic utilization in BMX athletes at the UCI World Championships: a retrospective study. *The Journal of the Canadian Chiropractic Association*, 54(4): 250-256.

Kopansky-Giles, D., Vernon, H., Steiman, I., Tibbles, A., Decina, P., Goldin, J. and Kelly, M. 2007. Collaborative community-based teaching clinics at the Canadian memorial Chiropractic College: addressing the needs of local poor communities. *Journal of Manipulative and Physiological Therapeutics,* 30(8): 558-565.

Korkia, P.K., Tunstall-Pedoe, D.S. and Maffulli, N. 1994. An epidemiological investigation of training and injury patterns in British triathletes. *British Journal of Sports Medicine,*28(3): 191-196.

Korporaal, C. 2002. A retrospective epidemiological investigation of the chiropractic students sports association sports questionnaire, with reference to field hockey: a methodological perspective. M.Tech., dissertation, Durban University of Technology.

Korporaal, C. 2015. *Personal communication.*

Korporaal, C. and Talmage, G. 2008. Manual therapy in Africa: an overview. (PowerPoint presentation).

Korr, I. M. (Ed.). 2012. *The Neurobiologic mechanisms in manipulative therapy.* Springer Science & Business Media.

Kraemer, W., Häkkinen, K., Newton, R., Nindl, B., Volek, J., McCormick, M., Gotshalk, L., Gordon, S., Fleck, S., Campbell, W., Putukian M., and Evans, W. 1999. Effects of heavy-resistance training on hormonal response patterns in younger vs older men. *Journal of Applied Physiology,*87(3): 982-992.

Kretsch, A., Grogan, R., Duras, P., Allen, F., Summer, J. and Gillam, I. 1984. 1980 Melbourne marathon study. *The Medical Journal of Australia,*141(12-13): 809-814.

Kruse, D. and Lemmen, B. 2009. Spine injuries in the sport of gymnastics. *Current Sports Medicine Reports,*8(1): 20-28.

Larsen, H. 2003. Kenyan dominance in distance running. *Comparative Biochemistry and Physiology,* A(136): 161-170.

Lavine, R. 2010. Iliotibial band friction syndrome. *Current Review of Musculoskeletal Medicine*, 3:18-22.

Leach, R. A. 2004. *The chiropractic theories: a textbook of scientific research.* Lippincott Williams & Wilkins.

Levine, D., Richards, J. and Whittle, M. 2012. *Whittle's gait analysis.* 5th ed. St Louis, MO.: Elsevier Ltd.

Longo, U. G., Rittweger, J., Garau, G., Radonic, B., Gutwasser, B., Gilliver, S. F., Kusy. K, Zieliński, J., Felsenberg, D. and Maffulli, N. 2009. No influence of age, gender, weight, height, and impact in Achilles tendinopathy in masters track and field athletes. *The American Journal of Sports Medicine,*37(7): 1400-1405.

Lopes, A.D., Hespanhol, L.C.,Yeung, S. and Pena Costa, L.N. 2012. What are the main running-related musculoskeletal injuries? *Sports Medicine,*42(10): 891-905.

Lun, V., Meeuwisse, W.H., Stergiou, P. and Stefanyshyn, D. 2004. Relation between running injury and static lower limb alignment in recreational runners. *British Journal of Sports Medicine,* 38(5):576-580.

Lysholm, J. and Wilkander, J. 1987. Injuries in runners*. American Journal of Sports Medicine,* 15(2):168-71.

MacDougall, T. 1999. The relative effectiveness of proprioceptive neuromuscular facilitative stretching as compared to static stretching in the treatment of active myofascial trigger points. M.Tech.,dissertation, Durban University of Technology.

Macera, C., Pate, R., Powell, K. Jackson, K., Kendrick, J. and Craven, T. 1989. Predicting lower-extremity injuries among habitual runners. *Archives of Internal Medicine,* 149(11):2565-2568.

Macera, C.A. 1992. Lower extremity injuries in runners. *Sports Medicine,* 13(1): 50-57.

