An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes

By

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I, Cuan Wayne Coetzee, 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 my Creator – I dedicate this research to You.

Psalm 145 v 3: Great is the LORD, and greatly to be praised; and His greatness is unsearchable.

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It's been one epic journey, and it's just the beginning - I would like to thank the following people for helping me make it to the end of this chapter of my life. Without your help, it would not have been possible.

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Abstract

Background: A triathlon comprises of a combination of swimming, cycling and running. Triathlons are usually classified as sprint distance, Olympic distance, and Ironman or ultra-distance. Triathlon was popularized in the 2000 Summer Olympic Games and, despite this, there is insufficient data relating to injuries in the South African context. This study aimed to determine the injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes.

Methods: This Institutional Research Board approved, cross sectional study, included 80 active members of the Kwa-Zulu Natal Triathlon Association. All triathletes completed a questionnaire on training and injury profiles; with only those having had a musculoskeletal complaint additionally completing a clinical consultation. In order to assess associations between presence of injury and explanatory variables, binary logistic regression using backward selection based on likelihood ratios was used. Data was described using frequency tables for categorical data and summary statistics for continuous data. Odds ratios was reported and a p value <0.05 was considered statistically significant. For triathletes reporting injuries, linear regression was used for factors associated with injury severity.

Results: Fifty seven triathletes responded giving a response rate of 71% (68% male, 32% female). The point and period (year) prevalence of triathlon-related musculoskeletal pain was 17.5% and 68.4% respectively. The ranking of the most common site of injury in the last 12 months included the knee (64%), low back (21%) and thigh (18%); with females having had a significantly higher risk of injury than males (p=.019). Additionally, injury risk also increased with weight (p=.055), number of triathlons undertaken in the previous year (p=.031), number of triathlons in the last 4 months (p=.009) and running distance during competition times (p=.011). Injury risk decreased with increasing distance of cycling (p=.061) and swimming (p=.030) in a competition, and length of training in- and off-season (p=.105 and p=.043 respectively). Strong trends were demonstrated between injury severity and long-slow training distance (p=.006) and weight (p=.006). By contrast to risk of injury, injury severity was negatively associated with weight, while a long-slow distance was positively associated with the severity of the injury. Of all the health professions, chiropractic was the most utilized health profession.

Conclusion and recommendations: The results concur with previous research, but add insights into factors predisposing triathletes to injury. The most common injuries require investigation to develop preventative interventions to reduce injuries in triathletes. Health professionals require education about triathlon-related injuries to improve preventative and curative interventions.

Key terms: Triathlon-related, triathletes, injury profile, chiropractic, musculoskeletal injuries, prevalence

Table of Contents

CHAPTER TWO – LITERATURE REVIEW

CHAPTER THREE - METHODOLOGY

CHAPTER 4 – RESULTS AND DISCUSSION

List of tables

List of figures

List of appendices

Definitions

Acute	Having a short and relatively severe course (Dorland, 2007)
Amateur	For the purposes of this study, an amateur is defined as a person who engages in a pursuit, especially a sport, on an unpaid basis.
Anterior	This refers to the front of the body or to a position closer to the front then another (Lippert, 2006)
Chronic	Persisting over a long period of time (Dorland, 2007)
Concentric muscle contraction	Occurs when there is joint movement, the muscle shortens, and the muscle attachments move closer together (Lippert, 2006)
Confidentiality	Confidentiality is the inability of other people to associate individual people with specific questionnaire responses (Salant and Dillman, 1994).
Eccentric muscle contraction	Occurs when there is joint movement, but the muscle appears to lengthen, and the muscle attachments separate (Lippert, 2006)
Effective	Successful in producing a desired research result.
Efficient	Achieving maximum productivity with minimum wasted effort or budgeted expense.
Epidemiological	The study of causes, effects and patterns of health conditions within a population.
IBM SPSS	Software package used for statistical analysis (www.ibm.com/us/en/)
Incidence	The number of new cases of a condition within a specified period of time.
Inferior	Indicates that a body part is below another (Lippert, 2006)
Instability	Inability of a joint to maintain support (Dorland, 2007)
Isometric muscle contractions	Occurs when a muscle contracts, producing a force without changing the length of the muscle (Lippert, 2006)
Kwa-Zulu Natal	Kwa-Zulu Natal is one of nine provinces in South Africa.
Musculoskeletal	A sensation of agony that inhibited the individual from

pain	participating in a triathlon or practice for a minimum of 24 hours (Ellapen *et al.,* 2011).
Overuse injury	An injury that did not occur from an acute traumatic event such as a twist or turn, collision or impact, or overstretch (Burns *et al.,* 2003).
Period prevalence	The proportion of the population having a condition over a 12 month period.
Point prevalence	The proportion of the population having a condition at the time of the study.
Posterior	This refers to the back of the body or to a position closer to the back then another (Lippert, 2006)
Prevalence	The proportion of the population having a condition.
Professional bicycle setup	The detailed process of evaluating the cyclist's physical and performance requirements and abilities and systematically adjusting the bike to meet the cyclist's goals and needs (www.medicineofcycling.com).
Semi-professional	For the purposes of this study, a semi-professional was defined as an athlete receiving payment for their participation in a triathlon but not relying entirely on it for a living.
Triathlete	A triathlete is an athlete who participates in a triathlon.
Triathlon	Triathlon an athletic contest consisting of three different events, typically swimming, cycling, and running.

Abbreviations

B	Beta
cm	Centimetre
DUT	Durban University of Technology
GP	General practitioner
IREC	Institutional Research Ethics Commity
ITB	Iliotibial band
ITBS	Iliotibial band syndrome
kg	Kilogram
km	Kilometre
KZN	Kwa-Zulu Natal
KZNTA	Kwa-Zulu Natal Triathlon Association
lbs	Pounds
m	Meter
min	Minimum
n/a	Not applicable
N/S	Not stated
OR	Odds ratio
Q	Question
QL	Quadratus lumborum
SI	Sacroiliac
sig.	Significance
SOAPE	Subjective, objective, assessment, plan and education
t	Student's t statistic
TFL	Tensor fascia lata
USA	United States of America

Chapter One

Introduction

1.1 Introduction

This purpose of this is chapter is to introduce the topic of triathlon injuries and creates a background for the study.

1.2 Background

Triathlon is a multidisciplinary sport that consists of three uninterrupted disciplines of swimming, cycling and running (Gosling *et al.,* 2010). Triathlon has become a popular international recreational and professional sport which made its Olympic Games debut in the 2000 Summer Olympic Games in Sydney (Gosling *et al.,* 2008). McHardy, Pollard and Fernandez (2006) suggested that the popularity of triathlon is due to the variety within the sport. Nevertheless, Clements, Yates and Curran (1999) and Vleck and Garbutt (1998) suggest this variety of sporting disciplines contributes to triathlon-related musculoskeletal pain and/or injury. Participants in triathlon events experience a wide range of racing conditions and physiological demands that are more than those found in an individual sport of similar duration (Dallam *et al.,* 2005). Consequently, a wide range of plausible medical issues or complications must be taken into account when preparing for such a race (Dallam *et al.,* 2005).

The prevalence of musculoskeletal pain and/or injury among triathletes is noted to vary from 47% (Korkia *et al.,* 1994) to 91% (O'Toole *et al.,* 1989). However, the extent to which these results may be reflective of reality, are restricted by the commonality of terminology used for different body regions injured, as the terminology remains unclear and is often contradictory between studies. As an example, Burns *et al.,* (2003) used a questionnaire that utilized information from triathletes that was limited from the back to the lower limb, even though their injury definition stated "… any bone or soft tissue problem …". As a result of the categorisation of injuries reported by Burns *et al.,* (2003), they may have reported comparatively more lower limb injuries and less upper limb injuries. According to McHardy *et al.,* (2006), these systematic issues exist in triathlon injury surveillance literature with respect to injury site and injury type and whether reporting these was done either as grouped sites or types (O'Toole *et al.,* 1989, Egermann *et al.,* 2003). The lack of consensus between studies makes comparisons and determining injury profiles in the triathlon arena difficult (McHardy *et al.,* 2006).

The inconsistent reporting of injuries is emphasized by studies that utilize "overuse injuries" in place of the nature of injury (assumption that "overuse" is synonymous with chronic injury) (Gosling *et al*., 2008). In this context, again using Burns *et al.,* (2003) study as an example, the results fail to report the nature of injuries, which is not dissimilar to O'Toole *et al.,* (1989); Wilk *et al.,* (1995); Vleck *et al.,* (1998) and Collins *et al.,* (1989) results. All the authors refer to acute injuries such as muscle strains or joint sprains as overuse injuries (O'Toole *et al.,* 1989). Additionally, reliance of the nature of injuries has been almost exclusively self-reported by triathletes (with the exception of Gosling *et al.,* (2010) who utilized medical doctors, ambulance paramedics or sports trainers to diagnose the nature of injury) and according to Mouton (1996), such self-reporting impacts on the reliability and validity of the data captured, as a result of recall bias. Therefore, large ranges in injury types have been recorded as the triathletes give the information they have, without clinical experience (Gosling *et al.,* 2008).

Of the papers identified in Gosling's *et al.* (2008) review and more recent studies reviewed by the researcher, seven studies provided diagnostic information self-reported by triathletes; however only three studies to the researcher's knowledge have used confirmed diagnoses by medical or allied health practitioners. Therefore, formal validation of self-reported nature and types of injuries has not yet been carried out in any triathlon-related injury profile study. Therefore, the triathlete's self-reporting of injuries and its difficulty is recognized, and as a result the data collection would be deduced with attention to the limitations (Burns *et al.,* 2003). In this context, prospective studies would limit recall bias and give more accurate injury information (Mouton, 1996; Gosling *et al*., 2008).

It is clear from Gosling's *et al*. (2008) review of triathlon-related musculoskeletal injuries that there is a significant knowledge gap in the triathlon literature that describes injury prevalence, injury profiles and proposed suggestions for preventative measures of injuries in triathlon participants. This gap can partly be informed using the criteria described by van Mechelen *et al*. (1992), who assessed and determined the severity of an injury based on six criteria: nature of injury, duration and nature of treatment, sporting time lost, working time lost, permanent damage and cost (van Mechelen *et al.,* 1992). This research is vital for describing injuries in detail and prioritizing injury preventative measures on the knowledge of the injury's severity or its impact (Gosling *et al.,* 2008).

Thus, this research presents the findings based on its primary aim, which is to investigate the injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes. The primary objective outcomes were to develop a demographic profile and to determine the period prevalence and the point prevalence of injuries in amateur and semi-professional Kwa-Zulu Natal triathletes. The secondary objective outcomes were to assess and determine these injuries in terms of diagnosis, location and severity, and to identify the associations between the demographic profile and injuries in terms of diagnosis, location and severity.

1.3 Research aim and objectives

The aim of this study was to investigate the injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes.

The First Objective was to develop a demographic profile of the triathletes (utilizing a self-administered questionnaire (Appendix Q)).

The Second Objective was to assess and determine injuries in terms of diagnosis, location and severity (utilizing objective and subjective data obtained in a consultation (Appendix R)).

The Third Objective was to determine the period prevalence and point prevalence of injuries in triathletes (utilizing both the self-administrated questionnaire (Appendix Q) and the consultation (Appendix R)).

The Fourth Objective was to identify the associations between the demographic profile (including training parameters) and injuries in terms of diagnosis, location and severity.

Null Hypothesis

Associations between the demographic profile and injuries in terms of diagnosis, location and severity did not exist.

1.4 Rationale and benefits of the study

Triathlon is now a major sport worldwide (Gosling *et al*., 2010), which mirrors the South African context (Ellapen *et al.,* 2011). Triathlon race distances and durations vary and injuries can occur as a consequence of the individual swim, cycle or run, or as a result of the nature of the triathlon being the combination of the three sports (McHardy *et al*., 2006). Thus, the probability of overuse injuries is high (McHardy *et al.,* 2006).

However, there has been limited research conducted on South African triathletes (Ellapen *et al.,* 2011). More research investigating the epidemiology of South African triathlon-related injuries should assist triathletes in becoming more competitive, having fewer injuries and therefore being able to compete more effectively and longer at national and international competition levels (Gosling *et al.,* 2008).

The above is however complicated in that triathletes experience a wide range of racing conditions and physiological demands that are more than those found in an individual sport of a similar duration. Consequently, a wide range of plausible medical issues or complications must be taken into account when preparing for such a race (Dallam *et al*., 2005). It is hoped that this research will assist in furthering the knowledge of injuries so that prevention of primary, secondary and tertiary injury among triathletes could be improved.

Additionally Gosling *et al.,* (2008), noted that there would be value in determining the association between prevalence and clinical characteristics in terms of diagnosis, location and severity of triathlon-related injuries in order to refine and improve treatment, management and prevention of such injuries (Gosling *et al.,* 2008) and to decrease injury rate and time away from competition (van Mechelen *et al*., 1992). Therefore, this research also intended to add to the literature, findings regarding specific clinical diagnoses and their specific characteristics.

Collectively, this research would benefit all health-care professionals in injury prevention and health promotion of triathletes in a triathlon event. This is particularly relevant to Chiropractic care, which is an increasingly utilised form of first line treatment (Daniels, 2010); particularly in sports medicine (Hyde *et al.,* 2007) and should be incorporated more into injury advancements in sport (www.acatoday.org, 2010; Coetzee, 2011).

1.5 Limitations of the study

It was expected that the triathletes complete the questionnaire openly and honestly, reflecting the reality of their pain at that point in time when they completed the questionnaire (Mouton, 1996; Dyer, 1997; Mouton, 2001). Additionally the outcomes of this study only includes information from triathletes that accepted the invitation to participate in this study, therefore the generalisability of the study was dependant on the numbers of participants from the total sample (this limitation and its effects are discussed in Chapter 4, which discusses response rates).

1.6 Outline of chapters

This chapter provided an introduction to the study, presenting the study's context and setting, the aim and objectives and the relevant hypothesis as well as the limitations and benefits of the study are also described. Chapter Two provides an expansion of the current literature in this field in order to expand the reader's understanding of the rationale behind the study. Chapter Three details the study design, which includes the materials and methods. Chapter Four presents the results and the discussion of these results in the context of the current literature. Chapter Five concludes the study and offers recommendations for future studies.

Chapter Two

Literature Review

2.1 Introduction

Chapter Two provides an overview of the current literature in order to enhance the reader's understanding of the rationale behind studying the injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes. This chapter also provides the reader with a brief overview of the incidence and type of common injuries experienced by triathletes. Chapter Two further discusses risk factors which have been identified in the literature that predispose triathletes to injury, as well as review the various mechanisms of injury pertaining to each discipline of a triathlon and the triathlon as a whole.

2.1.1 Triathlon

Triathlon is a multidisciplinary sport that consists of three uninterrupted disciplines: swimming, cycling and running (Gosling *et al*., 2010). Triathlon has become a popular international recreational and professional sport (Gosling *et al.,* 2008). In South Africa, triathlon races are classified as sprint distance, Olympic distance and long course triathlons (www.triathlonsa.co.za, 2013)

2.1.1.1 Sprint distance

Sprint distance triathlons vary in distance but more commonly include an 750 meter (m) swim, a 21 kilometre (km) cycle and finally a 5 km run (McHardy *et al*., 2006). Sprint distance triathlons are very popular and attractive to amateur and club level athletes as they allow beginners a chance to participate (www.triathlonsa.co.za, 2013)

2.1.1.2 Olympic distance

Olympic distance triathlons consist of a 1 500 m swim, a 40 km cycle and lastly a 10 km run. The Olympic distance triathlon is used at Olympic Games, Commonwealth Games, World Championships and most elite National Championships (www.triathlonsa.co.za, 2013). The Olympic distance is also used at interprovincial level for competition and is open to both amateur and semi-professional triathletes (Vleck and Garbutt, 1998).

2.1.1.3 Long Course triathlon

The long course triathlon consists of races that vary in distances from 1 900 m to 3 800 m for the swim discipline; 90 km to 180 km for the cycle discipline and a 21.1 km (half marathon) to 42.2 kilometre (standard marathon) for the run disciplines (Dallam *et al.,* 2005). The shorter distances (1 900 m swim, 90 km cycle, 21.1 km runs) are referred to as Ironman 70.3® and the longer distances (3 800 m swim, 180 km cycle, 42.2 km run) are referred to as an Ironman triathlon (IRONMAN.com, 2013).

Table 2.1 Triathlon event distances

Event	**Swim (m)**	**Cycle (km)**	**Run (km)**
Sprint	750	20	5
Olympic	1 500	40	10
Ironman 70.3®	1 900	90	21.1
Ironman	3 800	180	42.2

2.2 The link between triathlon and injury

McHardy, Pollard and Fernandez (2006) reported that the popularity of triathlon is predominantly due to the diversity within the sport. This diversity contributes to triathlon-related musculoskeletal pain and/or injury (Vleck and Garbutt, 1998 and Clements *et al.,* 1999). Triathletes will experience an array of conditions and physiological loads which are above that experienced in a single sport event of similar length (Dallam *et al*., 2005).

Subsequently, there is an extensive variety of possible health-related issues that must be expected when training for a triathlon (Dallam *et al.,* 2005).

2.2.1 Prevalence of triathlon-related musculoskeletal injuries

As a result of a triathlete's training, it predisposes them to overuse / chronic injuries (Korkia *et al.,* 1994, Vleck and Garbutt, 1998, Burns *et al*., 2003 and Shaw *et al*., 2004). The prevalence of musculoskeletal pain and/or injury amongst triathletes is noted to vary from 47% (Korkia *et al.,* 1994) to 91% (O'Toole *et al.,* 1989).

From a musculoskeletal vantage point, the following anatomical sites are most vulnerable; neck, shoulder, low back, knee, ankle, Achilles tendon and foot (O'Toole *et al.,* 1989, Vleck and Garbutt, 1998), while the anatomical site with the highest prevalence of triathlon-related musculoskeletal pain and/or injury is the knee (Vleck and Garbutt, 1998 and Ellapen *et al*., 2011) (Refer to summary Table 2.4).

Several studies have surveyed triathletes' injuries or pain complaints which are discussed in chronological order as follows:

- Collins *et al*. (1989) obtained data from 600 triathletes who completed a triathlon race in 1986. This was a response rate of 45%. This study reported that almost half (49%) (126 triathletes) of the triathletes surveyed suffered a self-reported injury during training which caused them to stop training for at least one day, seek medical care or take medicine (Refer to summary Table 2.2 and summary Table 2.3). Of the injuries reported, 62% were related to running (the only weight bearing activity), and the most vulnerable anatomical sites were the knee, shoulder, and ankle (refer to summary Table 2.4).

- Ultra endurance triathletes who competed in an Ironman triathlon in Hawaii were studied by O'Toole *et al.* (1989) and it was found that 85% of the injuries sustained were non-traumatic overuse injuries (refer to summary Table 2.2 and summary Table 2.3). In this sample, 91% of the triathletes sustained at least one overuse injury in the last 12 months. Additionally, 72% of triathletes reported low back pain or sciatica, while 84% with knee/thigh injuries and 78% with ankle/foot injuries also reported a back injury (O'Toole *et al.,* 1989).

- Korkia *et al.* (1994) surveyed 155 British triathletes for an eight week duration. A minimum of one injury was reported by 37% of the triathletes, which stopped their current training session (refer to summary Table 2.2 and summary Table 2.3). The most affected anatomical sites were the ankle/foot, thigh, knee, lower leg, and the back. Shoulder injuries were not frequently reported by these triathletes (refer to summary Table 2.4).

- An amateur triathlete racing club in Miami was studied by Wilk *et al*. (1995). Their definition of an injury was if the injury caused lost time from training, racing, working, or daily functioning (refer to summary Table 2.2 and summary Table 2.3). The response rate from 150 triathletes was 72 (48%). Overuse, as opposed to trauma, was the main cause of injury (78.9%) (refer to summary Table 2.4).