Macera, C.A., Pate., R.R,. Woods, J., Davis, D.R.and Jackson, K.L. 1991. Postrace morbidity among runners. *American Journal of Preventative Medicine,* 7(4): 194-198.

MacIntyre, D.L., Reid, W.D., Lyster, D.M.and McKenzie, D.C. 2000. Different effects of strenuous eccentric exercise on the accumulation of neutrophils in muscle in women and men. *European Journal of Applied Physiology,*81(1-2): 47-53.

MacIntyre, J.G, Taunton, J.E., Clement, D.B., Lloyd-Smith, D.R., McKenzie, D.C. and Morrell, R. W. 1991. Running injuries: a clinical study of 4,173 cases. *Clinical Journal of Sports Medicine,*1(2):81-87.

Maffulli, N. 1995. Ultrasound of the Achilles tendon after surgical repair: morphology and function. *British Journal of Radiology,*68(816): 1372-1373.

Maffulli, N. 1996. Clinical tests in sports medicine: more on Achilles tendon. *British Journal of Sports Medicine,*30(3): 250.

Maffulli, N. 1998. The clinical diagnosis of subcutaneous tear of the Achilles tendon: a prospective study in 174 patients. *American Journal of Sports Medicine,*26: 266-270.

Maffulli, N. 1999. Current concepts review: rupture of the Achilles tendon. *The Journal of Bone & Joint Surgery,*81: 1019-1036.

Maffulli, N., Barass, V.and Ewen, S.W. 2000. Light microscopic histology of Achilles tendon ruptures: a comparison with unruptured tendons. *American Journal of Sports Medicine,*28(6): 857-863.

Maffulli, N., Testa, V., Capasso, G. Oliva, F., Sullo, A., Benazzo, F., Regine, R. and King, J.B.2006.Surgery for chronic Achilles tendinopathy yields worse results in nonathletic patients. *Clinical Journal of Sport Medicine,*16(2): 123-128.

Mahomed, F. 2007. Chiropractic patients in South Africa: a demographic and descriptive profile. M. Tech., dissertation, Durban University of Technology.

Malisoux, L., Nielsen, R.O., Urhausen, A. and Theisen, D. 2014. A step towards understanding the mechanisms of running-related injuries. *Journal of Science and Medicine in Sport,*1068:1-6.

Manninen, J. and Kallinen, M. 1996. Low back pain and other overuse injuries in a group of Japanese traithletes. *British Journal of Sports Medicine,*30(2):134-139.

Marti, B., Vader, J.P., Minder, C.E. and Abelin, T. 1988. On the epidemiology of running injuries. *American Journal of Sports Medicine,*16(3): 285-294.

Massimino, F.A., Armstrong, M.A., O'Toole, M.L., Hiller, W.B.D. and Laird, R.H. 1988. Common triathlon injuries: special consideration for multisport training. *Annals of Sports Medicine,* 4:82.

Maughan R.J. and Miller, J.D. 1983. Incidence of training-related injuries among marathon runners. *British Journal of Sports Medicine,* 17(3): 162-165.

McAlery, C. 2015. An analysis of injury profiles and management strategies utilized by chiropractic students at the 2014 Durban 'Rugby Rush Tournament'. M.Tech., dissertation, Durban University of Technology

McBean, M. 2015. An injury surveillance of patients utilising the Durban University of Technology (DUT) Chiropractic Treatment Facilities at the 2013 World Transplant Games. M.Tech., dissertation, Durban University of Technology.

McGhee, D.E. and Steele, J.R. 2010. Optimising breast support in female patients through correct bra fit: a cross-sectional study. *Journal of Science and Medicine in Sport,*13(6): 568-572.

Meeuwisse, W. 1994. Assessing causation in sport Injury: a multifactorial model. *Clinical Journal of Sport Medicine,*4(3):166-170.

Messier, S.P., Davis, S.E., Curl, W.W., Lowery, R.and Pack, R.J. 1991. Etiological factors associated with patellofemoral pain in runners. *Medicine and Science in Sports and Medicine,* 23(9):1008-1015.

Montori, V., Brito, J.and Murad, H. 2013. The optimal practice of evidence-based medicine incorporating patient preferences in practice guidelines. *Journal of the American Medical Association*, 310(23):2503-2504.

Mootz, R. and McCarthy, K. 1999. *Sports chiropractic: topics in clinical chiropractic series*. Sudbury, MA: Jones and Bartlett Learning.

Morgan, D.L. 1996. Focus groups. *Annual Review of Sociology,* 22(1): 129-152.

Morgan, D.L. 1997. *Focus groups as qualitative research.* 2nd ed. London: Sage.

Mouton, J. 1996. *Understanding social research.* Pretoria: van Schaik Publishers.

Movassaghi, S., Nasiri Toosi, M., Bakhshandeh, A., Niksolat, F., Khazaeipour, Z., and Tajik, A. 2012. Frequency of musculoskeletal complications among patients receiving solid organ transplantation in a tertiary health-care center. *Rheumatology International* (online), 32(8): 2363-2366. Available: http://www.ncbi.nlm.nih.gov/pubmed/21644040 (Accessed 1 November 2013).

Mueller-Wohlfahrt, H., Haensel, L., Mithoefer, K., Ekstrand, J., English, B., McNally, S., Orchard, J., van Dijk, C. N., Kerkhoffs, G. M., Schamasch, P., Blottner, D., Swaerd, L., Goedhart, E.and Ueblacker, P. 2012. Terminology and classificationof muscle injuries in sport: a consensus statement. *British Journal of Sports Medicine,*0: 1-9.

Murgatroyd, T.L. 2009. A retrospective cohort analysis of the injury profile of internationally competitive surfers. M.Tech., dissertation, Durban University of Technology.

Murphy, D.F., Connolly, D.A.J. and Beynnon, B.D. 2003. Risk factors for lower extremity injury: a review of the literature. *British Journal of Sports Medicine*, 37(1): 13-29.

Murray E, 2007. Clinical decision-making: Physician's preferences and experiences. *BMC Family Pract*; March 15: 8-10.

National Research Council (US). Committee on Trauma Research. 1985. *Injury in America: a continuing public health problem*. Washington, DC: National Academy Press.

Newham, D.J., Jones, D.A.and Clarkson, P.M. 1987. Repeated high-force eccentric exercise: effects on muscle pain and damage. *Journal of Applied Physiology,* 63(4): 1381-1386.

Nicholl, J. and Williams. B. 1982a. Popular marathons: forecasting casualties. *British Medical Journal,* 285(6353): 1464-1465.

Nicholl, J. and Williams. B. 1982b. Medical problems before and after a popular marathon. *British Medical Journal,* 285(6353): 1465-1466.

Noakes, T. 2003. *The lore of running.* Leeds, UK: Human Kinetics.

Noakes, T. and Granger, S. 2003. *Running injuries: how to prevent and overcome them.* 3rd ed. Cape Town: Oxford University Press Southern Africa.

Nobel, C. 1997. *The Pfizer manual of sports injuries.* Cape Town: Medical Tribune Publication.

Norkin, C.C. and Levangie, P.K. 1992. *Joint structure and function: a comprehensive analysis.* 2nd ed. Philadelphia, PA.: F.A. Davis.

Novacheck, T. F. 1998. The biomechanics of running. *Gait and Posture*, 7: 77-95.

O'Toole, M., Hiller, W., Smith, R.and Sisk. 1989. Overuse injuries in ultra endurance triathletes. *American Journal of Sports Medicine,*17(4): 514-518.

Omar, M., Seedat, M.A., Dyer, R.B., Motala, A.A., Knight, L.T.and Becker, P.J. 1994. South-African Indians show a high prevalence of NIDDM and bimodality in plasma-glucose distribution patterns. *Diabetes Care,* 17(1):70-3.

Onywera, V.O. 2009. East African runners: their genetics, lifestyle and athletic prowess. *Medicine and Sports Science,* 54: 102-109.

Onywera, V.O., Scott, R., Boit, M.and Pitsiladis, Y. 2006. Demographic characteristics of elite Kenyan endurance runners. *Journal of Sports Sciences,* 24(4): 415-422.