- Vleck and Garbutt (1998) surveyed 12 elite male, 17 development male and 87 club male triathletes over the previous five years (refer to summary Table 2.3). Overuse injuries occurred in three quarters of the male elite and of development triathletes and 56.3% of the club triathletes (refer to summary Table 2.4).

- Clements *et al.* (1999) interviewed 58 triathletes, who were aged 15 to 55 years of age, in connection with knee injuries that they may have suffered during a race (refer to summary Table 2.2). Majority of knee injuries occurred during the running event (72%) (refer to summary Table 2.3).

- Burns *et al.* (2003) surveyed 131 triathletes over a 10-week period while a corresponding retrospective study over 6-months was conducted of their training history and prior overuse injuries (refer to summary Table 2.2).

- Egermann *et al.* (2003) surveyed 656 triathletes of the Ironman Europe 2000 triathlon and found that 74.8% of triathletes reported a minimum of one injury during their time competing in triathlons (Egermann, *et al.,* 2003).

- Shaw, Howat, Trainor and Maycock (2004) surveyed 258 triathletes in Australia from all triathlon disciplines (refer to summary Table 2.2 and summary Table 2.3). This cross-sectional study demonstrated that 62% of the sampled population had experienced an injury in the last twelve months. The majority of these injuries were in the lower limb (specifically the knee at 32%, refer to summary Table 2.4).

- Villavicencio's *et al*. (2006) study determined that the incidence of neck pain was 48.3% and the incidence of back pain in triathletes in Colorado (United States of America) was 67.8%.

- Vleck *et al.* (2010) conducted a retrospective analysis of injuries in the British National Squad (both Olympic distance and Ironman) (refer to summary Table 2.2). The response was 75% and 95% respectively, however, the sample was small (12 and 18 respondents respectively). Overuse injuries were sustained by 72.2% of the triathletes and 43.1% of the triathletes suffered traumatic injuries (refer to summary Table 2.3).

- Main *et al.,* (2010) surveyed 30 well-trained triathletes from a local triathlon club over a 45 week period. Signs and symptoms of injury and illness were significantly associated with increased training factors.

- Harris *et al.,* (2010) analyzed a total of 959 214 participants using online race results. Fourteen triathletes died during 14 triathlons (13 during the swimming discipline and 1 during the cycling discipline).

- Ellapen *et al*. (2011) surveyed 43 Kwa-Zulu Natal triathletes. Of these, 39 (90.69%) triathletes experienced triathlon-related musculoskeletal pain (refer to summary Table 2.2 and summary Table 2.3). The most common anatomical sites of triathlon-related musculoskeletal pain were the knees (32.39%), low back (16.9%) and foot (15.49%) (refer to summary Table 2.4).

- Rimmer and Coniglione (2012) surveyed triathletes who received medical attention during or after completion of the Redman Triathlon in Oklahoma City in 2010. There were a total of 575 participants. Reportings in the Ironman distance were predominantly dehydration (50.8%) and muscle cramps (36.1%) and in the Ironman 70.3 distance, muscle cramps were most common (38.9%) followed by dehydration (37.7%).

- A French triathlon league was surveyed by Galera *et al*. (2012) (refer to summary Table 2.2). Just over half of the 788 triathletes (52.4%) who responded to the survey reported having been injured at least once during the past season. The majority (83.5%) of injuries occurred during training, mostly in running (72.5%). The anatomical sites most frequently reported were the ankle (20.6%), knee (18.3%), thigh (15%), lumbar region (12.6%) and shoulder (8,3%) (refer to summary Table 2.3).

- Johnson *et al*.'s (2012) recruited 380 triathletes for their study to investigate a change in activity or injuries causing the athlete to completely stop training for a minimum of four days (refer to summary Table 2.2 and summary Table 2.3). The most common injury suffered was the knee (34%) (refer to summary Table 2.4).

- In a study compiled by Ansell *et al.* (2012), 1 250 triathletes competing in the Australian Ironman triathlon received questionnaires in their race packs. Less than a quarter (296) returned the questionnaires (refer to summary Table 2.2). A large majority (86.1%) had reported overuse injury that was related to either training or competition in the 12 months before the study (refer to Table 2.3). The most common anatomical sites of injury was the knee (35.1%), low back (34.1%) and the ankle/foot (30.7%) (refer to summary Table 2.4).

In addition to the above, Gosling's (2008) review of triathlon-related musculoskeletal injuries highlighted knowledge gaps between the triathlon literature that describes injury incidence, injury profiles and suggestions for preventative measures of injuries in triathlon participants.

2.2.2 TRIPP framework

Gosling *et al*.'s (2008) review followed the guiding Translating Research into Injury Prevention Practice (TRIPP) framework described by Finch (2006). The aim of the TRIPP framework is to guide the conduct of research that will have 'real-world injury prevention gains' in the sporting context (Finch, 2006).

The TRIPP Stage 1 is that of injury surveillance (Finch, 2006). The TRIPP Stage 2 understands the aetiology of why injuries occur (Finch, 2006). The TRIPP Stage 3 involves the identification of potential solutions to the injury problem and development of appropriate preventive measures (Finch, 2006). The TRIPP Stage 4 is essentially an ''ideal conditions'' evaluation of the preventive measures that arise from TRIPP Stage 3 (Finch, 2006). The TRIPP Stage 5 is necessary to developing and understanding the implementation context (Finch, 2006). The TRIPP Stage 6 is the final stage and involves both implementing the intervention in a real-world context and evaluating its effectiveness (Finch, 2006). This framework summarizes how this research could be used to develop injury prevention strategies for a range of health care professions in the future, but which is beyond the scope of this research.

Gosling's *et al*. (2008) selected reasons as to why other researchers provided unreliable injury epidemiological data include:

- recall periods of greater than 1 year (Mouton, 1996; Gosling *et al.,* 2008),
- failure to validate self-reported injuries against appropriate medical diagnosis (Massimino *et al.,* 1988, Collins *et al.,* 1989, O'Toole *et al.,* 1989, Cipriani *et al.,* 1998, Burns *et al*., 2003, Egermann *et al.,* 2003, Shaw *et al*., 2004, Villavicencio *et al.,* 2006 and Gosling *et al.,* 2008),
- inability to differentiate between injuries sustained in training and competition (Massimino *et al.,* 1988, O'Toole et al., 1989, Manninen and Kallinen, 1996, Vleck and Garbutt, 1998, Clements *et al.,* 1999, Shaw *et al*., 2004, Villavicencio *et al.,* 2006 and Gosling *et al.,* 2008),
- selection biases for those athletes either with or without injury (Villavicencio *et al.,* 2006 and Gosling *et al.,* 2008),
- exclusion of traumatic injuries (Collins *et al.,* 1989, Gosling *et al.,* 2008),
- comparatively small sample sizes (Massimino *et al.,* 1988, O'Toole et al., 1989, Manninen and Kallinen, 1996, Cipriani *et al.,* 1998, Clements *et al.,* 1999, Villavicencio *et al.,* 2006 and Gosling *et al.,* 2008),
- incomplete response rates for surveyed populations (Collins *et al.,* 1989, O'Toole *et al.,* 1989, Manninen and Kallinen, 1996, Cipriani *et al.,* 1998, Burns *et al*., 2003, Egermann *et al.,* 2003, Shaw *et al*., 2004, Villavicencio *et al.,* 2006 Gosling *et al.,* 2008) and
- failure to use standardized injury and exposure data definitions (Collins *et al.,* 1989, O'Toole *et al.,* 1989, Vleck and Garbutt, 1998, Burns *et al*., 2003, Egermann *et al.,* 2003, Shaw *et al*., 2004, Villavicencio *et al.,* 2006 Gosling *et al.,* 2008).

As a result of these limitations, this research was a retrospective/prospective study as the researcher identified both previously diagnosed injuries from the past year/season (Mouton, 1996) as well as triathletes that were in pain at the time of the study (Mouton, 1996). However, the study did not follow the triathletes over the period of a year/ season as would have been in a longitudinal study (Mouton, 1996).

2.3 Summary of injury studies

Table 2.2: Overview of identified triathlon specific injury studies identifying the race distance, the study design employed and the population number studied (Table adapted from Gosling *et al.* (2008))

Study	Triathlon Event Distances (Refer to Table 2.1)	Study Design	Population	
Ansell *et al.*, 2012	Ironman distance	Cross-sectional retrospective survey- previous 12 months	*n* =	296
Johnson *et al.*, 2012	All	Retrospective survey- previous 12 months	*n* =	380
Galera *et al.*, 2012	All	Retrospective survey	*n* =	389
Rimmer and Coniglione 2012	Ironman 70.3 to Ironman distance	Prospective study- 1 race	*n* =	104
Ellapen *et al.*, 2011	All	Retrospective survey	*n* =	43
Vleck *et al.*, 2010	Olympic to Ironman distance	Retrospective survey- previous five years	*n* =	35
Harris *et al.*, 2010	All	Retrospective survey	*n* =	959 214
Main *et al.*, 2010	All except Ironman distance	Prospective study- 45 weeks	*n* =	30
Villavicencio *et al.*, 2006	Mixed	Retrospective survey	*n* =	87
Shaw *et al.*, 2004	Not reported	Retrospective survey- previous 12 months	*n* =	258
Burns *et al.*, 2003	Not reported	Two retrospective surveys [6 months (pre-season) and 10 weeks (competition)]	*n* =, *n* =	131 pre-season 128 competition
Egermann *et al.*, 2003	Ironman	Retrospective survey	*n* =	656
Clements *et al.*, 1999	Not reported	Retrospective survey- previous 3 years	*n* =	58
Fawkner *et al.*, 1999	Olympic to Ironman distance	Prospective study- 13 weeks	*n* =	56
Cipriani *et al.*, 1998	Not reported	Retrospective survey- previous 10 years	*n* =	52
Vleck and Garbutt 1998	Olympic	Retrospective survey- previous five years	*n* =	194
Wilk *et al.*, 1995	Not reported	Retrospective survey	*n* =	72
Korkia *et al.*, 1994	All	Prospective study- 8 weeks	*n* =	155
Collins *et al.*, 1989	Other distance (1 km swim, 28 km cycle and 10 km run)	Retrospective survey- previous 12 months and single event surveillance	*n* =	257
O'Toole *et al.*, 1989	Ironman	Retrospective survey- previous 12 months	*n* =	95

Table 2.3: Summary of studies investigating triathlon injuries by discipline (Table adapted from McHardy et al., (2006))

Author	Injury Definition	Injury Mechanism		Discipline Injury Sustained			Comment
		Overuse	Acute	Swim	Cycle	Run	
Ansell *et al.,* 2012	Any long lasting injury or chronic pain	86.1%		N/S	N/S	N/S	The most common site of injury was the knee (35.1% of respondents)
Johnson *et al.,* 2012	Change in activity or causing the athlete to completely stop training for 4 or more days	N/S	N/S	N/S	N/S	N/S	The most common injury suffered, at the knee, occurred in 34% of triathletes surveyed
Galera, *et al.,* 2012	No injury definition described	61.7% to 75%	52.4%	3.9%	12.4%	39.9%	The prevalence of muscle injuries was significantly associated with number of training hours per week
Rimmer and Coniglione 2012	No injury definition described	N/S	N/S	N/S	N/S	N/S	The prevalence of injuries sustained was 37.7% and 10.8% in the Ironman and half Ironman events, respectively.
Ellapen *et al.,* 2011	Any sensation of distress to the musculoskeletal system ranging from uncomfortable to severely agonizing, which inhibited practice or racing for a minimum continuous duration of a day	94.36%	5.64%	19.23%	19.23%	61.54%	Among the 43 triathletes surveyed, 39 (90.69%) experienced triathlon-related musculoskeletal pain within the last 12 months
Vleck *et al.,* 2010	Any musculoskeletal problem causing cessation of training for at least 1 day, a reduction of training mileage or taking of medicine	72.2%	43.1%	15.2% (Olympic distance) 16 (Ironman)	26% (Olympic distance) 32 (Ironman)	65.2% (Olympic distance) 60 (Ironman)	The number of overuse injuries did not differ between Olympic distance races and Ironman races.
Harris *et al.,* 2010	Injury defined as sudden death during a triathlon	N/S	N/S	N/S	N/S	N/S	Fourteen triathletes died during 14 triathlons.
Main *et al.,* 2010	No injury definition described	N/S	N/S	N/S	N/S	N/S	Signs and symptoms of injury and illness were significantly associated with increased training factors.
Shaw *et al.,* 2004	Injury which reduced sport participation, medical advice, adverse social effects and alteration to training	N/S	N/S	N/S	N/S	N/S	Triathletes training for the shortest and longest period of time were most likely to sustain an injury
Egermann *et al.,* 2003	Injury during training or competition causing the triathlete to stop training	74.8%	N/S	5.8%	54.8%	33.7%	Injuries most often due to cycling

Table 2.3: Continued: Summary of studies investigating triathlon injuries by discipline continued …

Author	Injury Definition	Injury Mechanism		Discipline Injury Sustained			Comment
		Overuse	**Acute**	**Swim**	**Cycle**	**Run**	
Burns *et al.*, 2003	Any bone or soft tissue problem causing rest for at least 1 day, taking medicine, seeking medical aid and not from acute Trauma	N/S	N/S	N/S	N/S	N/S	Increased years of triathlon experience was the most significant predictor of pre-season injury
	Pre-season	68%	N/S	2%	5%	71%	
	Competition	78%	N/S	2%	8%	73%	
Clements *et al.*, 1999	Decrease or training termination for at least 2 days	N/S	N/S	N/S	22%	72%	The lateral knee was the most commonly affected area
Vleck and Garbutt 1998	Prevented from training more than 1 day Reduction in training Medication or medical aid						Running injuries correlate with the number of running sessions done
	Development level triathletes	75%	41%	N/S	34.5%	62.1%	
	Club triathletes	56%	37.5%	N/S	25%	64.3%	
	Elite triathletes	75%	56.3%	N/S	15.9%	58.7%	
Cipriani *et al.*, 1998	Injury which occurred over the last 10 years	Analysis not complete					Surveyed injury incidence and compared with other studies
Manninen and Kallinen 1996	Low back pain and other overuse injuries	N/S	N/S	N/S	74%	43%	Study focused on back pain
Korkia *et al.*, 1994	Injury stopped current training session	41%	10%	11%	16%	65%	Prospective investigation 8 Rest day after injury week training diary
O'Toole *et al.*, 1989	Not defined. Left up to the athletes judgment	91%	N/S	N/S	N/S	N/S	91% of the triathletes sustained an overuse injury in 1 year prior to the study
Wilk *et al.*, 1995	Any injury that occurred whilst training or racing in triathlon or single event	78.9%	33.3%	N/S	N/S	N/S	Overuse-related injuries interfering with daily function
Massimino *et al.*, 1988	No injury definition described	85%	15%	5%	20%	58%	Those who cycled faster and pushed higher gear had more injuries
Collins *et al.*, 1986	Decrease or training was stopped for more than a day or medical care was sought. Hazard encounters excluded	49%	N/S	11%	13%	62%	50% were injured in the past year

2.4 Intrinsic and extrinsic risk factors

Intrinsic risk factors in the context of a triathlon consist of personal factors specific to a triathlete that contributes to their injury (Gosling *et al*., 2008). This includes factors such as age (Burns *et al.,* 2003), gender (Egermann *et al*., 2003), anthropometric characteristics (Vleck and Garbutt, 1998), triathlon experience (Villavicencio *et al.,* 2006), presence or absence of previous injury (Korkia *et al.,* 1994), and biomechanics of each discipline of the triathlon (Manninen and Kallinen, 1996) (Gosling *et al.,* 2008).

Conversely, extrinsic factors are environmental (external factors) that previous study's findings have shown to contribute to triathlon injuries. Examples of these factors (including one example of a study that has explored the particular factor) include training hours per week (O'Toole *et al*., 1989), training distance per week (Massimino *et al.,* 1988), training sessions per week (Vleck and Garbutt, 1998), training intensity (Manninen and Kallinen, 1996), training load increases (Manninen and Kallinen, 1996), presence or absence of a coach (Collins *et al.,* 1989), medical care (Egermann *et al.,* 2003), strength training (Korkia *et al*., 1994), running surface (Korkia *et al*., 1994), athletic status (Villavicencio *et al.,* 2006), triathlon competition distance (Korkia *et al*., 1994) and participation in other sports (Collins *et al*., 1989) (Gosling *et al*., 2008).

In Gosling's *et al*. (2008) review, the review utilized the TRIPP framework to study these various factors. The first TRIPP stage is injury surveillance (Finch, 2006). The described second stage of this framework emphasized the importance for understanding the aetiology of injuries (Finch, 2006), in other words, the mechanism of injury. The injury mechanism and discipline of triathlon at the time of the injury are knowledge that is necessary for the development of preventative protocols (Gosling *et al*., 2008). Awareness of intrinsic and extrinsic risk factors offers the triathlete knowledge as to what to avoid (Bahr and Krosshaug, 2005). The nature of these risk factors is established through multi- and interdisciplinary studies using a variety of research methodologies (Krosshaug *et al*., 2005; Finch, 2006 and Gosling *et al.,* 2008).

2.5 Injuries

2.5.1 Most common injuries

The results of the studies compiled by Egermann *et al.,* (2003) and O'Toole *et al.,* (1989), found that the back was the most regularly injured part of the body (refer to summary Table 2.4). Cipriani *et al.,* (1998) reported that the most frequently injured part of the body was the knee (25%), the foot/ankle/Achilles tendon next (24%) (refer to summary Table 2.4). In the study completed by Ansell *et al*., (2012), 31% of the respondents reported an ankle/foot injury and this was the third highest reported injured area (refer to summary Table 2.4). Findings from O'Toole's *et al.,* (1989) study reported percentages for those areas which areas were much higher with 72% of the athletes having reported back pain and 84% having reported a knee injury over a twelve month period (refer to summary Table 2.4). On the contrary, the percentages reported by Burns *et al.,* (2003) were much lower, with only 15% of their sample reporting low back injury and 17% an injury of the knee (refer to summary Table 2.4) . Markedly, Burns *et al.,* (2003) had the smallest sample (n=96) but they interviewed people directly after completion of a race. The other studies used a paper-based questionnaire and this may have had some bearing on the differences in data obtained (Ansell *et al.,* 2012).

While there is a marked deviation in injury rates between triathlon injury studies, the knee and low back are consistently stated to be the most frequently injured sites (Vleck *et al.,* 1998, Massimino *et al.,* 1988, Collins *et al.,* 1989, Cipriani *et al.,* 1998, Manninen and Kallinen, 1996, Egermann *et al*., 2003, Shaw *et al.,* 2004, Vleck *et al*., 2010, Migliorini, 2011, Ellapen *et al*., 2011, Johnson *et al*., 2012 and Ansell *et al.,* 2012) (refer to summary Table 2.4). This has implications for further research and for educating health care practitioners that focus on sports and particularly the prevention and management of injuries in these athletes (Ansell *et al.,* 2012).

2.5.2 Acute versus chronic injuries

According to findings from previous studies, acute musculoskeletal injuries are rare in triathlons compared to overuse injuries (Massimino *et al.,* 1988, Korkia *et al*., 1994, Wilk *et al*., 1995, Vleck *et al*., 2010, Ellapen *et al*., 2011 and Galera, *et al*., 2012) and most of the injuries are reported to be minor. Blisters, contusions and abrasions are some of the most common acute musculoskeletal race day injuries (Gosling, 2010). The most serious of the acute musculoskeletal injuries are predominantly caused by falls during the cycle discipline of competitions or training sessions (Migliorini, 2011). Most falls are as a result of technical errors or as a result of the triathlete making an error in judgement or simply accidental in nature (Migliorini, 2011). Many triathlon races would include cycle sections on open road and triathletes may also be in danger of traffic accidents (Migliorini, 2011).