Oxford Dictionaries (online). 2015. Available: http://www.oxforddictionaries.com/ (Accessed 29/06/2015).

Paluska, S. 2005. An overview of hip injuries in running. *Sports Medicine,*35(11): 991-1014.

Pechter, E.A. 1998. A new method for determining bra size and predicting post augmentation breast size. *Plastic and Reconstructive Surgery,*102(4): 1259-1265.

Pickar, J.G. 2002. Neurophysiological effects of spinal manipulation. *The Spine Journal,* 2(5): 357-371.

Pluim, B.M., Fuller, C. W., Batt, M.E., Chase, L., Hainline, B., Miller, S., Montalvan, B., Renstrom, P., Stroia, K.A., Weber, K. and Wood, T.O. 2009. Consensus statement on epidemiological studies of medical conditions in tennis, April 2009. *British Journal of Sports Medicine*, 43(12): 893-897.

Poudevigne, M., O'Connor, P.and Pasley, J. 2002. Lack of both sex differences and onfluence of resting blood pressure on muscle pain intensity. *The Clinical Journal of Pain,* 18(6):386-393.

Powell, K. E. 1986. An epidemiological perspective on the cause of running injuries. *Physician Sports Medicine,* 14(6):100-108.

Puckree, T., Govender, A., Govender, K.and Naidoo, P. 2007. The quadriceps angle and the incidence of knee injury in Indian long distance runners. *South African Journal of Sports Medicine,* 19(10):9-11.

Ramasamy, A, Hill, A.M. and Clasper, J.C. 2009. Improvised explosive devices: pathophysiology, injury profiles and current medical management. *Journal of the Royal Army Medical Corps*, 155(4): 265-272.

Rasmussen, C.H., Nielsen, R.O., Juul, M.S.and Rasmussen, S. 2013. Weekly running volume and risk of running-related injuries among marathon runners. *The International Journal of Sports Physical Therapy,*8(2): 111-120.

Rattan, A. 2007. The knowledge and perception of Grade 12 learners from selected secondary schools in the Durban Metropolitan Region on the chiropractic profession. M.Tech., dissertation, Durban University of Technology.

Reid, D. 1992. *Sports injury assessment and rehabilitation.* New York: Churchill Livingstone.

Ren, L., Jones, R. K.and Howard, D. 2007. Predictive modelling of human walking over a complete gait cycle. *Journal of Biomechanics,* 40(7): 1567-1574.

Renström, P. and Peterson, L. 2003. *Sports injuries: their prevention and treatment*. 3rd ed. London: Martin Dunitz, an imprint of the Taylor and Francis Group.

Renström, P.A.F.H. 1993. *Sports injuries: basic principles of prevention and care*. Oxford: Blackwell Scientific Publications.

Republic of South Africa. Allied Health Professions Act 63, 1982. Government Gazette no. 1746: 1 August. Pretoria: Government Printer.

Riddle, D., Pulisic, M., Pidcoe, P.and Johnson, R. 2003. Risk factors for plantar fasciitis: a matched case-control study. *The Journal of Bone and Joint Surgery,* 85A(5): 872-877.

Rinard, J., Clarkson, P.M., Smith, L.L.and Grossman, M. 2000. Responses of males and females to high-force eccentric exercise. *Journal of Sports Sciences,*18(4): 229-236.

Robergs, R. and Roberts, S. 1997. *Exercise physiology.* St Louis, MO.: Mosby

Running USA. 2015. Available: http://www.runningusa.org/statistics (Accessed 15/6/2015).

Sackett, D.L., Straus, S.E., Scott Richardson, W., Rosenberg, W. and Haynes, R.B. 2000. *Evidence-based medicine: how to teach EBM*. 2nd ed. Edinburgh: Churchill Livingstone.

Saltin, B., Terrados, N., Larsen, H., Svedenhag, J.and Rolf, C.J. 1995. Morphology, enzyme activities and buffer capacity in leg muscles of Kenyan and Scandinavian runners. *Scandinavian Journal of Medicine & Science in Sports,* 5(4): 222-230.

Satterthwaite, P., Larmer, P.and Gardiner, J. and Norton, R.1996.Incidence of injuries and other health problems in the Auckland Citibank marathon, 1993. *British Journal of Sports Medicine,* 30(4): 324-326.

Satterthwaite, P., Norton, R., Larmer, P.andRobinson, E. 1999. Risk factors for injuries and other health problems sustained in a marathon. *British Journal of Sports Medicine,*33(1): 22-26.

Scarfe, A. 2011. From theory to practice: running kinematics of triathletes. PhD,thesis, University of Birmingham.

Schwarzer, A.C., Aprill, C.N., Derby, R. Fortin, J., Kine, G. and Bogduk, N. 1994a. The relative contributions of the disc and zygapohyseal joint in chronic low back pain. *Spine,* 19(7): 801-806.

Schwarzer, A.C., Aprill, C.N., Derby, R. Fortin, J., Kine, G. and Bogduk, N. 1994b. The value of the provocation response in lumbar zygapophyseal joint injections. *Clinical Journalof Pain,* 10: 309-313.

Scollen, R. and Scollen, S.W. 1995.*Intercultural communication*. Cambridge, MA: Blackwell.

Scott, R., Wilson, R., Goodwin, W., Moran, C., Georgiades, E., Wolde, B.and Pitsiladis, Y. 2005. Mitochondrial DNA lineages of elite Ethiopian athletes. *Comparative Biochemistry and Physiology,* B(140): 497-503.

Shaibani, A., Workman, R.and Rothschild, B. M. 1993. The significance of enthesopathy as a skeletal phenomenon. *Clinical and Experimental Rheumatology*, 1(4): 399-403.

Shamus, E.and Shamus, J. 2001. *Sports injury prevention and rehabilitation*. New York: McGraw-Hill Medical Publishing

Silverman, D. 1997. *Qualitative research: theory, method and practice*. London. Sage

Simons, D.G., Travell, J.G.and Simons, L.S. 1999. *Myofascial pain and dysfunction: the trigger point manual*. 2nd ed. Baltimore, MD.: Williams and Wilkins.

Sports Chiropractic. 2013. (online). Available: http://www.chirosport.co.za/sports-chiropractic (Accessed28/03/2014).

Sports Medicine Australia. 2010. *Soft tissue injuries, a guide to prevention and management.* Available: http://sma.org.au/resources-advice/injury-fact-sheets/soft-tissue-injuries/ (Accessed: 16/06/2015).

Stanish, W.D. 1984. Overuse injuries in athletes: a perspective. *Medicine and Science in Sports and Exercise,* 16(1): 1-7.

Statistics South Africa. 2015. Available: http://www.statssa.gov.za (Accessed 16/06/2015).

Steinacker, T., Steuer, M.andHöltke, V. 2001. Orthopädische probleme bei älteren Marathon läufern. (Orthopedic problems in older marathon runners.) *Sportverletz Sportschaden,* 15: 12-15.

Stergiou, N., Bates, B.and James, S. 1999. Asynchrony between subtalar and knee joint function during running. *Journal Articles.* Paper 61: 1645-1654.

Subotnick, S. I. 1991. *Conventional, homeopathic and alternative treatments: sports and exercise injuries.*Berkeley, CA.: North Atlantic Books.

Subotnick S. I. 1999. Clinical biomechanics: biomechanics of the foot and ankle.In: Subotnick, S. I. ed.*Sports medicine of the lower extremity.* 2nd ed. Philadelphia, PA.: WB Saunders Co, 127-136.

Suter, E., McMorland, G., Herzog, W. and Bray, R. 1999. Decrease in quadriceps inhibition after sacroiliac joint manipulation in patients with anterior knee pain. *Journal of Manipulative and Physiological Therapeutics*, 22(3): 149-153.

Suter, E., McMorland, G., Herzog, W. and Bray, R. 2000. Conservative lower back treatment reduces inhibition in knee extensor muscles: a randomised controlled trial. *Journal of Manipulative and Physiological Therapeutics*, 23(2): 76-80.