2.5.3 Overuse injuries

According to the results from previous research, a large proportion of triathletes appear to suffer with overuse injuries as opposed to acute injuries (Massimino *et al.,* 1988; O'Toole *et al.,* 1989; Wilk *et al.,* 1995). Throughout triathlon epidemiological literature, running has consistently been the most frequent discipline of a triathlon associated with musculoskeletal overuse injuries (Collins *et al.,* 1989) followed by cycling and then lastly by swimming. Some studies in the literature proposed the second transition between the cycle and running discipline is of specific risk for both low back and musculoskeletal knee injuries (Vleck *et al.,* 2008). The knee, the ankle, the foot and the low back are thus the anatomical sites indicated as the major injury sites (O'Toole *et al.,* 1989; Korkia *et al.*, 1994; Manninen and Kallinen, 1996; Vleck and Garbutt, 1998; Cipriani *et al*., 1998; Clements *et al*., 1999; Migliorini, 2003; Egermann *et al*., 2003; Burns *et al*., 2003 and Migliorini, 2011).

Musculoskeletal injuries can occur at any stage in a triathlon; any of the three disciplines or the two transitions between the disciplines.

2.5.4 The first transition

The first transition is the change over from the swim to the cycle disciplines. Limited research by Borchers and Buckenmeyer (1986) and Lepers *et al*., (1995) has been carried out on the first transition. Gosling *et al.,* (2010) reported 5 cases of injuries during the first transition in a season, giving a rate of 0.49 injuries per 1000 race starts.

2.5.5 The second transition

The second transition (the change over from the cycle to the run disciplines) is the stage of a triathlon in which the difference between elite, professional and semi-professional triathletes can be observed compared to that of the amateur triathletes (Millet and Vleck*,* 2000). This observation is due to differences in muscle fatigue and energy expense / reserves which aid in the instant reorganizing of the running mechanics in the next discipline of the event following the mechanics from the previous cycle discipline (Millet and Vleck*,* 2000). Gosling *et al.,* (2010) reported 4 cases of injuries during the second transition in a season, giving a rate of 0.39 injuries per 1000 race starts.

2.6 Injury types

As previously alluded to in Section 2.1.1, triathlons combine three sporting disciplines into one, and therefore the physical and mental requirements is much more demanding than that of a single event. The average triathlete spends roughly 800 hours per annum doing some type of physical training (Cipriani *et al.,* 1998).

Many musculoskeletal complaints that triathletes experience are attributed to overuse and fatigue (Strock *et al.,* 2006). As a result of training for three endurance disciplines, it is more common to be afflicted by the same injuries and complaints that each of these individual sports poses (Strock *et al*., 2006). Examples of injuries from the individual sports include blisters, calluses, strains, sprains, shin splints, tendonitis, tendinopathy, iliotibial band syndrome (ITBS), patellofemoral syndrome, impingement syndrome, rotator cuff tears, plantar fasciitis, compartment syndrome, stress fractures and occult fractures from trauma (Strock *et al*., 2006).

Almost half of the triathletes (50%) have previous experience in running, 20% of the triathletes have previous experience in swimming, and 10% have previous experience in cycling (Laurenson *et al.,* 1993). Yet, the majority of injuries occur during running (65%), 16% during cycling, and 11% during swimming (Korkia *et al.,* 1994). However, injuries were unrelated to the amount, frequency, or intensity of training (Korkia *et al.,* 1994). Wilk *et al*. (1995) found that 79% of injuries could be accredited to overuse, while 33% were as a result of trauma. Lower limb injuries accounted for the majority of injuries in a triathlon. Burns *et al.,* (2003) found that 75% of injuries that occurred during training and 72% of injuries that occurred during competition were lower extremity injuries, which concurred with Cipriani's *et al.,* (1998) study. They also stated that the knee, foot, ankle, and lower leg accounted for 61% of injuries, with the knee being the most complained about injury (25%). Korkia *et al.,* (1994) found that of the three most common injuries (ankle and/or foot, knee, and lower leg) sustained by triathletes during the previous twelve months, 35% were of a strain nature, 25% tendonitis, and 22% presented as tear.

2.6.1 Summary

The triathlon injury literature states that the knee is a common site for injury compared to any other region of the body ranging from 21.9% (Vleck *et al.,* 1998) to 44% (in ironman triathletes) (Vleck *et al*., 2010).

Table 2.4: Studies investigating the percentage of triathlon injuries according to different body regions (Table adapted from McHardy *et al*., (2006))

Anatomical Region	Shoulder (%)	Low Back (%)	Knee (%)	Lower leg (%)	Foot/ Ankle (%)	Neck (%)
Author						
Ansell *et al.,* 2012	23.6	34.1	35.1	Hips, buttock, Groin 26.4, Thigh 8.8, Calf 17.6, Shin 12.2	30.7	17.9
Johnson *et al.,* 2012	20.3	20.3	34	Quadriceps 6.6, Shin 9.5	31.6	10.3
Galera, *et al.,* 2012	8.3	12.6	18.3	68.8	20.6	
Rimmer and Coniglione (2012)	N/S	N/S	N/S	N/S	N/S	N/S
Ellapen *et al.,* 2011	12.68	16.9	32.9	Thigh 9.86	15.49	7.04
Harris *et al.,* (2010)	N/S	N/S	N/S	N/S	N/S	N/S
Main *et al.,* (2010)	N/S	N/S	N/S	N/S	N/S	N/S
Vleck *et al.,* 2010						
Olympic Distance	+- 10	17.9	14.2	Achilles 14.3	+- 17	+- 17
Ironman	+- 10	20	44	Calf 20, Hamstrings 20		+- 4
Shaw *et al.,* 2004	N/S	N/S	32	N/S	N/S	N/S
Egermann *et al.,* 2003	19	31.2	42.7	27.4	22.4	N/S
Burns *et al.,* 2003						
Pre-season	N/S	13	15	19	14 and 16	N/S
Competition	N/S	15	17	17	23 and 12	N/S
Clements *et al.,* 1999	N/S	N/S	Run 72, Cycle 22	N/S	N/S	N/S
Cipriani *et al.,* 1998	7	8	25	12	24	N/S
Vleck and Garbutt. 1998						
Elite	N/S	17.9	14.2	Achilles 14.3	N/S	16.7
Development	14.2	N/S	17.9	Achilles 17.9	N/S	N/S
Club	N/S	15.8	21.9	Achilles 10.3	N/S	N/S
Manninen and Kallinen 1996	9	28	33	12	13.4	4
Korkia *et al.,*1994						
8-week diary	N/S	14	19	16	27	N/S
Previous year	N/S	N/S	32	22	38	N/S
O'Toole *et al.,* 1989	N/S	72	63	N/S	61	N/S
Massimino *et al.,* 1988	N/S	10	22	4	21	N/S
Collins *et al.,* 1989	13.8	4.2	25	17.36	12.57	N/S

2.7 Common structures injured

2.7.1 Tendons

A tendon attaches muscle to bone (Lippert, 2006 and Comfort and Abrahamson, 2010), therefore a tendonitis is defined by inflammation of the tendon resulting in mild pain (Khan *et al.,* 2000 and Lippert, 2006). With time, long standing tendon problems result in degenerative changes within the tendon itself and it starts to add to increased pain. The long standing degenerative condition then becomes known as tendinosis (Khan *et al.,* 2000). Brown (2002) stipulates that injury to tendons are known to be associated with the use of performance enhancing drugs.

2.7.2 Muscles and Fasciae

Muscle and fasciae injuries result from conditions of neuromuscular dysfunction (Simons, Travell and Simons, 1999). As the muscle is required to contract repetitively during, the repetitive motion required of the legs for running and cycling and of the arms for swimming, fatigue sets in resulting in musculoskeletal pain (Hyde and Gengenbach, 2007). The affected muscles develop trigger points that can result in referred pain (Simons, Travell and Simons, 1999). Biomechanical imbalances can cause muscle and fascia problems, which consequently also affects the spine, resulting in a phenomenon referred to as a spinal segmental dysfunction (Brown, 2002).

2.7.3 Bursae

Bursae are potential spaces that form to reduce friction between joint surfaces or areas where surfaces tend to friction over one another which can include tendons, bones or muscles. Inflammation or irritation of bursa is known as bursitis (Brown, 2002).

2.7.4 Nerves

The nervous system can be divided anatomically into the central nervous system, the peripheral nervous system and the autonomic nervous system (Lippert, 2006). The peripheral nervous system includes nerves outside the spinal cord (Lippert, 2006). Compression of peripheral nerves is known as neuropathy and is characterized by peripheral nerve dysfunction (Brown, 2002 and Lippert, 2006). In cyclists the most common compression neuropathy is ulna neuropathy resulting from pressure on the palmer surface of the wrist (typical grip on the handle bars) and in men, pressure on the pudendal nerve resulting in a perineal region (Brown, 2002).

2.8 Disciplines of a triathlon

A triathlon, as mentioned previously, consists of three uninterrupted disciplines of swimming, cycling and running (Gosling et al., 2010). The following three sections describe literature relating to each of the disciplines, the injury mechanisms and common musculoskeletal sites for injuries.

2.9 Swimming

2.9.1 Overview of literature relating to swimming and injury mechanisms

Swimming is the first discipline of a triathlon and presents the unique scenario of a mass start (McHardy *et al*., 2006). Triathletes line up to start the race which presents a problem as they jostle for position into the first buoy which may cause the possibility of accidental collisions between the triathletes (Dallam *et al*., 2005 and McHardy *et al*., 2006). Triathletes wear wetsuits to prevent hypothermia or abnormally low body temperature (Trappe *et al.,* 1995) because the water is often at a temperature ranging between 13 and 32ºC (Dallam *et al.,* 2005). The nature of the suits allows the triathlete to be more buoyant in the water and therefore have less drag in the water (McHardy *et al*., 2006). Better buoyancy results in less friction through the water (de Lucas *et al.,*

2000) and consequently the triathlete needs a reduced amount of effort to stay buoyant and as a result a greater percentage of effort can be used in the swimming stroke itself (McHardy *et al*., 2006). As a result of the benefit of using a wetsuit, the International Triathlon Union has rules that govern wetsuit use (www.triathlon.org). For swim disciplines up to 1500 m, wetsuits are forbidden above 20°C and mandatory below 14°C and for swim disciplines from 1501 m and longer, wetsuits are forbidden above 22°C and mandatory below 16°C (www.triathlon.org).

The incidence of swimming-induced injuries is minor, in view of the general inexperience of most triathletes with regards to swimming (Strock *et al.,* 2006). Burns *et al.* (2003) established that triathletes ascribed in the region of 2% of their injuries to swimming. Injuries that are related to swimming commonly involve the shoulder, such as tendonitis and impingement-related problems (Strock *et al.,* 2006). Gosling *et al.,* (2010) reported 33 cases of injuries during the swim discipline in a season, giving a rate of 3.24 injuries per 1000 race starts, and 27 reported injuries as a result of the swimming action, giving a rate of 2.65 injuries per 1000 race starts.

The freestyle stroke can be separated into two phases; a propulsive phase and a recovery phase (Pollard *et al.,* 2004). During the propulsive phase, at the time the leading hand enters the water, the shoulder complex continuously completes adduction and internal rotation (Pollard *et al.,* 2004). Conversely, during recovery phase (when the hand is above the surface) the shoulder complex goes through abduction and external rotation (Pollard *et al.,* 2004). The path the hand makes in the water thrusts the body through the water (Pollard *et al.,* 2004).

The above mechanism of freestyle results in the shoulder rotator cuff (which is made up of the supraspinatus, infraspinatus, teres minor and subscapular muscles) being at risk of injury (Kammer *et al*., 1999). The supraspinatus tendon and the long head of the biceps are prone to injury, leading to an impingement syndrome (Kammer *et al.,* 1999). Injury to these structures happens in recovery phase of the freestyle stroke as the hand and arm are out of the water (Kammer *et al.*, 1978).

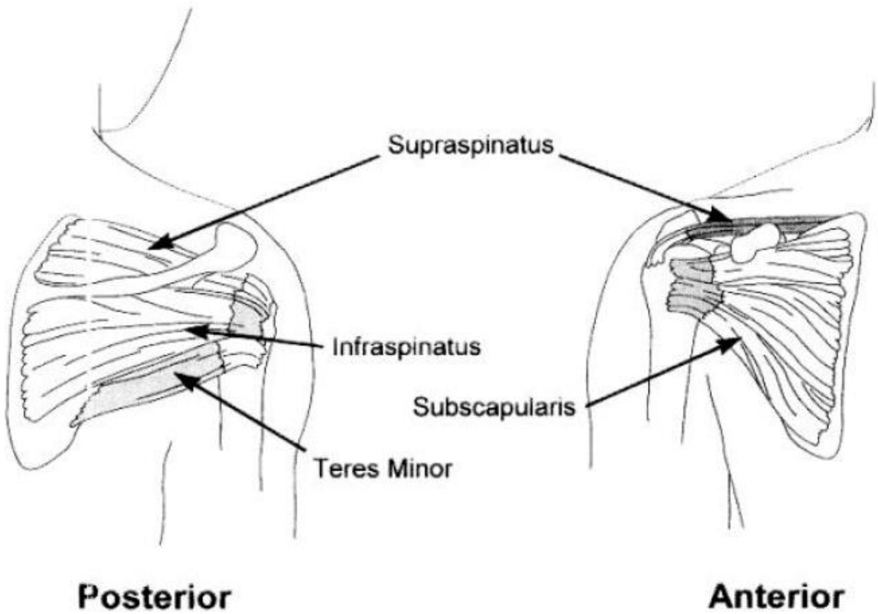


Figure 2.1: Posterior and anterior view of the rotator cuff musculature. Adapted from Cavallo (1998).

There are three stages of impingement (Cavallo and Speer, 1998; Pribicevic and Pollard, 2004). First stage is oedema accompanied with aching pain when at rest, diminished movement and tenderness. The second stage includes bursal thickening, fibrosis and recurring tendinosis, with the third stage resulting in possible rotator cuff or biceps tendon tears and bony changes (Cavallo and Speer, 1998; Pribicevic and Pollard, 2004). These are complicated more if there is insufficient extension ability within the thoracic spine (McHardy et al., 2006), which highlights the classic "swimmers posture" which functionally predisposes to impingement and tendinopathy (Pollard *et al.,* 2004).

The end result of the complex shoulder pathologies, usually result from a faulty technique and coupled with long training hours can in the long term cause instability (McHardy *et al*., 2006). Abnormal translation of the humeral head from the glenoid labrum is termed instability and instability decreases the functionality of the shoulder (McHardy *et al.,* 2006). Anterior/ inferior is the most common direction of instability (McHardy *et al*., 2006).

The upper body rotates or rolls in the region of 160 degrees during the freestyle stroke (Pollard *et al.,* 2004). The rotation improves swimming momentum, which amateur swimmers lack, which leads to the humeral head migration forward (translation) as the long head of biceps and the supraspinatus tendon offer stability to this abnormal forward translation (Cavallo and Speer, 1998).

Like the swimming stroke, the kick action of freestyle is also divided into the same two phases. Recovery phase typically involves extension of the hip while the knee is in full extension with the ankle assuming a slightly plantarflexed position (McHardy *et al*., 2006). Propulsive phase begins with hip and knee flexion and ends with full knee extension as the ankle stays plantarflexed (McHardy *et al*., 2006). As the ankle is predominantly in a plantarflexed state, this could result in the triceps surae muscle and Achilles tendon to become shortened, resulting in a increased chance of repetitive injury to the calf from overuse, which is largely concentric during the cycle discipline and mostly eccentric during the running discipline of a triathlon (Bentley *et al.,* 2002).

2.9.2 Common swimming musculoskeletal sites for injuries

2.9.2.1 Shoulder

Shoulder injuries are the most frequent musculoskeletal complaint in competitive swimmers (Kammer *et al.,* 1999). Shoulder injuries are mostly of an overuse nature or result from repetitive microtrauma (Kammer *et al.,* 1999). The propulsion phase of the swim stroke causes maximum forces to the upper extremity, along with extreme ranges of motion (Shamus and Shamus, 2001).

"Swimmers shoulder" is the most frequent musculoskeletal overuse disorder in swimming (Kammer *et al.,* 1999). It involves the supraspinatus and biceps brachii tendons, inflammation of these structures and clinical or observable shoulder instability (Kammer *et al.,* 1999).

2.9.2.2 Elbow

Elbow injuries are not as common as shoulder injuries in swimming and are usually due to overuse and/or incorrect swimming techniques. The high elbow position during pull phase predisposes the triathlete to medial collateral ligament stress (Kammer *et al.,* 1999). Common injuries to the elbow include triceps brachii strain and triceps brachii synovitis, with a triceps brachii strain presenting as pain on resisted isometric contraction of the muscle itself (Kammer *et al.,* 1999). Gosling *et al.,* (2010) reported as little as 6% of all injuries during a triathlon season attributed to the elbow.

2.9.2.3 Knee

The knee is the most common lower limb injury in some swimmers (Kammer *et al.,* 1999). The pain is mostly noted as medial knee pain. These injuries are predominantly overuse in nature and result from the breaststroke whip kick as this action strains the medial collateral ligament (Kammer *et al*., 1999). They occur as repetitive flutter kick in freestyle and backstroke, resulting in repetitive contraction of the quadriceps femoris muscle and ultimately overload on the patellofemoral joint (Kammer *et al*., 1999).

2.9.2.4 Foot and ankle

A large degree of ankle plantarflexion is needed to position the foot during the flutter kick (used in freestyle) and the dolphin kick (used in butterfly) to attain maximum surface area to propel the swimmer forward (Kammer *et al.,* 1999). The repetitive nature of the flutter and dolphin kicks could result in tendonitis of the foot and ankle extensor tendons (Kammer *et al.,* 1999).

2.10 Cycling

2.10.1 Overview of literature relating to cycling and injury mechanisms

Traumatic injuries are more commonly associated with the cycling discipline and these injuries normally include abrasions, contusions and lacerations (Thompson and Rivara, 2001).

Overuse injuries conversely arise from an overload of the muscles, tendons or ligaments that occur because an athlete may not execute a particular movement appropriately as a result of trying too hard, fatigue, lack of fitness or previous injury. Therefore, one might say that the resultant injury may have been avoided had the individual been fitter or the technique better (Khan *et al.,* 2000). Overuse arouses an inflammatory response in the body, which damages local tissue by the release of vasoactive elements, inflammatory cells and enzymes (Khan *et al.,* 2000). Eventually this type of microtrauma leads to injury. Degenerative changes result from continuous activity and causes weakness, loss of flexibility, and chronic pain. Consequently, the problem is often chronic degeneration known as tendinosis (Khan *et al.,* 2000).

Injuries from the cycling discipline of the triathlon are relatively uncommon compared to the running discipline (Cipriani *et al.,* 1998, Burns *et al.,* 2003) even though Gosling *et al.,* (2010) reported injuries from the cycle discipline as 3.5 times greater than the swimming discipline. These injuries are usually a result of overuse, poor biomechanics (ergonomic or as a result of a non-professional bike setup) (Mills *et al*., 2006). The majority of cycling injuries involve the knee (Strock *et al.,* 2006). Knee injuries includes iliotibial band syndrome (Strock *et al.,* 2006). In addition to the overuse aspect of injury, ergonomic factors associated with a non-professional bike setup (e.g. seat height and position, handlebar height and position, pedal position) play an important role in cycling-associated injuries (Strock *et al.,* 2006). The cyclist's knee should be flexed in the region of 25 degrees with the cyclist seated on the bike and the pedal and crank arm inferiorly directed (Strock *et al.,* 2006). A seat that is too high could result in tight hamstrings or posterior knee pain. A seat that is too low could result in patellofemoral syndrome, patellar tendonitis, or iliotibial band syndrome (Baker, 2000).

A triathlete using aerobars (figure 2.2) and cycling long distances may suffer with musculoskeletal back pain. Findings from previous studies substantiate this, indicating that 72% of the ultra-distance triathletes in a research study completed by O'Toole *et al*. (1989) reported back injuries.

A high majority of triathletes have minimal cycling experience (90%), and so they tend to use relatively "big" gears to increase velocity instead of a higher cadence (revolutions per minute) on a "smaller" gear (Strock *et al.,* 2006). When terminology is used for cycling, gears refers to the posterior cogs and the term "big" actually refers to fewer teeth (this results in a greater gear differential in relation to the front chain ring) and translates to a greater distance travelled per revolution of the crank arm (refer to figure 2.3) (Strock *et al.,* 2006). However, this would require greater force to be exerted (Strock *et al.,* 2006). An example, triathletes may have a cadence of 60 revolutions per minute compared to a more desirable 90 to 120 revolutions per minute whilst using ''smaller'' gears (Strock *et al.,* 2006). In comparison to an amateur triathlete, an experienced cyclist would typically utilize a cadence of more than 100 revolutions per minute (Strock *et al.,* 2006). Relating to overuse injuries, the ''bigger'' gears consequently cause a larger stress on the patellofemoral joint and the quadriceps femoris muscles (Cipriani *et al.,* 1998). For this reason a triathlete is subject to overuse injuries particularly when followed by the running discipline of the triathlon (Strock *et al.,* 2006). For this reason, a triathlete is subject to overuse injuries particularly when followed by the running discipline of the triathlon (Holmes *et al.,* 1993).

The cycle discipline is competed on tar roads (McHardy *et al.,* 2006). If full road closure is not obtained by officials, the cycle discipline may happen on national roads with traffic (McHardy *et al*., 2006). This also occurs predominantly during training for the cycling discipline. Triathlon bicycles can be fitted with aerodynamic rims, tyres and aerobars (refer to figure 2.2 and figure 2.3) (Jeukendrup *et al.,* 2001). The aerobars force the triathlete into a more efficient aerodynamic position (refer to figure 2.2) which reduces anterior wind resistance (Jeukendrup *et al.,* 2001 and Gnehm *et al.,* 1997). A sacrifice of this type of setup is usually less stability and control (McHardy *et al.,* 2006). That scenario combined with large groups of triathletes cycling at high speeds is a significant factor in bicycle accidents during the cycling discipline (McHardy *et al.,* 2006). These injuries vary vastly from cuts and grazes to serious ailments such as fractures (clavicular fractures are most common) (Egermann *et al.,* 2003) and even fatality (Harris *et al.,* 2010).

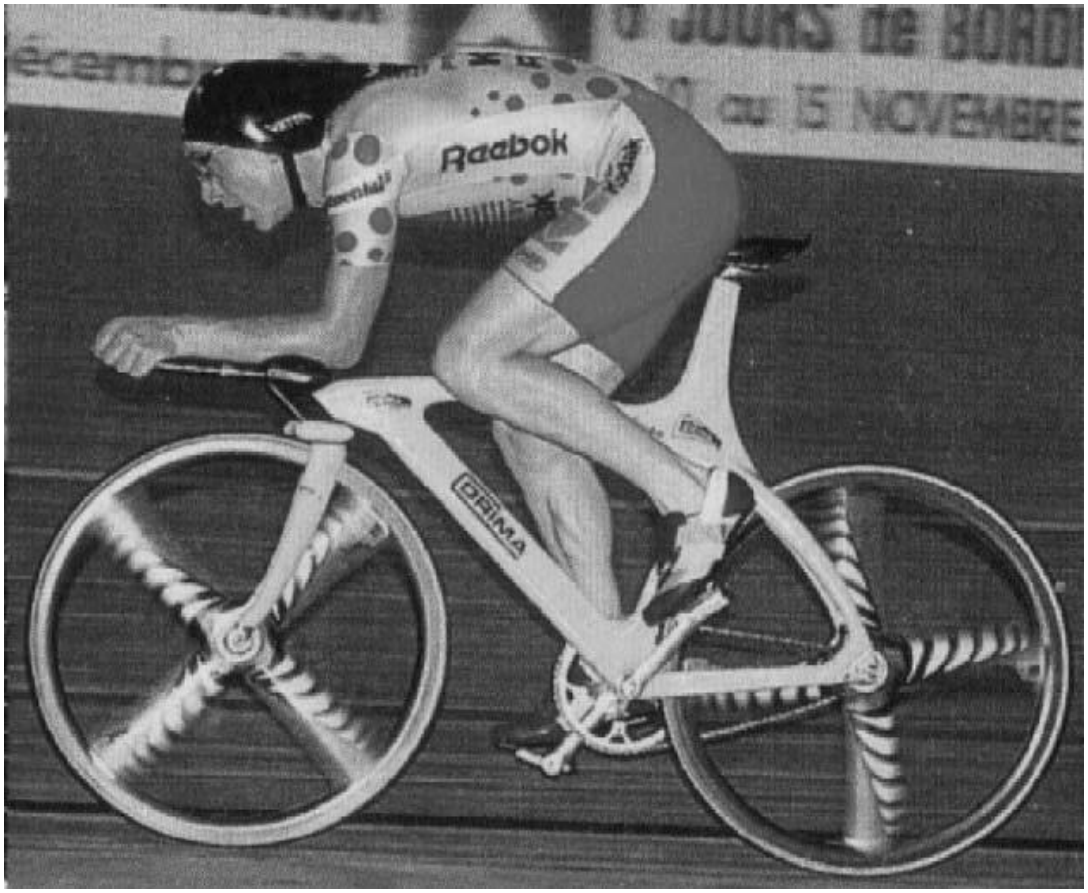


Figure 2.2: Aerobars force the triathlete into a more efficient aerodynamic position. Adapted from Callaghan (2005)

Correct and professional bicycle setup is therefore extremely important in order to obtain a more efficient cycling action as well as a factor in cycling-associated overuse injuries (McHardy *et al*., 2006). The main constituents are seat height, saddle position and arm reach/handlebar height (Mills *et al.*, 2006, Strock et al., 2006). With regards to optimal seat height, a seat that is too low will reduce the range that the hip joint can move, which would result in the gluteal muscles producing less power (McHardy *et al*., 2006). To add to this, the resultant increase in knee flexion predisposes the triathlete to patellofemoral tracking problems due to increased compression forces (McHardy *et al*., 2006). A seat that is fixed too high will also result in decreased power (due to altered length-tension range of motion) (McHardy *et al*., 2006). Weakened core muscles results in instability on the bike as the body sways from side to side during the pedal motion (Brown *et al.,* 1996).

Therefore, common overuse injuries include neck and low back pain (McHardy *et al*., 2006). These can be caused from the continued forward flexed trunk position on a bicycle (McHardy *et al*., 2006). Furthermore, aerobars increase the already excessive lumbar forward flexion and also draws the triathlete forward on the bike (Cipriani *et al.,* 1998). Neck pain results from the triathlete extending their neck to allow full visibility of the route ahead (McHardy *et al*., 2006). Coupled with aerobar usage, greater neck extension is needed to view the road (McHardy *et al*., 2006). This also seems to be associated with decreased thoracic spine mobility, especially with the neck extension. This results in a greater activation and contraction of cervical extensor muscles to gain visibility, with negative impact on the cervical facet joints (McHardy *et al*., 2006). Consequently, these contractions of the cervical extensors, predominantly the suboccipital muscles, have been associated with cervicogenic headaches (Bogduk, 1992).

The knee is also exposed to overuse in the cycling discipline of a triathlon (McHardy *et al*., 2006). Pedalling using high gears, hill climbing and incorrect cleat (pedal) placement sprains the patellofemoral joint (McHardy *et al*., 2006). Patellofemoral dysfunction is more often seen in triathletes who ride using higher gears and therefore at a lower cadence (McHardy *et al.,* 2006). The triathlete could implement a method called “spinning” which uses lower gears and lower force output with increased cadence (McHardy *et al*., 2006). Inexperienced triathletes are especially susceptible in this scenario (Cipriani *et al.,* 1998). Thus, iliotibial band syndrome usually results from prolonged use of bigger gears (McHardy *et al*., 2006). The Achilles tendon also undergoes stresses when the triathletes climbs hills in the standing position and can get worse with incorrect pedal fitting (McHardy *et al*., 2006).

According to Brown (2002), the following reasons are postulated as causes for cycling injuries:

- Training error. The most common cause of training errors includes: increasing mileage too soon; unnecessary hill or speed work, or use of incorrect gears (Brown, 2002).

- Incorrect position on the bicycle. This includes problems in the knees (due to a high saddle or low saddle, too far forward or backward cleat position; crank arms that are incorrectly positioned or too long, a bent pedal axle, position of the cleat (pedal) or limited degree of cleat play) (refer to figure 2.3) (Brown, 2002).

- Uncommon body type for the triathlete. Body type problems include leg length and pelvis discrepancies; excessive pronation of the foot; rotation of the tibia (shin bone); and imbalanced muscles leading to abnormal tracking of the patella knee cap (Brown, 2002).

Figure 2.3: A bicycle commonly used in triathlon events

2.10.2 Common cycling musculoskeletal sites for injuries

2.10.2.1 Hand

Ulnar nerve lesions are the most common of the compression syndromes, with the median nerve less common (Comfort and Abrahamson, 2010). Ulnar nerve compression creates symptoms of sensory changes and muscle weakness, a condition that is known as cyclists palsy (Reid, 1992). Compression of the ulnar nerve is common for both professional and amateur cyclists and is caused by direct pressure on the ulnar nerve from the grip on the handlebars (Reid, 1992). The pathology is caused by pressure on the ulnar nerve as it passes into the hand through the Guyon's canal (Reid, 1992). Median nerve entrapment at the wrist is known as Carpal Tunnel syndrome (Reid, 1992).

The most common overuse syndrome in the wrist is De Quervain's Tenosynovitis (Reid, 1992), which involves the first dorsal compartment inflammation (viz. the abductor pollicus longus and the extensor pollicus brevis muscles). Clinical presentation comprises of pain along the tendons, with palpation eliciting tenderness and on occasions crepitation. Many individuals will complain of difficulty when grasping objects firmly and cyclists have difficulty braking and grasping the handlebars (Reid, 1992).

2.10.2.2 Neck

Neck pain is caused by the tension developed in muscles of the shoulder, neck and upper spine that are in a hyper-extended position (Simons, Travell and Simons, 1999). Lengthy excessive extension of the neck results in trigger point development in the muscles of the neck and of the upper back (Asplund, Webb and Barkdull, 2005). The vibrating movement that is caused from cycling, can aggravate this problem (Simons, Travell and Simons, 1999). Myofascial muscle pain is common, because trigger points become active as a result of prolonged isometric contraction of the muscles which easily intensified by emotional stress, cold and fatigue (Simons, Travell and Simons, 1999). Isometric contractions of muscles decreases blood flow and may cause an ischemic response that may further cause a muscular spasm and consequently increase pain. In addition, metabolic waste products may collect in the muscle, which leads to pain (Sheets and Hochschuler, 1990).

2.10.2.3 Low back pain

Many activities in cycling involve sitting and leaning forward. The Transversus Abdominus and Multifidus muscles are weakened in these postures (Simons, Travell and Simons, 1999).

Additionally, failure of the hamstring muscles to lengthen normally increases the stress placed on the posterior elements of the lumbar spine, particularly if the spine is in a forward flexed position as in the cycling posture, because the extensor muscles of the low back are elongated and cannot disperse the applied stress (Schafer and Faye, 1989).

2.10.2.4 Knee pain

The patella is a sesamoid bone encapsulated in the patella tendon, attaching the quadriceps femoris muscle to the tibia (Lippert, 2006). Tendon disorders of the patella tendon are very tender and well confined to the lower end of the patella, ordinarily due to eccentric injury (Mills *et al*., 2006). Pain is experienced with knee extension resisted isometric muscle contractions (Souza, 1996). Patellofemoral pain syndrome is caused by incorrect patella tracking in the femoral groove or patellar tendinopathy (Brown, 2002) or is due to irritation of surrounding structures such as fat pad, retinaculum or ligaments (Souza, 1996). In progressive cases the injury results in the development of chondromalacia patella (Souza, 1996).

A clinical diagnosis will clarify that an inflamed patellofemoral joint will rarely give rise to swelling on the knee (Brown, 2002). It is vitally important that any swelling not related to trauma on the knee should be assessed by a medical practitioner (Brown, 2002).

Additionally, tenderness at the insertion of biceps femoris tendon is often found in cyclists (Souza, 1996). Disorders in the low back can also refer into this region and thus must also be considered (Brown, 2002).

Medial knee pain is commonly associated with anserine tendonitis (Asplund and St. Pierre, 2004). The anserine tendon attaches to the upper medial aspect of the tibia. It is the junction of four muscles: the semitendinosus, semimembranosus, gracilis and the sartorius muscles (Reid, 1992).

Iliotibial band syndrome (ITBS) is typically categorized by the sudden onset of a confined pain while pedaling. ITBS is due to the irritation of the iliotibial band (ITB) tendon from repetitive chafing of the ITB tendon over the lateral femoral condyle, which causes inflammation of the tendon and or bursa, or tight, thick, or widened ITB tendon (Souza, 1996). The ITB tendon contacts with the condyle at about 30 degrees of knee flexion (Comfort and Abrahamson, 2010).

2.10.2.5 Foot and ankle

In cycling the feet are in a relatively fixed position, thus the cyclist has no choice but to adapt to the drive mechanism and risk potential injury if not accustomed to the position (Mills *et al*., 2006).

2.11 Running

2.11.1 Overview of literature relating to running and injury mechanisms

The triathletes ability to run proficiently has been predicted as the discipline of the race that reflects the overall race outcome and as a result, triathletes depend greatly on their ability to run proficiently (Bonacci *et al.,* 2010a).

2.11.1.1 Running gait cycle

Typically the gait cycle is the time interval between initial contacts of one foot on the ground followed by the opposite foot (Novacheck, 1997 and Dicharry, 2010). The gait cycle can be divided into two phases: stance phase and swing phase. Stance is when the foot is in contact with the ground, and in swing phase the foot does not contact the ground (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011). The running gait cycle is distinguished from the walking gait cycle by the characteristic periods of double float that occur at the start and finish of swing phase during which both feet are not in contact with the ground (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011). The stance phase can be further subdivided into absorption and propulsive phases (Figure 2.4).

During the running gait cycle, approximately 40% of the gait cycle is spent in stance and 60% in the swing phase (which includes two stages of double float, one stage at the beginning and one stage at the end of the swing phase) (Novacheck, 1997 and Dicharry, 2010). As the pace of the running stride increases, the time occupied in the stance phase decreases and there is a corresponding increase in swing time (Novacheck, 1997 and Dicharry, 2010).

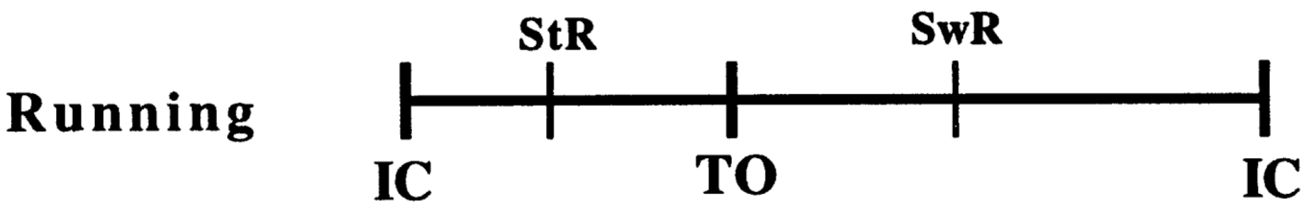


Figure 2.4 Running gait cycle: for running; IC, initial contact; TO, toe off; StR, stance phase reversal; SwR, swing phase reversal; absorption, from SwR through IC to StR; generation, from StR through TO to SwR. Adapted from Novacheck (1997).

The first contact with the ground is accompanied by rapid flexion of the hip, knee and ankle in order to absorb the impact of the leg contacting the ground (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011). During the absorption phase of stance (part of the gait cycle from first contact to mid-stance), the knee and ankle continue to flex enabling further energy reduction. Mid-stance is defined as the point at which the transition from absorption to propulsion occurs and is identified by the cessation of the energy absorbing flexion and the commencement of joint extension (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011). It is at this point that centre of gravity reaches its lowest height above the ground (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011).

The greatest hip, knee and ankle extension occur when the toe leaves the ground and allows translation of propulsive forces into a forward direction (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011). During the swing phase, both the hip and knee flexes to clear that leg in the swing phase (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011). In the final part of the swing phase, hip extension initiates to position the foot under the body at first contact. Without this movement of the hip, foot placement would be ahead of the centre of gravity and cause ground reactions forces to occur in a posterior direction, resulting in deceleration (Novacheck, 1997, Dicharry, 2010 and Scarfe, 2011).

2.11.1.2 The effect of cycling on running kinematics

Triathletes report that cycling before a run causes a lack of coordination during the run (Bonacci *et al*., 2010a; Hausswirth and Brisswalter, 2008; Heiden and Burnett, 2003). Altered muscle recruitment patterns when running directly after the cycle discipline have also been reported (Chapman *et al*., 2009). Altered muscle recruitment patterns are linked to exercise-related leg pain but may also recognize an injury risk within triathletes (Bonacci *et al.*, 2010b). Triathletes display a different running gait to pure runners exhibiting shorter relative strides and decreased hip range of motion, thigh extension, hip flexion and anterior pelvic tilt (Scarfe, 2011). During endurance events, this requires that the hips and knees need to be maintained in a flexed position for long periods of time, both during races and during training (Callaghan, 2005). The excessively flexed position of cycling means that knee extension minimises the muscular length required. This results in optimal power generation in this muscle group which takes place at longer muscle lengths in cyclists compared to runners (Scarfe, 2011). Such adaptations to cycling have been linked to compromised running performance within triathlon (Tew, 2005) and reduced running economy (Bonacci *et al.*, 2010a).

Approximately 70% of injuries suffered during training and competing in triathlon are related to running (Collins *et al.,* 1989 and Burns *et al.,* 2003). While running is the best predictor of a triathletes performance (O'Toole *et al.,* 1989), increased hours of running training are connected to increased injury (Burns *et al.,* 2003). Conditions like fatigue and potential muscle tightness from the swim and cycle disciplines could predispose the triathlete to overuse injuries in running (Strock *et al.,* 2006). The primary factor for injury is expectedly related to running biomechanics and the specific training regimen (Strock *et al.,* 2006).

The run is after the cycle discipline and therefore is the finishing discipline of the triathlon race (McHardy et al., 2006). Succeeding the cycle discipline, lower limb musculature fatigues causing a lowered velocity of muscle contraction (Cipriani *et al.,* 1998). Fatigue also causes a decreased maximum force that the muscle can produce (Cipriani *et al.,* 1998). The decreased force is predominantly in the plantar flexors during the swim discipline and in the hip flexors during the cycle discipline (Cipriani *et al.,* 1998). Beginning the run of a triathlon race, following a cycle, leg muscles produce less power compared to a run on its own (Cipriani *et al.,* 1998). Triathletes use shorter strides, and their speed is slower and triathletes will have a subjective feeling that the run is more difficult (Hausswirth *et al.,* 1997). Therefore, Hausswirth *et al.,* (1997) stressed that triathletes would take longer to complete a 10 km run at the end of an Olympic distance race than they would when completing a single-even 10 km run.