Taimela S., Kujala, M.and Oesterman, K. 1990. Intrinsic risk and athletic injuries. *Sports Medicine,* 9(4):205-215.

Tandogan, R.N., Taşer, Ö., Kayaalp, A., Taşkıran, E., Pınar, H., Alparslan, B.and Alturfan, A. 2004. Analysis of meniscal and chondral lesions accompanying anterior cruciate ligament tears: relationship with age, time from injury and level of sport. *Knee Surgery, Sports Traumatology, Arthoscopy,* 12: 262-270.

Taunton, J.E., Ryan, M.B., Clement, D.B., McKenzie, D.C., Lloyd-Smith, D.R.and Zumbo, B.D. 2002.A retrospective case-control analysis of 2002 running injuries*. British Journal of Sports Medicine*, 36(2): 95-101.

Taunton, J.E., Ryan, M.B., Clement, D.B., McKenzie, D.C., Lloyd-Smith, D.R.and Zumbo, B.D. 2003. A prospective study of running injuries: the Vancouver Sun Run “In Training” clinics. *British Journal of Sports Medicine*, 37(3): 239-244.

The Free Dictionary (online). 2013Available: http://medical-dictionary.thefreedictionary.com (Accessed 10/10/2014).

Thomas, S.J., McDougall, C., Brown, I., Jaberoo, M.C., Steams, A., Ashraf, R., Fisher, M.and Kelly, I. 2007. Prevalence of symptoms and signs of shoulder problems in people with diabetes mellitus. *Journal of Shoulder &Elbow Surgery,*16(6): 748-751.

Tiemstra, J.D. 2012. Update on acute ankle sprains. *American Family Physician,* 85(12): 1170-1176.

Travell, J.G. and Simons, D.G. 1999. *Travell and Simons' myofascial pain and dysfunction: the trigger point manual*. 2nd ed. Baltimore, MD.: Williams and Wilkins.

Triano, J. J. 2001. Biomechanics of spinal manipulative therapy. *The Spine Journal,* 1: 121-130.

Van Gent, R.N., Siem, D., Van Middelkoop, M., Van Os, A.G., Bierma-Zeinstra, S.M.A.and Koes, B.W. 2007. Incidence and determinates of lower extremity running injuries in long distance runners:a systemic review. *British Journal of Sports Medicine,* 41(8): 469-480.

Van Mechelen, W. 1992. Running injuries: a review of the epidemiological literature. *Sports Medicine,* 14:320-335.

Van Middelkoop, M., Kolkman, J., Van Ochten, J., Bierma-Zeinstra, A.and Koes, B. 2007. Prevalence and incidence of lower extremity injuries in male marathon runners. *Scandinavian Journal of Medicine and Science in Sports*, 18: 140-144.

Vetter, R and Symonds, M. 2010. Correlations between injury, training intensity and physical and mental exhaustion among college athletes. *Journal of Strength and Conditioning Research,*24(3): 587-596.

Vicenzino, B., Branjerdporn, M., Teys, P. and Jordan, K. 2006. The initial changes in posterior talar glide and dorsiflexion of the ankle after mobilization with movement in individuals with recurrent ankle sprain. *Journal of Orthopaedic and Sports Physical Therapy,* 36(7):464-471.

Villavicencio, A.T., Burneikienė, Hernández, T.D. and Thramann, J. 2006. Back and neck pain in triathletes. *Neurosurgical Focus,*21(4): 1-7.

Vlaeyen, J.W.S. and Linton, S.J. 2000. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain*, 85(3): 317-32.

Vleck, V.E. and Garbutt, G. 1998. Injury and training characteristics of male elite, development squad and club triathletes. *International Journal of Sports Medicine,*19(1): 38-42

Von Duvillard, S.P., Braun, W.A., Markofski, M., Beneke, R.and Leithäuser, R. 2004. Fluids and hydration in prolonged endurance performance. *Nutrition,* 20(7): 651-656.