2.11.2 Common running musculoskeletal injury sites

It has been projected that roughly 27% to 70% of runners will sustain an injury in any given year of running (Hreljac and Ferber. 2006). According to Reid (1992) and Taunton *et al.,* (2002), common injuries during running include:

- patellafemoral pain syndrome
- iliotibial band friction syndrome
- plantar fasciitis
- meniscal injuries
- tibial stress syndrome
- Achilles and patellar tendinopathies

2.12 Prevention of injuries

According to Gosling *et al.,* (2008) injury prevention can be regarded in three ways:

1. preventing a complaint from occurring at all (primary),
2. preventing a complaint from becoming a chronic condition once it has occurred (secondary), and
3. preventing the complaint from occurring again after it has been resolved (tertiary).

Although secondary and tertiary injury preventative protocols are imperative in reduction of musculoskeletal triathlon injury, the improvement of primary injury preventative protocols are targeted at reducing injury occurrence and or reducing injury severity (Gosling *et al.,* 2008). Primary injury prevention protocols listed in the literatureinclude stretching (Cipriani *et al*., 1998 and Massimino *et al*., 1988); warm-up and cool-down (Burns *et al*., 2003); shock absorption in running shoes and the use of appropriate foot wear (Cipriani *et al.,* 1998 and O'Toole *et al*., 1989); appropriate usage of gear ratios during cycling (Gosling *et al*., 2008); appropriate conditioning and correct training techniques (Cipriani *et al*., 1998) and practicing cycling to running transitions (Gosling *et al*., 2008).

Injury prevention at a primary level should include proper technique (in each of the disciplines) and avoidance of sudden increases in training intensity (Migliorini, 2011).

2.13 Summary

To the researcher's knowledge, the research conducted by Ellapen *et al.,* (2011) has been the only research conducted on South African triathletes. Their research has identified the prevalence of musculoskeletal pain among triathletes in Kwa-Zulu Natal, South Africa. Research investigating the epidemiology of South African triathlon-related musculoskeletal injuries will assist triathletes in being successful at both national and international competitions (Ellapen *et al.,* 2011).

Therefore, the primary aim of this study was to investigate the injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes. Primary objective outcomes were to develop a demographic profile and to determine the incidence, period prevalence and point prevalence of injuries in amateur and semi-professional Kwa-Zulu Natal triathletes. Secondary objective outcomes were to assess and determine these injuries in terms of diagnosis, location and severity, and to identify the associations between the demographic profile and injuries in terms of diagnosis, location and severity by identifying previously diagnosed injuries from the previous year as well as diagnosing triathletes who currently are in pain.

Chapter Three

Methodology

3.1 Introduction

This chapter deals with the research methodology employed and the procedure used to collect data. The statistical analysis is also discussed in this chapter.

3.2 Methods

3.2.1 Research study design

This research was a cross-sectional, retrospective/prospective study which documented triathlon-related musculoskeletal pain (retrospective in terms of injury information from the prior 12 months to the study and prospective in terms of intervention with the triathletes and their reported current pain at the time of the study, both discussed in the sections to follow). The study employed a quantitative and descriptive design (Fink and Kosecoff, 1985). In order for the study to be both effective and efficient, the data was required to be of good quality with regards to its recording of a triathlete's musculoskeletal pain and hence the use of an expert group and pilot study were utilised to strengthen the questionnaire development process.

Participation was by voluntary informed consent (Appendix F, Appendix L and Appendix P).

Data was obtained from:

- All participating triathletes who completed a self-administered questionnaire detailing and documenting triathlon-related musculoskeletal pain (Salant and Dillman, 1994) (Appendix Q), and

- All participating triathletes who had consented to be part of the research at the Durban University of Technology (DUT) Chiropractic Day Clinic. This consultation involved a case history (Appendix S), physical examination (Appendix T) and a pertinent orthopaedic examination (Appendix U to Appendix DD). A SOAPE note was drawn up which contained the details of the injury in terms of diagnosis, location and severity (Appendix EE). All data was then recorded on Appendix R.

Based on the above study design, ethical clearance was given by the Durban University of Technology's Institutional Research and Ethics Committee (Appendix A (original approval) and Appendix C (amendment to methodology approval)). This clearance indicated that the study was approved and complied with the principles outlined in the Declarations of Helsinki, Nuremburg and Belmont of 1975 (Johnson, 2005).

3.2.2 Advertising/ recruitment

In principle permission was obtained prior to ethics approval and clearance from Kwa-Zulu Natal Triathlon Association (KZNTA) (Appendix O), which was fully endorsed when ethical approval had been obtained. As a result, no formal advertising was required, as participants were informed through the Kwa-Zulu Natal Triathlon Association. The contact details of the Association were accessible through the secretary of the Association and through this mechanism the researcher was able to access potential participants.

3.2.3 Participant Sampling

3.2.3.1 Population Size

At the time of proposal approval, there were 80 active triathletes registered with KZNTA (n= 80). Permission to access these triathletes was obtained from the KZNTA (Appendix O).

A maximum response rate (full sample) was attempted due to the small population size. However, with a realistic 10%-15% attrition rate anticipated (Schoenbach and Rosamond, 2000), as well as the need for some triathletes to participate in the expert group and the pilot study, a minimum sample size of 70% (56 triathletes of the total sample) was denoted as the baseline for this study to complete data collection.

3.2.3.2 Allocation

Triathletes were not allocated to groups as this is an investigation of an entire population group and any sub-grouping only occurred during the data analysis.

3.2.3.3 Method

All triathletes meeting the inclusion criteria were invited to participate. Triathletes who suffered with triathlon-related musculoskeletal pain at the time of the study, underwent a clinical consultation and were also requested to complete the questionnaire. By contrast, triathletes that were not suffering from a triathlon-related musculoskeletal pain at the time of the study, only answered the questionnaire (and were not required to undergo the clinical consultation (Appendix C amendment to proposal), as the aim of the clinical consultation was to verify the diagnosis of the athletes' presenting complaint.

Participation in this study was a method of self-selection process (Mouton, 1996) based on a triathlete's willingness to participate in the study and undergo the required consultation where necessary.

3.2.3.4 Sample Characteristics

In order for the triathletes to participate in this study, they were required to meet the following criteria:

The expert group consisted of members representative of the specific areas of expertise related to the research (Salant and Dillman, 1994). Thus, the relevance of the questions could be critically assessed so as to enhance the questionnaires face validity (Bernard, 2000). In order to the meet the requirements for the purposive sampling as well as the guidelines for an expert group (Salant and Dillman, 1994; Morgan, 1998(a); Morgan, 1998(b); Morgan, 1998(c)), the following criteria were laid out in terms of the participants required for the expert group. It was noted that any one participant may represent one or more category (e.g. person with questionnaire experience may also have been a triathlete).

3.2.3.4.1 Inclusion criteria

Inclusion criteria for the expert group:

- At least two triathletes.
- At least one Master's student
- At least one person with research experience utilizing questionnaires.
- A statistician.
- The researcher.
- The researcher's supervisors.
- All of the above would be required to voluntarily sign a letter of information (Appendix E) and an informed consent form (Appendix F) as well as a code of conduct (Appendix G) and confidentiality statement (Appendix H).

Inclusion criteria for the pilot study group:

- Were required to meet the same criteria as the research procedure (see following point).

Inclusion criteria for the research procedure:

- Triathletes were required to be based in the greater Durban area and be members of the KZNTA.
- Any person who voluntarily signed the letter of information and informed consent form (Appendix P) to participate in the research procedure.
- Triathletes were required to be 18 years of age or older.
- Triathletes were required to be amateur or semi-professional athletes.

3.2.3.4.2 Exclusion criteria

Exclusion criteria for the expert group:

- Any person invited that declined the invitation to participate.
- Any person who did not voluntarily sign the letter of information (Appendix E), the informed consent form (Appendix F) as well as the code of conduct form (Appendix G) and confidentiality statement (Appendix H) to participate in the expert group.

Exclusion criteria for the pilot study group:

- Any person who did not meet the same criteria as the research procedure.
- Any person that participated in the expert group.
- Any person who does not voluntarily sign the letter of information and informed consent form (Appendix L) to participate in the pilot study.
- Any person approached who declines the invitation to participate.

Exclusion criteria for the research procedure:

- The exclusion criteria consisted of any triathlete who was not registered with the KZNTA.
- Professional triathletes.
- Members of the expert or pilot study groups.
- Any person approached who declined the invitation to participate.
- Any person who did not voluntarily sign the letter of information and informed consent form (Appendix P) to participate in the pilot study.

3.2.4 Research tools/ Instruments

3.2.4.1 **Questionnaire** (Appendix Q)

3.2.4.1.1 Phase one: questionnaire development

A self-report musculoskeletal questionnaire (adapted from Ellapen *et al.,* 2011) (for permission see: Appendix D) was developed for this research.

This research employed the same definition as Ellapen *et al*., (2011) who used the following definition of musculoskeletal pain: a sensation of agony that inhibited the individual from participating in a triathlon or practice for a minimum of twenty-four hours.

Musculoskeletal pain and/or injury are common among triathletes (O'Toole *et al.,* 1989, Vleck and Garbutt, 1998). The fundamental problem concerning international epidemiological investigations was the inconsistent definition of musculoskeletal injury. This study attempted to determine the severity of injury based on six criteria including: nature of injury, duration and nature of treatment, sporting time lost, working time lost, permanent damage and cost (van Mechelen *et al.,* 1992).

Therefore, these aspects were covered by the questionnaire adapted from Ellapen *et al.,* (2011) and assessment data sheet adapted from Mills *et al.,* (2006). In order to adapt the questionnaire, an expert group (Appendix I and Appendix J) was utilized.

3.2.4.1.2 Expert group procedure

After approval of the proposal and ethics clearance, the questionnaire was finalized through an expert group discussion.

An expert group enabled a group of individuals to discuss the questionnaire, stimulating their thinking and encouraging their ideas (Salant and Dillman, 1994). The members of the expert group critically assessed the relevance of questions presented in the questionnaire, as well as add to, delete or clarify any questions to ultimately strengthen the face validity of the questionnaire.

The reason why an expert group had been chosen was based on the fact that within a questionnaire one needs to address issues that surround validity, the components of which are: face validity, construct validity, content validity and criterion validity (Table 3.1). The definitions of these concepts and how they were addressed in the questionnaire follows (definitions taken from Bernard, (2000)).

Table 3.1: Validity

Face validity	Researchers are taking the validity of the test at face value by looking at whether the questionnaire seems to measure what is intended to measure.
Content validity	The content of the questionnaire is considered effective, well-rounded enough and represents the entire range of possible concepts the questionnaire should cover.
Construct validity	Measures the ability of the questionnaire to actually measure the concept being studied.
Criterion validity	Measured when a particular tool produced similar results when compared with another tool already known to be trustworthy. This type of validity would not to be addressed as part of this current research and has only been included for completeness in discussing validity.

The following procedures were utilized following guidelines from Seymour (2004), unless otherwise stated.

Individuals meeting the inclusion criteria were selected. These individuals were then approached personally or contacted by telephone in order to establish whether they would consider participation in the proposed expert group. If the triathlete refused participation, they then did not meet the inclusion criteria to this study and were excluded. If the triathlete had agreed to the expert meeting and fitted the inclusion criteria, they were included in the expert group.

Once the expert group had been established according to the inclusion criteria, arrangements were made to have the expert group meeting. These arrangements included: establishing a date and time, booking the boardroom, arranging refreshments, stationery and audiovisual equipment.

Once everyone had arrived at the arranged time, the meeting commenced. The researcher opened the meeting by welcoming all participants and explaining the procedure for the meeting. All the participants were required to read and sign the letter of information (Appendix E) and informed consent form (Appendix F) as well as a code of conduct (Appendix G) and confidentiality statement (Appendix H) before the questionnaires were handed out. The questionnaire was discussed question by question and changes to the questions were made based on the advice/concerns raised by the members of the expert group. During this meeting, refreshments and stationery was provided. An audiovisual recording of the expert group proceedings was made (Appendix FF) for the use of the examiners only due to the confidentiality agreement.

The changes that were made as per the expert group are indicated in Appendix K.

3.2.4.1.3 Pilot study procedure

A pilot study (Appendix L and Appendix M) involved taking a very small population for which it is intended to be used and administer the questionnaire exactly as it would be administered to the research sample. The purpose of the pilot study was to determine the time taken and any problematic areas in the questionnaire (Fink and Kosekoff, 1985).

After the post expert group questionnaire had been finalized, the questionnaire was delivered to a pilot study group. These were hand-delivered to the respective triathletes and were collected on another arranged date if the triathlete could not complete it immediately. Feedback from the pilot study group was used to make changes to the post expert group questionnaire, and the changes are shown in Appendix N.

3.2.4.1.4 Phase Two: assessment of the triathletes

Attempts to document the prevalence of musculoskeletal injury have been unreliable in the absence of clinical diagnosis. Therefore, Phase Two of the study involved a consultation with the triathletes who experienced triathlon-related musculoskeletal pain at the time of the study (which includes regional assessments of the affected areas) in order to verify any current complaint that they reported.

Each consultation was supervised by a qualified clinician (i.e. a registered Chiropractor). At the consultation each participant was given a letter of information and informed consent form to read and sign (Appendix P). The entire research protocol was explained in detail to every prospective participant by the researcher. Each prospective participant underwent a case history (Appendix S), physical examination (Appendix T) and relative orthopaedic examination (Appendix U to Appendix DD). A SOAPE note was drawn up which contained the details of the injury in terms of diagnosis, location and severity (Appendix EE).

3.2.4.2 Data collection procedure for the main study

The members of the KZNTA were contacted and briefed about the questionnaire and the study. Members of the KZNTA were contacted and those triathletes who had triathlon-related musculoskeletal pain at the time of the study were invited to the DUT Chiropractic Day Clinic. Alternatively, those triathletes who could not attend the DUT Chiropractic Day Clinic underwent the consultation at an external venue, but the same consultation criteria (aforementioned) were met. The consultation was free of charge. Upon arrival, the triathlete was briefed about the research, its contents, the questionnaire and the consultation. The questionnaire was given to the triathlete and completed during the consultation.

Subsequent consultations, if required were on an outpatient basis and were administered by any of the students, based on the patient’s time and availability for treatment.

Members of the KZNTA who did NOT have triathlon-related musculoskeletal pain at the time of the study were contacted and arrangements made to meet with the researcher to complete the questionnaire under his supervision.

3.3 Statistical methodology

IBM SPSS version 20 was used to analyse the data (www.ibm.com/us/en).

The data was analyzed descriptively, (mean, mode, frequency and percentages). Thus data were described using frequency tables for categorical data and summary statistics such as mean and standard deviation for continuous data, and inferentially, (regression analysis and crudes odd ratios).

The probability was set at $p \leq 0.05$ (a p value <0.05 was considered as statistically significant).

In order to assess associations between presence of injury and explanatory variables, binary logistic regression using backward selection was used based on the likelihood ratios. Odds ratios and 95% confidence intervals were reported. For the participants who reported current or past injuries, linear regression for factors associated with injury severity was used. Forward/stepwise selection was employed, and coefficients and p values were reported.

The study design was cross sectional thus you did not measure incidence, only point and period prevalence. To measure incidence you would have had to conduct a cohort study on injury free individuals and follow them up to count how many new cases of injury there were over the study period (Esterhuizen, 2013).

A first step prior to conducting regression analysis is always bivariate anlayses such as chi square and t-tests. The results of the bivariate analyses were not reported, as regression analysis was conducted thereafter and the results of the regression analyses reported. Regression analysis results are not subject to confounding effects, as bivariate analyses are, therefore reporting of regression results was deemed the most appropriate way to report the results (Esterhuizen, 2013).

For the logistic regression, all independent variables which were significantly associated with the outcome on bivarate analysis were entered into the mode at stage 1, and a backwards stepwise method based on likelihood ratios and probabilities set at 0.1 for removal from the model was used to determine the final model. No interaction terms were tested due to the relatively small sample size and large number of independent variables to be tested (Esterhuizen, 2013).

The Crude odds ratios determined any association between exposure and outcome (Thomas *et al.,* 2011). With the use of the Crudes odds ratios, data gathered from Appendix Q was compared against the data gathered from Appendix R which is, in order to assess the association between variables in each of these data tools. This was done to define relationships but not imply causality.

3.4 Conclusion

This chapter described the methodology that was used to conduct this study; How the initial questionnaire was developed, and amendments (as reflected in the appropriate appendices) that were made to it and procedural changes after the expert group meeting and pilot study. The statistical methods used were also presented.

Chapter Four

Results and Discussion

4.1 Introduction

This chapter presents the results obtained from the data collection process. It should be noted that although unconventional, the chapter presents the results and discussion per objective, due to the large complexity of the various objectives. Bar graphs and tables are used to graphically present the data, with a short description accompanying each bar graph or table. The results and discussion are organised as they relate to the respective objectives (one to four) of this research study.

This chapter first discusses the characteristics of amateur and semi-professional KZN triathletes with regards to gender, ethnicity, height and weight. Secondly, this chapter discusses the training demographic profile detailing a variety of training parameters. This is followed by discussion of injuries in terms of diagnosis, location and severity and various subjective and objective data obtained in a consultation. The triathletes' injuries including sites and contributing factors are also discussed. The period and point prevalence of the injuries are subsequently presented. Finally, the associations between the demographic profile and injuries in terms of diagnosis, location and severity are identified.

4.2 Data

The primary data for this study was a process that occurred only once per triathlete – at the time of completion of the questionnaire. The secondary data was obtained from the triathletes at the clinical consultation, particularly with reference to triathletes who had reported triathlon-related injury / pain at the time of the study.

4.3 Abbreviations specific to this chapter

The following abbreviations appeared in this chapter:

B	Beta
CI	Confidence interval
cm	Centimetre
GP	General practitioner
ITB	Iliotibial band
ITBS	Iliotibial band syndrome
kg	Kilogram
km	Kilometre
KZNTA	Kwa-Zulu Natal Triathlon Association
lbs	Pounds
m	Meter
min	Minimum
n/a	Not applicable
OR	Odds ratio
Q	Question
QL	Quadratus lumborum
SI	Sacroiliac
sig.	Significance
t	Student's t statistic
TFL	Tensor fascia lata
USA	United States of America

4.4 Triathlete participation

4.4.1 Population

The total sample population in this study was 80 active triathletes who were members of the KZNTA. A high as possible response rate was sought, to minimise bias and to enable the findings to be generalised across other triathlon populations (McHardy *et al*., 2006 and Lapane, Quilliam and Hughes, 2007). This, along with a recommendation from a statistician, indicated that a 70% and higher response rate was shown to adequately address these concerns (Esterhuizen, 2013). This meant that the required target population was 56 triathlete responses.

4.4.2 Consort diagrams

The number of triathletes who participated in this research study is revealed in the consort diagram (Figure 4.1).

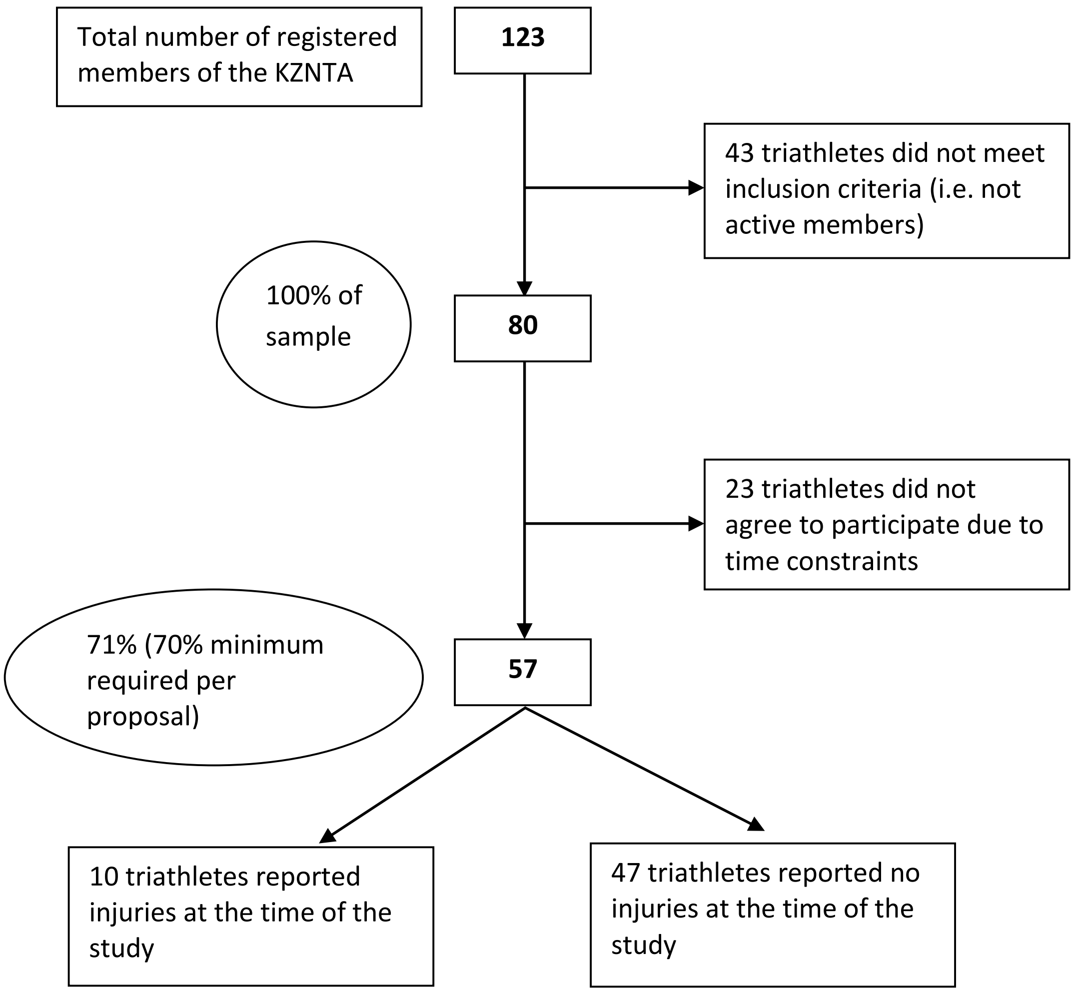


Figure 4.1: Consort diagram indicating the progression of the triathlete's through the research

4.4.3 Response rate

This study data was collected by means of a self-administered questionnaire (Appendix I), which gathered the data prospectively and enabled it to be quantified and analysed (Mouton, 1996).

This method of data collection may have exhibited some bias (Mouton, 1996). Some triathletes may have reported more injuries or increase their severity, whereas healthy triathletes may have considered this study of no value and have not agreed to participate.

Descriptively, this study has provided a unique observation of injuries in triathletes in the setting of a consultation, based on Gosling's *et al.*, (2008) observation that only two older studies (1980's) considered clinical evaluation of their research participants. Rimmer and Coniglione (2012) and Gosling *et al.,* (2010) used information from triathletes seeking medical aid at triathlon races, which is different to this study where triathletes were seen at a time not at the race.

Therefore, this study attempted to increase the response rate in that the:

1. Sampling procedure was a consecutive convenience sampling of the entire population of the KZNTA:
    a. This, however, implies that the sampling would be specific to the group of triathletes and that they would not necessarily represent the general population of South Africa (Statistics South Africa, www.statssa.co.za, 2011). This lack of commonality would imply that the results of the study would only be applicable to groups that are similar in nature to the population outlined in terms of the demographics (refer to Section 4.5) and not be generalizable (Lapane et al., 2007).
    b. Secondly, it is anticipated that the outcomes of the study are dissimilar to the individual disciplines of swimming, running and cycling; as the

compound effect of the different injuries may present in a different manner.

Notwithstanding the above process, fifty-seven triathletes from a total sample of eighty participated in this research. The data was collected, in person by the researcher, over a period spanning November 2012 – June 2013, a period of eight months. This method of data collection was chosen in preference to posted questionnaires or questionnaires delivered by a neutral third party. Reasons for this included the decreased return rate of questionnaires in studies where postal surveys were utilised (Lapane *et al.,* 2007), affecting the viability of the sample and biasing the results.

Additionally, the research budget was also not able to facilitate incentives (Asch *et al.*, 1998; Halpern *et al.*, 2002), advance incentives (Delnevo *et al*., 2004; Leung *et al.,* 2004) and/ or use the lottery (as an example) as an incentive (Robertson *et al.,* 2005) as suggested by the publications cited in this text.

4.4.4 Discussion of the response rate and study method: population size

There were 80 active triathletes in KZN at the time of the study (Storm, 2012). A total of 57 triathletes responded (response rate 71%) (Figure 4.1), and therefore the minimum response rate required by the Institutional Research and Ethics Committee (70% response rate) was attained. By comparison to a previous study done on triathletes within the South African context, this study was able to achieve significantly higher response than Ellapen *et al.,* (2011).

The outcome of this study is substantially better than global studies which have achieved response rates between 21.23% (Korkia *et al*., 2004 to 55% (Shaw *et al*., 2004). This indicates that the results of this current study are stronger than the previous studies. Additionally, although the response rate of this study was lower than Vleck *et al.,* (2010), who attained 75% (Olympic distance triathletes) and 95% (Ironman triathletes), the numbers of participants in this study was more than double of those analysed in the Vleck *et al*., (2010) study. This implies that the results from this current study, by comparison, reflected a truer clinical picture of triathlete injuries.

4.5 Objective One

Objective One was to develop a demographic profile of triathletes (utilizing a self-administered questionnaire) (Appendix Q).The demographic profile included gender, ethnicity, height and weight as well as a training demographic profile detailing a variety of training parameters.

4.5.1 Age, gender and ethnicity: results and discussion

Table 4.1 shows that nearly two thirds (68%) of the sample were male, leaving one third (32%) female. The vast majority (95%) of respondents were White, 3% were African, 2% Coloured. No other ethnical groups responded to the research request and therefore these categories were not represented.

Table 4.1: Age, gender and ethnicity

		Count	Column N %
Age (years)	Minimum	18	n/a
	Maximum	64	
	Average	31.64	
	Median	29	
Gender	Female	18	31.6%
	Male	39	68.4%
Ethnicity	African	2	3.5%
	Coloured	1	1.8%
	White	54	94.7%

The triathlete sample surveyed in this study was considered to be representative of the triathlete population and not dissimilar to the gender and ethnicity data of triathlete samples described and presented in previous survey research studies both in South Africa (Ellapen *et al*., 2011) and internationally - for example - O'Toole *et al*., (1989) in Hawaii, Collins *et al*., (1989) in USA, Wilk *et al*., (1995) in USA, Cipriani *et al*., (1998) in USA, Clements *et al.,* (1999) in the United Kingdom, Burns *et al.,* (2003) in Australia, Shaw *et al.*, (2004) in Australia, Korkia *et al*., (2004) in Britain, Manninen and Kallinen.,

(2006) in Japan, Villavicencio *et al*., (2006) in USA, Johnson *et al*., (2010) in USA, Galera *et al.,* (2012) in France and Ansell *et al*., (2012) in Australia.

In a local study done by Ellapen *et al.* (2011), 72.09% of the population was male and 27.91% females. That study also showed that the ethnical population was: White (83.72%), Indian (11.62%), African (2.33%) and Coloured (2.33%).

Internationally, this population compares to the following gender populations for males and females respectively:

- 79% and 21% (O'Toole *et al.,* 1989);
- 77% and 23% (Collins *et al.,* 1989);
- 56.9% and 43.1% (Wilk *et al*., 1995);
- 85% and 15% (Cipriani *et al.,* 1998);
- 79% and 21% (Clements *et al*., 1999);
- 70% and 30% (Burns *et al*., 2003);
- 74% and 26% (Shaw *et al.,* 2004);
- 80% and 20% (Korkia *et al.,* 2004);
- 35.6% and 64.4% (Villacencio *et al.*, 2006);
- 76% and 24% (Manninen and Kallinen., 2006);
- 67% and 33% (Main *et al.,* 2010)
- 65% and 34% (Johnson *et al.,* 2010);
- 82.1% and 17.9% (Galera *et al*., 2012) and
- 76% and 24% (Ansell *et al.,* 2012).

In terms of ethnicity, the population was similar to a study done in Hawaii by O'Toole *et al*. (1989) who showed the great majority of the triathletes (94%) were White with 1% Black, 1% Hispanic, 3% Asians, and 1% Mixed Racial background. Further extrapolation was limited as other studies failed to report this demographic finding.

4.5.2 Height and weight: results and discussion

The height and weight of the triathletes in this study were collected as self-reported data. The tallest athlete was 191 cm while the shortest was 150 cm. The weight of the athletes ranged from 43 kg to 97 kg. Table 4.2 shows that the mean height is 174.7 cm and the mean weight is 71.0 kg.

Table 4. 2 Height and weight

	Mean	Standard Deviation	Minimum	Maximum
Height (cm)	174.7	9.7	150	191
Weight (kg)	71.0	11.8	43	97

The triathlete sample surveyed in this study was marginally taller than the anthropometric data of triathlete samples described in a previous survey research study in South Africa (67.86 kg and 172 cm) (Ellapen *et al*., 2011) and an international study done in Japan (61 kg and 167.7 cm) (Manninen and Kallinen, 1996). However, the weight and height of these respondents were nearly identical (174 cm (68.47 inches) and 70 kg (155.58 lbs)) to an international epidemiological study done in USA by Wilk *et al.* (1995).

Further studies were more descriptive and reported height and weight for male and female triathletes respectively. The average height and weight reported was 179 cm and 78 kg for males and 168 cm and 65.96 kg for females (Johnson *et al.,* 2010). The average height and weight reported was as 181.1 cm (71.3 inches) and 73.4 kg (162 lbs) for men and 165.1 cm (65 inches) and 57.1 kg (126 lbs) for women (O'Toole *et al*., 1989). Similarly, Korkia *et al.*, (1994) reported the average height and weight was 176.7 cm and 71.6 kg for males and 166.5 cm and 58.0 kg for females and Cipriani *et al.,* (1998) outlined an average height and weight of 179.4 cm and 77 kg for males and 163.2 cm and 56.4 kg for females. These outcomes are not dissimilar to the outcomes in this study, particularly when the published results are aggregated around the percentage contribution of males (2/3) and females (1/3) that were found in this study.

4.5.3 Number of competitions in which a triathlete has competed: results and discussion

Table 4.3 shows that the median of triathlon competitions participated in by the triathletes in the 12 months prior to this research study was three. The median of triathlon competitions participated in by the triathletes in the four months prior to this research study was one.

Table 4.3: Number of competitions

Questionnaire Section A	Median	Minimum	Maximum
		Responses	
Q6 How many triathlon competitions (number) have you participated in the previous 12 months?	3	0	20
Q7 How many triathlon competitions have you participated in the previous 4 months?	1	0	8

These results are lower than that of Wilk *et al.* (1995) who showed the mean number of triathlons in the year prior to his study was five.

The projected results of this study are higher than that of Collins *et al.* (1989) who reported that 50.6% of triathletes had only participated in 1-3 triathlons in their lifetime and only 49.4% participated in more than 4.

The differences in these results may be attributed to the locality within which each of the studies was conducted as well as the year in which the studies were conducted. Miami (USA) is known for its outdoor weather most of the year round (Wilk *et al.,* 1995), giving the opportunity for more triathlon events to occur in this locality. Whereas, Seattle (USA), has reduced opportunity to host such events based on the longer and harsher winter period (Collins *et al.,* 1989). Additionally, it would seem that triathlons may not have been as well supported in 1989 (Collins *et al.,* 1989) as compared to 1995 (Wilk *et al.,* 1995). These discussions fall in line with the results in this study where the Kwa-Zulu Natal climate fluctuates between the Miami and Seattle weather. In addition, triathlon participation has been impacted positively since 1995 in terms of growth, but has been negatively impacted by the relatively recent development of triathlon as a specific and sponsored (supported) discipline in South Africa limiting the number of professional triathletes in the country.

4.5.4 Average length (kilometres) and duration (minutes) of each discipline: results and discussion

Table 4.4 shows that the median of each discipline in a triathlon (swim, cycle and run) was 1 000m, 25km and 10km respectively. The median of time for each of these disciplines was 20, 75 and 45 minutes respectively. This indicates that the average amateur and semi-professional triathlete in KZN will compete in distances between sprint and Olympic distance triathlon races.

Table 4.4: Average length and duration of each discipline

Questionnaire Section A	Median	Minimum	Maximum
		Responses	
Q8 What is the average length (in kilometres) of a competition? Swim	1 000	0	3 800
Q8 What is the average length (in kilometres) of a competition? Cycle	25	3	180
Q8 What is the average length (in kilometres) of a competition? Run	10	3	42
Q9 What is the average length (in time) of a competition? Swim	20	0	120
Q9 What is the average length (in time) of a competition? Cycle	75	2	420
Q9 What is the average length (in time) of a competition? Run	45	15	270

These results are lower than that shown by Manninen and Kallinen, (1996) in Japan who stated over half (57%) of the triathletes trained for half and full Ironman distance events and the remainder (43%) trained for Olympic distance and sprint events.

Possible explanation for this would be that Manninen and Kallinen (1996) surveyed members from triathlon clubs where members are more active (viz. organised more opportunities for the Ironman distances (full and half)), as compared to KZN, where no Ironman events are hosted, resulting in all the events being either sprint or Olympic distance. In addition, the KZNTA offers a greater variety of off-road triathlon events (as opposed to the ironman events), which typically have random distances usually somewhere between sprint and Olympic distances.

4.5.5 Duration (years) of triathlon participation and training regime description: results and discussion

The median number of years that a triathlete has participated in the sport is three years, with a maximum of 30 years (Table 4.5). In-season training regimens were considerably higher than pre- and off-season training regimens at an median of 40 weeks.

Table 4.5 Triathlon participation and training regimen description

Questionnaire Section B	Median	Minimum	Maximum
		Responses	
Q1 How many years (number) have you been participating in triathlon?	3	0	30
Q2a What is the length of your training regimen? Pre-season	6	0	24
Q2b What is the length of your training regimen? In-season	40	2	52
Q2c What is the length of your training regimen? Off-season	2	0	32

Triathletes surveyed in a similar study in Britain (Korkia *et al.,* 1994) showed that 30% had practised the sport for over four years, 19% between three and four years, 21% between two and three years, 20% between one and two years, and 11% for less than one year. Korkia's *et al.*, (1994) results are consistent with an Australian study done by Burns *et al.* (2003) who showed the median number of years of triathlon participation to be 3.5 years. Similarly, the duration of participation (in years) showed 22% of the triathletes had more than one year experience and 34% had 2 to 5 years (Clements *et al.,* 1999). An average of 4 years of participation was shown in a USA study (Johnson *et al*., 2010), 3.4 years in a Hawaiian study (O'Toole *et al*., 1989), 4.1 years in a Japanese study (Manninen and Kallinen, 1996) and 3.61 years in a Miami study (Wilk *et al*., 1995)

The majority of the athletes surveyed in this study were relatively new to the sport with the average triathlete competing for about 3 years. This was marginally less than other survey studies (O'Toole *et al.,* 1989, Korkia *et al.,* 1994, Wilk *et al*., 1995, Manninen and Kallinen, 1996, Clements *et al.,* 1999 and Johnson *et al*., 2010).

When comparing the above published literature to this study, it is evident that there is commonality in that the average triathlete has been participating for a relatively small period in time, with some extreme exceptions. In the South African context this may again be due to the relative “newness” of triathlon as a discipline, but may also be due to the late entry of athletes into this discipline (with an increased average age). This may additionally be re-inforced by the fact that most South African participants are amateur and semi-professional triathletes.

The amount of time spent training in-season was considerably higher than pre- and off-season regimens combined at an average of 40 weeks (refer to Table 4.5).

No data was found on the length of season training regimens. However triathletes in a USA study were active in triathlon competitions for an average of 5.3 months in one year (Johnson *et al.,* 2010). So if an assumption is made that this represents the in-season which is approximately 22 weeks, which is considerably shorter than this study which reported a mean in-season duration of 40 weeks; an explanation is that amateurs would predominantly view their entire year as an in-season as they are not accustomed to pre- and off-season training regimens.

4.5.6 Triathlete participation in cross-training activities: results and discussion

Combined core and gym training were the most common cross-training activity (23%) in which triathletes participated (Figure 4.2). Singularly, gym participation equalled 21%, core, CrossFit and gym combined at 9%, CrossFit and gym combined at 5%, core, CrossFit, functional training and gym together at 4%, functional training and gym at 4% and gym and other together at 1.8%. These findings showed that 66.8% of the triathletes supplemented their triathlon training with some form of gym training.

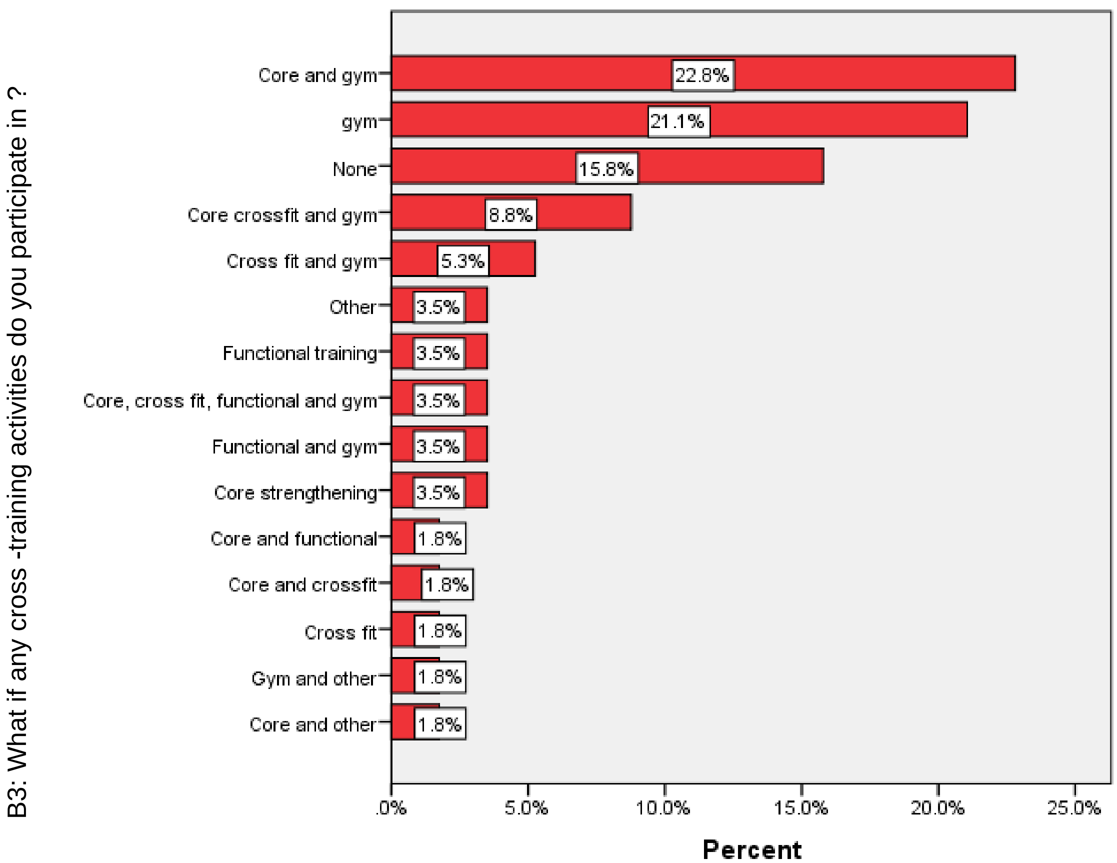


Figure 4.2: Cross-training activities

The 66.8% gym participation is higher than a Hawaiian study by O'Toole *et al*., (1989) and also higher than a Colorado study by Villavicencio *et al.,* (1996) that showed 58% and 63% of triathletes respectively supplemented their three-sport training with gym training. The results are however lower than the 73% of triathletes who performed weight training in a Japanese study (Manninen and Kallinen, 1996). This seems to support the assertion by Manninen and Kallinen's (1996) study, that the greater the average number of years triathlon participation, the greater the likelihood of athletes employing other training regimens such as weight training.