Wainwright, A., Kelly, A. and Winson, I. 1995. Calcaneal spurs and plantar fasciitis. *The Foot,*5(3): 123-126.

Walter, S.D., Hart, L.E., McIntosh, J.M. and Sutton, J. R.1989. The Ontario cohort study of running-related injuries. *Archives of Internal Medicine,* 149(11): 2561-2564.

Wang, L., Zhang, Z., McArdle, J. and Salthouse, T. 2009. Investigating ceiling effects in longitudinal data analysis. *Multivariate Behavioral Research,* 43(3): 476-496.

Watkins, R.G. 1996. *The spine in sports.* St Louis, MO.: Mosby.

Wen, D.Y. 2007. Risk factors for overuse injuries in runners. *Current Sports Medicine Reports,* 6(5): 307-313.

Wen, D.Y., Puffer, J.C. and Schmalzried, T.P. 1998. Injuries in runners: a prospective study of alignment. *Clinical Journal of Sport Medicine,* 8(3): 187-194.

Weston, A., Mbambo, Z. and Myburgh, K. 2000. Running economy of African and Caucasian distance runners. *Medicine and Science in Sports and Exercise,* 32(6): 1130-1134.

White, J.L., Scurr, J.C. and Smith, N.A. 2009. The effect of breast support on kinetics during overground running performance. *Ergonomics,*52(4): 492-498.

Whitman J.M., Childs, J.D. and Walker, V. 2005. The use of manipulation in a patient with an ankle sprain injury not responding to conventional management: a case report. *Manual Therapy,* 10(3): 224-231.

Wood, K., Cameron, M. and Fitzgerald, K. 2008. Breast size, bra fit and thoracic pain in young women: a correlational study. *Chiropractic & Osteopathy,*16(1): 1-7.

Yeung, E. and Yeung, S. 2001. A systematic review of interventions to prevent lower limb soft tissue running injuries. *British Journal of Sports Medicine,*35: 383-389.

Zainuddin, Z., Newton, M., Sacco, P. and Nosaka, K. 2005. Effects of massage on delayed-onset muscle soreness, swelling, and recovery of muscle function. *Journal of Athletic Training,* 40(3): 174-180.

APPENDIXES

Appendix A

[NAME OF SELECTED MARATHON]

By signing alongside this statement, you agree to have the data collected at the [SELECTED MARATHON] in respect of your condition documented in research – without disclosure of your name or identifying details.
Sign:____________________Date:__________

[DATE OF SELECTED MARATHON] **FILE No:_______**
NAME: ____
POSITION: ATHLETE (state type), MANAGE, MEDT OTHER:_______________________
RACE: W B IN OTHER:________AGE:____________________SEX: MALE / FEMALE
TRAVEL HISTORY:____

NEW PATIENT	**REPEAT PATIENT**
NEW COMPLAINT	**CONTINUATION OF CARE**

REGION OF COMPLAINT

HEAD	NECK	THORAX	LUMBAR
SHOULDER	ELBOW	WRIST/HAND	FOREARM
UPPER ARM	HIP	KNEE	FOOT/ANKLE
SHIN/CALF	THIGH	CHEST	ABDOMEN

MECHANISM OF INJURY : ________________________________
DID INJURY CAUSE THE PATIENT NOT TO PARTICIPATE IN THE EVENT? YES NO
HAS THE AREA BEEN INJURED BEFORE ? YES NO
PREVIOUS TRAUMA: ____

CLINICAL IMPRESSIONS: ACUTE CHRONIC

HEAD/CONCUSSION	JNT SPRAIN	MM STRAIN	PFPS
HEAT EXHAUSTION	ABRASION	CONTUSION	LACERATION
C FACET	T FACET	SI SYNDROME	L FACET
TENDINITIS			

MYOFASCIALOF:____
_
GEN. MUS. TIGHT (DOMS) OF:____
NEURO / SYSTEMIC / OTHER:____
RANGE OF MOTION:____
OTHER:____

TREATMENT:

MANIPULATION	MOBILISATION	MASSAGE	STRETCH / PNF
STRETCH (STATIC)	TENS	NEEDLE	ISCH COMP
VOLTAREN USED	TRANSACT USED	REFERAL	

Indicate specific regions for the modalities

CONTINUATION OF PLAY: YES NO IF RESTRICTED - WHY ?____________________
CLINICIAN : NAME____
SIGN____
STUDENT : NAME____
SIGN____

APPENDIX A

Appendix B

MEMORANDUM

To : Prof Puckree
Chair : RHDC
Prof Adam
Chair : IREC

From : Dr Charmaine Korporaal
Clinic Director : Chiropractic Day Clinic : Chiropractic and Somatology

Date : 08.11.2014

Re : Request for permission to use the Chiropractic Day Clinic for research purposes

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Permission is hereby granted to :

Ms Giselle van Niekerk (Student Number: 20904729)

Research title : "An injury profile and management analysis of marathon runners at selected marathons in the greater EThekwini and UMgungundlovu Area in 2014."

The above permission allows the student to :

1. Receive copies of the data collection sheets from the relevant marathons.
2. These copies are to be stored safely, in a locked cabinet to which only the researcher has access.
3. These copies are to be shredded by the student on completion of the data capture.

It is requested that Ms van Niekerk submit a copy of her RHDC / IREC approved proposal to the Clinic Administrators before she starts with her research in order that any special procedures (with respect to the bullet points above) with regards to her research can be implemented prior to the commencement of her seeing patients.

Thank you for your time.

Kind regards

[redacted]

Dr Charmaine Korporaal
Clinic Director : Chiropractic Day Clinic : Chiropractic and Somatology
Cc: Mrs Pat van den Berg : Chiropractic Day Clinic
Dr L O'Connor : Research co-ordinator
Dr H White : Research supervisor

APPENDIX B

Appendix C

RACE		GENDER		NATURE OF VISIT	
White	1	Male	1	New Patient	1
Black	2	Female	2	Repeat Patient	2
Indian	3			New Complaint	3
Colored	4			Continuation of care	4
Other	5				
Information not available	99				
MECHANISM OF INJURY		**HISTORY OF PREVIOUS INJURY**		**HISTORY OF PREVIOUS TRAUMA**	
Trauma	1	Yes	1	Yes	1
Overuse	2	No	2	No	2
Idiopathic	3	Information not Available	99	Information not Available	0
DIAGNOSIS				**CLINICAL IMPRESSION**	
Head/concussion	1			Acute	1
Jt Sprain	2			Chronic	2
Muscle Strain	3			Subacute	3
PFPS	4			Acute on Chronic	4
Heat exhaustion	5				
Abrasion	6			**ABLE TO CONTINUE PLAY**	
Contusion	7			Yes	2
Laceration	8			No	1
C-facet Syndrome	9			Information not provided	0
T-facet Syndrome	10				
Si Syndrome	11			**CONTINUATION OF PLAY PERMITTED**	
L-facet Syndrome	12			Yes	1
Tendinitis	13			No	2
Myofascial Pain Syndrome	14			Information not provided	0
Tendinopathy – achilles	15				

Appendix D

DURBAN UNIVERSITY OF TECHNOLOGY

Institutional Research Ethics Committee
Faculty of Health Sciences
Room MS 49, Mansfield School Site
Gate 8, Ritson Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2900
Fax: 031 373 [illegible]
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http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

2 December 2014

IREC Reference Number: **REC 79/14**

Ms G van Niekerk
18 Parklodge Gardens
369 Berea Road
Berea
Durban
4001

Dear Ms van Niekerk

An injury profile and management analysis of marathon runners at selected marathons in the greater eThekwini and uMgungundlovu Municipalities during 2014

I am pleased to inform you that Full Approval has been granted to your proposal REC 79/14.

The Proposal has been allocated the following Ethical Clearance number **IREC 1[illegible]/14**. Please use this number in all communication with this office.

Approval has been granted for a period of one year, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's. In addition, you will be responsible to ensure gatekeeper permission.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

[redacted]

Professor J K Adam
Chairperson: IREC