The relatively high reporting of CrossFit participation by the triathletes in this study has never been surveyed in any other triathlon study. This would most likely be as a result of the "newness" of this training style. Therefore, further research into the combination of CrossFit into the cross-training of triathletes should be further investigated and explored.

4.5.7 Frequency and duration of cross-training sessions: results and discussion

Table 4.6 shows that the median number of cross-training sessions performed by triathletes per week was two sessions (in-season) and most average duration was also in-season (60 min).

Table 4.6: Frequency and duration of cross-training sessions

Questionnaire Section B	Median	Minimum	Maximum
		Responses	
Q4a Pre-season sessions per week	1	0	8
Q4b Pre-season duration	30	0	180
Q4c In-season sessions per week	2	0	11
Q4d In-season duration	60	0	180
Q4e Off-season sessions per week	1	0	7
Q4f Off-season duration	10	0	240

These results are less than international studies that show the average duration per week for cross-training (e.g. including weight training) is 1.2 hours (Manninen and Kallinen, 1996), 1.3 hours (Johnson *et al.,* 2010) and 1.5 hours (Villavicencio *et al.,* 1996). However, the number of sessions per week was similar to O'Toole's *et al*. (1989) study that showed the majority of the triathletes who cross-trained did so either 2 or 3 times per week.

Reasons for this difference may be related to the fact that the majority of participants in this study were amateur triathletes. This, however, is speculation and it is suggested that a future study look at differences in training patterns between amateur and professional triathletes to determine the differences between these groups of triathletes. A study of this kind may also indicate the impact of injuries on injury profiles of triathletes.

4.5.8 Running, cycling and swimming training: results and discussion

4.5.8.1 Running training

Table 4.7 shows that the most frequent type of running training is “long-slow” sessions with a median of one session per week.

Table 4.7: Running training

Questionnaire Section B			Median	Minimum	Maximum
				Responses	
Q5a	“Long-slow”	Sessions	1	0	4
Q5b		Distance	10	0	32
Q5c		Duration	60	0	180
Q5d	Fartlek	Sessions	0	0	5
Q5e		Distance	0	0	30
Q5f		Duration	0	0	120
Q5g	Tempo	Sessions	0	0	3
Q5h	sessions	Distance	0	0	12
Q5i		Duration	0	0	75
Q5j	Interval	Sessions	0	0	3
Q5k	sessions	Distance	0	0	30
Q5l		Duration	0	0	75
Q5m	Sprint	Sessions	0	0	3
Q5n		Distance	0	0	20
Q5o		Duration	0	0	90
Q5p	Other	Sessions	1	1	1
Q5q		Distance	8	6	9
Q5r		Duration	60	30	90

4.5.8.2 Cycling training

Table 4.8 shows that the most frequent type of cycling training is endurance at a median of one session per week.

Table 4.8: Cycling training

Questionnaire Section B			Median	Minimum	Maximum
				Responses	
Q6a	Enduro (endurance)	Sessions	1	0	7
Q6b		Distance	55	0	300
Q6c		Duration	150	0	380
Q6d	Sprint	Sessions	0	0	3
Q6e		Distance	0	0	70
Q6f		Duration	0	0	150
Q6g	Spinning	Sessions	0	0	3
Q6h		Distance	0	0	60
Q6i		Duration	0	0	90
Q6j	Other	Sessions	1	1	4
Q6k		Distance	45	25	70
Q6l		Duration	90	50	190

4.5.8.3 Swimming training

The most frequent type of swimming training is endurance at a median of one session per week (Table 4.9).

Table 4.9: Swimming training

Questionnaire Section B			Median	Minimum	Maximum
				Responses	
Q7a	Enduro (endurance)	Sessions	1	0	10
Q7b		Distance	2000	0	7000
Q7c		Duration	60	0	240
Q7d	Sprint	Sessions	0	0	7
Q7e		Distance	0	0	4000
Q7f		Duration	0	0	120
Q7g	Open water swimming	Sessions	0	0	1
Q7h		Distance	0	0	4000
Q7i		Duration	0	0	60
Q7j	Other	Sessions	1	1	3
Q7k		Distance	4000	3500	4000
Q7l		Duration	90	75	90

4.5.8.4 Discussion

From Table 4.7 it can be seen that the most frequent type of running training is "long-slow sessions" with a median of one session per week and an average of one hour per session. And the most frequent type of swimming training is endurance at a median of one session per week and an average of one hour per session (Table 4.9). By contrast, Table 4.8 shows that the most frequent type of cycling training is endurance at a median of one session per week, at an average 2.5 hours per session.

Only one study to the researcher's knowledge has shown the number of sessions per week of the various types of training sessions (Vleck *et al.,* 2010). The results of this research study are similar in trend but lower than the British study reported by Vleck *et al.,* (2010), who found that "long-runs" averaged at 0.7-1 session per week at an average duration of 1.3-1.6 hours per session and "long-bike" averaged at 1.1-1.5 sessions per week at an average duration 3.2-4.7 hours per session.

The difference could be accounted for in that Vleck *et al.* (2010) surveyed members of the British National team in contrast to this study portrayed professional triathletes.

4.5.9 Professional bicycle setup: results and discussion

It was shown in Figure 4.3 that nearly half the triathletes (51%) have had their bicycle professionally set up.

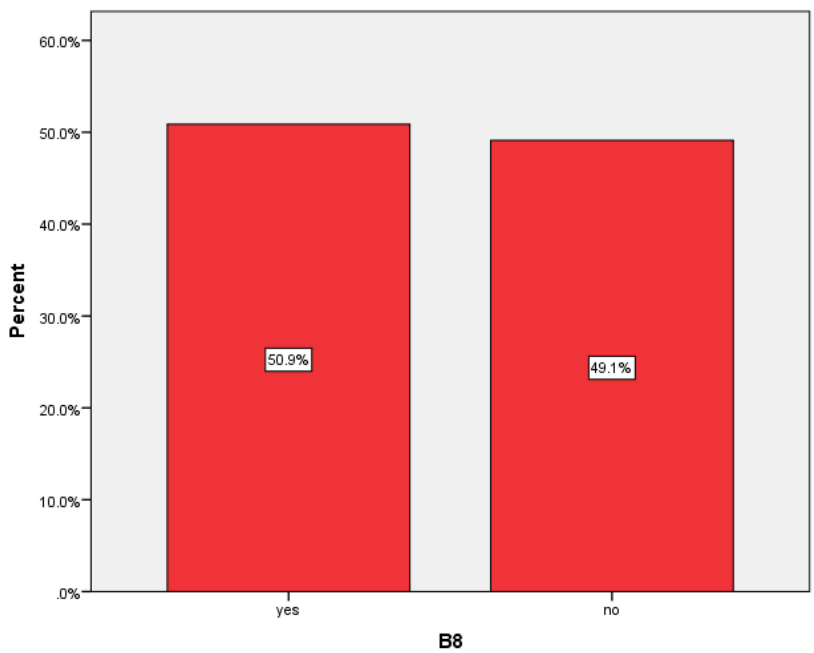


Figure 4.3: Professional bicycle setup

In recent years, bicycle specialists have been involved in measuring triathletes and cyclists and professionally fitting their bicycle to them (Asplund *et al.,* 2004). This process is still an emerging science and there are different approaches to the task (Ansell *et al.,* 2012). This study had a smaller percentage of triathletes who have had a professional bicycle setup as compared to Ansell's *et al*., (2012) study on Australian Ironman triathletes, which showed that 66.6% had had their bicycle professionally fitted.

The above outcome may have been influenced by the fact that the Ansell's *et al.,* (2012) study, was an Ironman event where the cycle discipline is 180km in length. As previously identified, this study's population predominantly took part in sprint and Olympic distance events, where the cycle discipline is a fraction of the ironman event's cycle distance. It would therefore appear that the necessity for a professional bicycle setup is not perceived to be as great for shorter events. This perception should be tested, as it may be an additional source of injury. It is therefore recommended that a future study delve into the association of bicycle setup as it relates to distance within the different triathlon types and the triathlete injury profile.

4.5.10 Coaching received: results and discussion

Figure 4.4 shows that majority of triathletes did not receive any form of coaching (56%) and the most common individual discipline to receive coaching was for swimming (14%), followed by running (4%) and lastly cycling (2%).

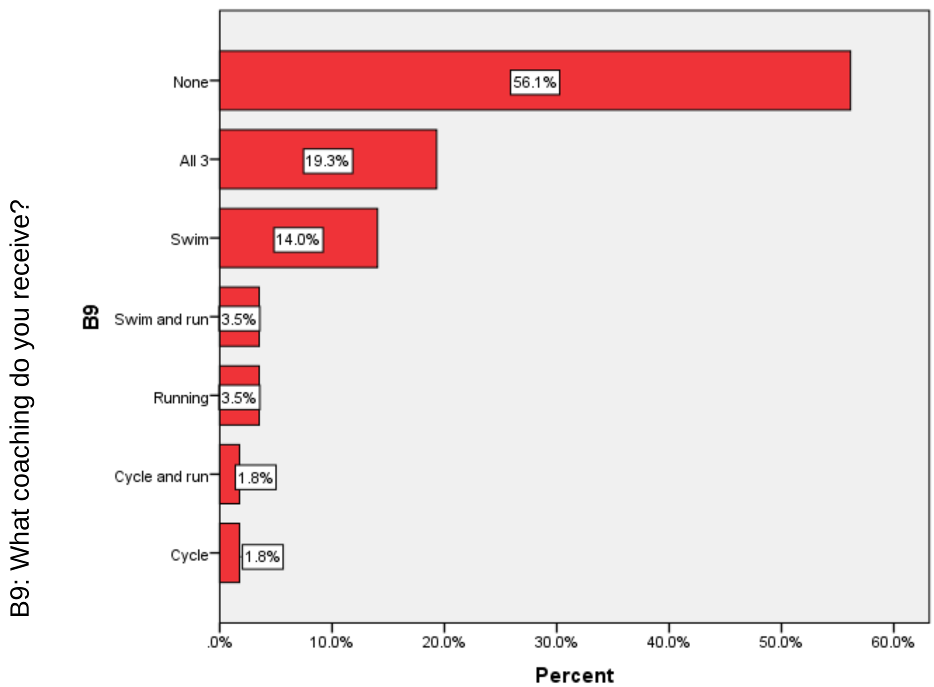


Figure 4.4: Coaching

The triathletes surveyed reported remarkably less coaching per discipline than that found by Collins *et al.,* (1989) who showed 47% of the triathletes received swimming coaching, 10.5% cycling coaching and 26% running coaching. However, the results were comparable to Ansell's *et al*., (2012) study that showed that of their respondents, 18.2% used a swim coach, 2.1% requested the expertise of a cycle coach and similarly, 2.1% used a running coach.

Although the sport of triathlon consists of three disciplines, instead of using three coaches, triathlon coaches covering all three disciplines have become available. This is as a result of accredited training this has been further supported by triathlon coaching courses that have become available in recent years (Ansell *et al.,* 2012). This allows triathletes to use just the one coach instead of three. This was reflected in the higher percentage of triathlon coached athletes (36.5%) versus the use of individual discipline coaches (Ansell *et al*., 2012). The number of coaches utilised by the triathletes was not noted in this study and therefore it was not possible to draw a comparison in this regard.

With respect to the injury profile, this study reflected similar results to that of Egermann *et al* (2003), Ansell's *et al.* (2012) study in which there was found no significant relationship between injury and having a coach (Objective Four Section 4.8). This relationship was explored because coaching of triathletes may impact on injury profiles. The lack of a significant relationship between coaches and injury occurance is based on the coaches demanding or not demanding a particular intensity during training and/or if the coaches assist or not assist triathletes in managing their training regimen better (Ansell *et al*., 2012).

4.5.11 Preferred swimming stroke: results and discussion

Freestyle was the preferred swimming stroke in 79% of the triathletes (Table 4.10).

Table 4.10: Preferred swimming stroke

Questionnaire Section B		Frequency	Percentage
Q10	Freestyle	45	78.9
	Butterfly	1	1.8
	Backstroke	1	1.8
	Breaststroke	2	3.5
	All strokes	1	1.8
	Freestyle and breaststroke	3	5.3
	None	3	5.3
	Freestyle and butterfly	1	1.8
	Total	57	100.0

Freestyle was the preferred swimming stroke in this study, which was similar to another South African study that showed all respondents performed freestyle swimming stroke (Ellapen *et al*., 2011). It would therefore seem that the freestyle stroke is the choice stroke in triathlons or multidiscipline sports (Koskella, 2006).

4.5.12 Rest days, active rest days and double sessions: results and discussion

Table 4.11 shows that the median of rest days per week was one, the median of active rest days per week was also one and the median of double sessions per week was three.

Table 4.11: Rest days, active rest days and double sessions

Questionnaire Section B	Median	Minimum	Maximum
		Responses	
Q11 Rest days	1	0	6
Q12 Active rest days	1	0	7
Q13 Double sessions	3	0	7

This is very similar to a Hawaiian study that showed 36% reporting rest (no training in any sports) one day a week (O'Toole *et al*., 1989) and Johnson's *et al*. (2010) USA study showing that triathletes took an average of 1.40 days off per week when in-season. Additionally, these findings agrees with Shaw *et al*.'s (2004) study on members of the Western Australia Triathlon Association showing that 45% of the triathletes trained six days a week (one rest day), 30% trained five days per week (2 rest days) and 16% trained seven days per week (no rest days).

Participants in Ellapen's *et al*. (2011) study trained an average of 4.97 days per week, thereby allowing themselves to rest for 2.03 days per week. Rest in that study was not defined into either active rest or complete rest (performing no training in any sport), which could account for the difference in rest days.

No other study to the researcher's knowledge reports active rest days or specific days of double sessions.

4.6 Objective Two

Objective two was to assess and determine injuries in terms of diagnosis, location and severity (utilizing subjective and objective data obtained in a consultation). Table 4.12 gives the definition of subjective data and objective data.

Table 4.12: Subjective and Objective data

Type of data	Definition
Subjective	Information given by the triathlete in the questionnaire
Objective	Questions asked by researcher during the consultation

4.6.1 Subjective data

Each triathlete was presented with a diagram of the body and the different parts of the body were labelled according to a letter of the alphabet. The triathlete was asked to indicate by means of a corresponding letter which of the areas that were painful at the time of the study (Table 4.13) and the areas they had injured in the past twelve months prior to the study (Table 4.14).

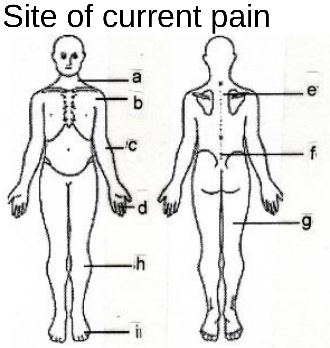
The difficulty involved with self-reporting of injuries by triathletes in a questionnaire like this study is acknowledged, firstly as a result of recall bias (which is high risk for retrospective information) (Burns *et al*., 2003) and secondly memory decay (Mouton, 1996). This is further compounded by the triathlete's interpretation of injury and the variation of the injury site between athletes, despite instructions from, and the assistance of, the researcher during the interview and or consultation (Burns *et al*., 2003). Therefore, as a result of these limitations, the information gained by this form of data collection should be interpreted with some consideration (Burns *et al*., 2003). And it should be considered that future studies of a similar nature should attempt to address any aspects of this research which may impact participant bias.

4.6.2 Sites of pain: results and discussion

4.6.2.1 Current pain

Ten triathletes reported current pain at the time of the study at 16 anatomical sites. Table 4.13 shows the anatomical sites of the pain experienced at the time of the study. Low back and knee were the most commonly affected (both at 40%). The next most common site of pain was the neck, shoulder and foot/ankle at 20% each. Least common site of pain was upper back and thigh, both at 10%. Some respondents reported more than one site affected.

Table 4.13: Sites of current pain (pain at the time of the study)

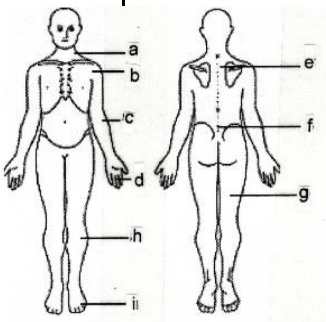
Questionnaire Section C		Count	Column N %
Site of current pain	Q3-a	2	20.0%
	Q3-b	2	20.0%
	Q3-c	0	0.0%
	Q3-d	0	0.0%
	Q3-e	1	10.0%
	Q3-f	4	40.0%
	Q3-g	1	10.0%
	Q3-h	4	40.0%
	Q3-i	2	20.0%

4.6.2.2 Pain in the last 12 months

Thirty Nine triathletes reported pain in the last 12 months prior to the study at 56 anatomical sites. Table 4.14 shows that the knee was the most common anatomical site of pain in the 12 months prior to the study at 64%. Other sites of pain were low back (21%), thigh (18%), neck (13%), foot/ankle (13%), shoulder (10%) and upper back (5%). Many reported pain in more than one site over this period.

Table 4.14 Sites of pain in the last 12 months

Questionnaire Section C		Count	Column N %
previous pain site	Q20-a	5	12.8%
	Q20-b	4	10.3%
	Q20-c	0	0.0%
	Q20-d	0	0.0%
	Q20-e	2	5.1%
	Q20-f	8	20.5%
	Q20-g	7	17.9%
	Q20-h	25	64.1%
	Q20-i	5	12.8%



4.6.2.3 Discussion

The anatomical sites of injury reported in the current study were consistent with previous reports irrespective of whether the injury information was collected prospectively or retrospectively (Gosling *et al*., 2010). The triathlon injury literature states that the knee is a common site for injury ranging between 21.9% (Vleck *et al.,* 1998) and 44% (Vleck *et al*., 2010). Similarly, some studies classified injuries per region (e.g. lower limb), and these results indicate a dominance of knee injuries in that category: 19% (Burns *et al*., 2003) and 68.8% (Galera *et al.,* 2012).

The results also correspond with studies which showed a proportionate significance of low back injuries as the common site of pain ranging between 17.9% and 72% (O'Toole *et al*., 1989). Studies by Ellapen *et al*. (2011) and Ansell *et al*. (2012) similarly showed the low back to be a common site of pain at 16.9% and 34.1% respectively.

The prevalence of low back pain among triathletes requires further studies (Galera *et al.,* 2012), as the technical aerodynamic position on the bike, cycling to running transition and cycling training volume create opportunities for the development of low back pain. This association has been proposed as an explanation of the high prevalence of low back pain among triathletes (Manninen and Kallinen, 1996).

By contrast, the results indicate that shoulder injuries represent only 20% of injuries at the time of the study and 10.3% of injuries (within the prior year). This may, however, be linked to the relative amount of training devoted to swimming training compared to cycling and running, from the amateur triathletes (Collins *et al.,* 1989, O'Toole *et al.,* 1989, Manninen and Kallinen, 1996 and Vleck *et al.,* 1998).

Although there is a marked variation in injury rates between these studies, the knee and low back are consistently stated to be the most commonly injured sites. This has implications for further research and for educating health professionals and triathletes, particularly to assist them in the prevention and management of injury in this sport (Ansell *et al.,* 2012).

4.6.3 Impact of pain on activity: results and discussion

4.6.3.1 Current pain

Table 4.15 shows that running precipitated onset of pain in 30% of triathletes and running precipitated the most amount of pain in 40% of the triathletes.

Table 4.15: Impact of current pain on activity

Questionnaire Section C		Count	Column N %
Q4	Swim	0	0.0%
What activity precipitates the	Run	3	30.0%
onset of pain?	Cycle	2	20.0%
	Swim and run	1	10.0%
	Swim and cycle	0	0.0%
	Cycle and run	2	20.0%
	All three	2	20.0%
	None	0	0.0%
	Other	0	0.0%
Q5	Swim	2	20.0%
What activity precipitates the	Run	4	40.0%
most of pain?	Cycle	2	20.0%
	Swim and run	1	10.0%
	Swim and cycle	0	0.0%
	Cycle and run	1	10.0%
	All three	0	0.0%
	None	0	0.0%
	Other	0	0.0%
Q6	Yes	3	30.0%
Did the pain prevent you from participating in competition?	No	7	70.0%
Q7	Yes	5	55.6%
Did the pain prevent you from participating in training?	No	4	44.4%

4.6.3.2 Pain experienced within the last 12 months

Running was shown to be the reason for the onset of pain (44%) and the cause of the most severe pain (68%) during the previous 12 months (Table 4.16). The pain prevented over three-quarters of the triathletes from participating in training.

Table 4.16 Impact of the pain experienced within the last 12 months

Questionnaire Section C		Count	Column N %
C21	Swim	3	7.7%
What activity precipitated the	Run	17	43.6%
onset of pain?	Cycle	3	7.7%
	Swim and run	0	0.0%
	Swim and cycle	0	0.0%
	Cycle and run	12	30.8%
	All three	2	5.1%
	None	0	0.0%
	Other	2	5.1%
C22	Swim	3	7.9%
What activity precipitated the	Run	26	68.4%
most of pain?	Cycle	5	13.2%
	Swim and run	0	0.0%
	Swim and cycle	0	0.0%
	Cycle and run	3	7.9%
	All three	0	0.0%
	None	0	0.0%
	Other	1	2.6%
C23	Yes	20	51.3%
Did the pain prevent you from participating in competition?	No	19	48.7%
C24	Yes	30	76.9%
Did the pain prevent you from participating in training?	No	9	23.1%

4.6.3.3 Discussion

The cause of triathlon-related injury is vast and multifactorial in nature and a large number of proposed risk factors can be implicated (Burns *et al*., 2003). The findings in this study in general are in accordance with previous studies that have found significant relationships between extrinsic and intrinsic risk factors and overuse injury in triathletes (refer to Section 4.8 detailing the most statistically significant injury risk factors).

As a result of the reporting (Table 4.15, Table 4.16 and Table 4.34), the frequency of injury was found to increase in participants who ran longer distances, particularly in training.

In congruence with the above findings, the predisposing over-use factors producing triathlon-related musculoskeletal pain reported by the triathletes in a South African study were (Ellapen *et al.,* 2011):

- running (61.54%),
- swimming (19.23%) and
- cycling (19.23%).

In support of Ellapen's *et al.,* (2011) study, most results confirm that the most frequent injuries in triathlon training occur during running ranging between 53% (Ansell *et al.,* 2012), and 72.5% (Galera *et al*., 2012).

The injured triathletes reported that running produced the most musculoskeletal pain (Ellapen *et al*., 2011). Collectively, these results seem to support the theory that running is the most stressful of all exercises (Burns *et al.,* 2003; McHardy *et al.,* 2006). Thus, these findings support the need for directed and structured preventive strategies including the choice of specific and technical parameters on running training volume (Galera *et al.,* 2012).

By contrast to the above discussion, Egermann *et al.,* (2003) indicated that the most frequent injuries in triathlon training occurred during cycling at 54.8%. Egermann *et al*. (2003) found that cycling training was the leading cause of lower limb and low back injury. However, the triathletes they surveyed were predominantly German and according to Ansell *et al.* (2012), was known for having a strong bias for cycling compared to other countries which may explain the different results. This assertion by Ansell *et al.,* (2012), however still needs further investigation.

4.6.4 Effect on training and competing

4.6.4.1 Length of time current pain prevented training sessions

Table 4.17 shows that the median length of time that the current injury has prevented training is 1.5 weeks (range 0 to 7 weeks).

Table 4.17: Length of time current pain prevented training sessions

Questionnaire Section C Q8		
N	Valid	10
	Missing	0
Minimum		0
Maximum		7
Percentiles	25	.00
	50	1.50
	75	3.50

4.6.4.2 Length of time current pain prevented triathletes entering into a competition

Nearly three-quarters (70%) of the triathletes did not allow pain to prevent them from participating in competitions (Table 4.18).

Table 4.18: Length of time current pain prevented from competition

Questionnaire Section C		Frequency	Percentage
Q 9	0	7	70.0
	1 race	2	20.0
	5 races	1	10.0
	Total	10	100.0

4.6.4.3 Duration of pain as experienced in the last 12 months and its effect on training

This answer highlighted that 26% of the triathletes were not prevented from training even though they may have been experiencing pain (Table 4.19).

Table 4.19 Duration of pain as experienced in the last 12 months and its effect on training

Questionnaire Section C		Count	Column N %
Q25 How long did it prevent		1	2.6%
you from training?	0	10	25.6%
	2 days	2	5.1%
	3 days	1	2.6%
	1 week	4	10.3%
	2 weeks	3	7.7%
	3 weeks	4	10.3%
	4 weeks	6	15.4%
	2 months	5	12.8%
	3 months	1	2.6%
	6 months	1	2.6%
	2 years	1	2.6%

4.6.4.4 Duration of pain as experienced in the last 12 months and its effect on competing

This answer highlighted that 49% of the triathletes were not prevented from competing even though they may have been experiencing pain (Table 4.20).

Table 4.20 Duration of pain as experienced in the last 12 months and its effect on competing

Questionnaire Section C		Count	Column N %
Q26 How long did it prevent you from competing?		1	2.6%
	0	19	48.7%
	1 race	1	2.6%
	2 races	1	2.6%
	3 races	1	2.6%
	4 races	2	5.1%
	1 week	1	2.6%
	4 weeks	3	7.7%
	5 weeks	1	2.6%
	8 weeks	1	2.6%
	3 months	4	10.3%
	4 months	1	2.6%
	6 months	2	5.1%
	1 year	1	2.6%

4.6.4.5 Discussion

Pain prevented 56% of triathletes from participating in training and 30% from participating in competition (Table 4.15). In this context, Table 4.17 shows that the median length of time that the "current" injury prevented training was 1.5 weeks (range 0 to 7 weeks).

By contrast, 77% of triathletes with pain in the previous 12 months were prevented from training and 51% were prevented from participating in a competition (Table 4.16). It was, however, noted that the results for training interruption were lower than the findings from a French study (91%) by Galera *et al*. (2012) and a study in Miami (77.8%) by Wilk *et al*. (1994). The results were similar to those of an Australian study by

Ansell *et al.* (2012) where 51.7% of their respondents were unable to train for some period of time during the twelve months prior to the study.

Additionally, the results from this study were considerably higher than Korkia's *et al*. (1994) study undertaken in Britain, where injuries had been reported to be severe enough to stop training for all three training activities in 16% of cases (Korkia *et al*., 1994).

This study also revealed that competition interruption was considerably less than training interruption, which was similar to Wilk's *et al*. (1995) study showing that scheduled triathlon competition interruption was reported by 33.3% of their triathletes. However, the results were higher than Korkia's *et al*. (1994) British study, where only 17% of the injured research cohort missed a planned competition.

A reason that a higher percentage of triathletes may have stopped / been prevented from training rather than being prevented from completing in a competition may have been that a triathlete's discretion to push through the pain to compete in a competition as compared to training (Brogan, 2012).

4.6.5 Type and duration of pain

4.6.5.1 Description of current pain and duration of current pain

Dull sensation of pain was reported by 70% of triathletes and the pain persisted for three days in 30% of triathletes (Table 4.21).

Table 4.21: Description of current pain and duration of pain

Questionnaire Section C		Count	Column N %
Q10	Dull	7	70.0%
What type of pain	Sharp shooting	0	0.0%
have you	Aching	1	10.0%
experienced?	Radiating	0	0.0%
	Pins and needles	1	10.0%
	sharp and aches	1	10.0%
Q11	Years	1	10.0%
How long does the	Months	2	20.0%
pain last / persist?	Days	3	30.0%
	Hours	2	20.0%
	Minutes	1	10.0%
	Seconds	1	10.0%

4.6.5.2 Type and duration of the pain experienced in the last 12 months

A third of the triathletes described their pain that they previously experienced during the past 12 months as a sharp shooting sensation (Table 4.22).

Table 4.22 Type and duration of the pain experienced in the last 12 months

Questionnaire Section C		Count	Column N %
Q27	Dull	9	23.1%
What type of pain	Sharp shooting	13	33.3%
have you	Aching	8	20.5%
experienced?	Radiating	2	5.1%
	Pins and needles	1	2.6%
	Sharp and aches	2	5.1%
	Dull and ache	3	7.7%
	Dull and pins and needles	1	2.6%
Q28	Years	2	5.3%
How long does the	Months	4	10.5%
pain last / persist?	Days	15	39.5%
	Hours	10	26.3%
	Minutes	6	15.8%
	Seconds	1	2.6%

4.6.5.3 Discussion

The description of pain revealed that 33% of injuries within the previous 12 months were described as sharp shooting sensations which lasted for several days (Table 4.22) and 70% of triathletes injured at the time of the study reported dull sensations of pain. All pain at the time of the study, irrespective of the description, was reported to persist for a number of days in 30% of triathletes (Table 4.21).

However, the above symptoms (e.g. pain) are incongruent with the most common symptoms of musculoskeletal pain reported by the triathletes in another South African study which included pain described as: aching (38.46%), followed by dull (30.76%), sharp (19.23%), pins and needles (5.76%), and radiating pain (5.76%) (Ellapen *et al*., 2011).

According to Ellapen *et al*., (2011), it is possible that sharp and dull pain descriptions result from the high training volume which reduces the rest time between training sessions. The more often the triathletes trained the greater the prevalence of micro-tearing of ligaments and muscle tissue, which could produce sharp, dull, aching sensations (Ellapen *et al*., 2011).

4.6.6 Severity of pain

4.6.6.1 Severity of current pain

Table 4.23 shows that the mean pain severity was 5.6 with a range from three to eight out of ten.

Table 4.23: Pain severity at time of the research study

Questionnaire Section C : Q12 How would you rate the severity of the pain from 0 – 10 (0 no pain and 10 is worst pain ever experienced)		
N	Valid	10
	Missing	0
Mean		5.60
Std. Deviation		1.776
Minimum		3
Maximum		8

4.6.6.2 Severity of the pain experienced in the last 12 months

Table 4.24 shows that the mean pain experienced was six on a scale of zero to ten.

Table 4.24 Severity of pain experienced in the last 12 months

Questionnaire Section C : Q29 How would you rate the severity of the pain from 0 – 10 (0 no pain and 10 is worst pain)		
N	Valid	39
	Missing	0
Mean		6.08
Std. Deviation		2.057
Minimum		3
Maximum		9

4.6.6.3 Discussion

From Table 4.24, it is evident that the mean pain in the prior 12 months was 6 on a scale of 0 to 10 (see Tables 4.23 and 4.24), which contrasts to the variance in Table 4.23, which shows that the mean pain severity at the time of the study was 5.6 with a range from 3 to 8 out of 10.

The Kee and Seo Pain Rating Scale (2007) was used to determine the intensity of musculoskeletal pain experienced by the triathletes (Ellapen *et al.,* 2011). This survey had a range from 1-5: 1 being uncomfortable, 2 being low, 3 being moderate, 4 being high and 5 being severe). The prevalence of the musculoskeletal pain rated by these triathletes for the 12 months prior to the study were as follows: moderate pain intensity (61.53%), high (20.51%), low (10.25%), uncomfortable (7.69%) (Ellapen *et al*., 2011).

4.6.7 Timing and aetiology of the musculoskeletal pain

4.6.7.1 Timing and aetiology of the current musculoskeletal pain

Pre-season and in-season are the two training regimens that incurred the most injury (both 40%) and 50% of triathletes suggested over training as the cause of their injury (Table 4.25).

Table 4.25 Reason for current musculoskeletal pain

Questionnaire Section C		Count	Column N %
Q13 When did this musculoskeletal pain occur?	Pre-season	4	40.0%
	In-season	4	40.0%
	Off-season	1	10.0%
	Not related to sport	0	0.0%
	Pre-season and in-season	0	0.0%
	Pre-season and off-season	0	0.0%
	In-season and off-season	0	0.0%
	All three seasons	1	10.0%
Q14 How did you sustain the injury that caused the pain?	Traumatic during race	2	20.0%
	Traumatic during training	0	0.0%
	Overtraining	5	50.0%
	Cross-training	0	0.0%
	Not stated	2	20.0%
	Unknown by respondent	0	0.0%
	Overtraining and unknown by respondent	1	10.0%

Of the category "*not stated*" causes of pain (Questionnaire Section C: Question 14) at the time of the study, high jump (10%) and lack of functional training (10%) were the reported mechanisms.

4.6.7.2 Timing and aetiology of the musculoskeletal pain experienced in last 12 months

Table 4.26 shows that 67% of injuries occurred during in-season and 51% of the time attributed to overtraining.

Table 4.26: Reason for the musculoskeletal pain experienced in last 12 months

Questionnaire Section C		Count	Column N %
Q30 When did this musculoskeletal pain occur?	Pre-season	7	17.9%
	In-season	26	66.7%
	Off-season	2	5.1%
	Not related to sport	2	5.1%
	Pre-season and in-season	2	5.1%
	Pre-season and off-season	0	0.0%
	In- and off-season	0	0.0%
	All three seasons	0	0.0%
Q31 How did you sustain the injury that caused the pain?	Traumatic during race	2	5.1%
	Traumatic during training	4	10.3%
	Overtraining	20	51.3%
	Cross-training	3	7.7%
	Not stated	7	17.9%
	Unknown to the triathlete	3	7.7%
	Overtraining and unknown	0	0.0%

Of the category "*not stated*" causes of previous pain (Questionnaire Section C: Question 31), biomechanical causes (3%), poor cleat position of the cycling shoes (3%), rugby (8%) and a traumatic slip off the starting block at the beginning of the swim (3%) were the reported mechanisms.

4.6.7.3 Discussion

Pre-season and in-season were two of the disciplines from which the triathletes incurred the most injury (both 40%) and 50% of triathletes suggested overtraining as the cause of their injury; whereas 20% attributed their injury to traumatic incidences (Table 4.25). By contrast, in-season was the training regimen that incurred the most injury of triathletes with pain in the 12 months prior to the study (67%) and 51% of the triathletes suggested overtraining as the cause of their injury (15% suggested traumatic incidences) (Table 4.26).

These results are comparable with several studies reviewed by the researcher that confirmed that triathlete injuries are mostly non-traumatic in nature and occurred due to overuse activity ranging from 41% (Korkia *et al*., 1994) to 91% (O'Toole *et al.,* 1989).

4.6.8 Preferred practitioner

4.6.8.1 Preferred practitioner to treat current pain

Chiropractors were the most commonly sought for treatment at 40% with 75% of the triathletes reported satisfactory outcomes (Table 4.27).

Table 4.27 Treatment of current pain

Questionnaire Section C		Count	Column N %
Q15 When you sustained the pain which medical practitioner did you seek treatment from	Biokineticist	0	0.0%
	Chiropractor	4	40.0%
	GP	0	0.0%
	Orthopaedic surgeon	0	0.0%
	Pharmacist	0	0.0%
	Physiotherapist	1	10.0%
	None	2	20.0%
	Other	1	10.0%
	Biokineticist and physiotherapist	1	10.0%
	Chiropractor and physiotherapist	1	10.0%
	Biokineticist and chiropractor	0	0.0%
	Biokineticist and GP	0	0.0%
	Biokineticist, chiropractor, orthopaedic surgeon, and physiotherapist	0	0.0%
	Orthopaedic surgeon and physiotherapist	0	0.0%
	Chiropractor, orthopaedic surgeon, GP, physiotherapist	0	0.0%
	Biokineticist, chiropractor and pharmacist	0	0.0%
Q16 What (if anything) did the above practitioner diagnose?	None	4	40.0%
	Biomechanical	1	10.0%
	Fluid under the bone	1	10.0%
	Overuse	1	10.0%
	Plantar fasciitis	1	10.0%
	Pulled muscle	1	10.0%
	Weakness in rhomboids (rhomboid dysfunction)	1	10.0%
Q17 Were you happy with the treatment you received?	Yes	6	75.0%
	No	2	25.0%
	Missing/ did not answer	2	25.0%
Q18 What is your reason for the above?	No reason	6	60.0%
	Did not “fix”	1	10.0%
	“Fixed” the injury	1	10.0%
	Improvement	1	10.0%
	Still in pain	1	10.0%

4.6.8.2 Preferred practitioner to treat pain during the last 12 months

Chiropractors are the individual treatment of choice by 39% of triathletes who experienced pain during the last 12 months (Table 4.28).

Table 4.28 Treatment of pain during last 12 months			
Questionnaire Section C		Count	Column N %
Q33 When you sustained the pain which medical practitioner did you seek treatment from?	Biokineticist	0	0.0%
	Chiropractor	15	38.5%
	GP	2	5.1%
	Orthopaedic surgeon	0	0.0%
	Pharmacist	0	0.0%
	Physiotherapist	8	20.5%
	None	3	7.7%
	Other	0	0.0%
	Biokineticist and physiotherapist	1	2.6%
	Chiropractor and physiotherapist	2	5.1%
	Biokineticist and chiropractor	2	5.1%
	Biokineticist and GP	1	2.6%
	Biokineticist, Chiropractor, orthopaedic surgeon, and physiotherapist	1	2.6%
	Orthopaedic surgeon and physiotherapist	2	5.1%
	Chiropractor, orthopaedic surgeon, GP, physiotherapist	1	2.6%
	Biokineticist, chiropractor and pharmacist	1	2.6%
Q34 What (if anything) did the above practitioner diagnose?	Breaks	1	2.6
	Cartilage (damage)	1	2.6
	Dropped left arch (foot biomechanics)	1	2.6
	Hamstring tendinosis	1	2.6
	ITB	1	2.6
	ITB issue	1	2.6
	Joint sprain	1	2.6
	Liquid in knee	1	2.6
	Low back, hip flexor and hamstring	1	2.6
	Muscle strain (non-specified)	5	12.8
	Muscle strain (calf)	1	2.6
	Muscle strain (hamstring and calf)	1	2.6
	Muscle tear	2	5.1
	Muscle tear (calf)	1	2.6
	Nothing	1	2.6
	Osteoarthritis	1	2.6
	Patella tendonitis (slight meniscus tear)	1	2.6
	Patellofemoral pain syndrome	4	10.3
	Pinched nerve	2	5.1
	Shin splints	2	5.1
	Strained shoulder with a leg imbalance	1	2.6
	Tendonitis	1	2.6
	Torn cartilage	1	2.6
	Torn ligaments	1	2.6
	Total	39	100.0

4.6.8.4 Response to treatment of pain experienced in the last 12 months

82% of triathletes were satisfied with the treatment (Table 4.29).

Table 4.29 Response to treatment

Questionnaire Section C Q35 Were you happy with the treatment?		Frequency	Percentage
Valid	Yes	32	82.1
	No	4	10.3
	Total	36	92.3
Missing	System	3	7.7
Total		39	100.0

4.6.8.5 Outcome of treatment for pain experienced in the last 12 months

Table 4.30 Treatment outcome

Questionnaire Section C		Frequency	Percentage
Q36	Diagnosis is treated to my satisfaction	1	2.6
What is your	Fixed	1	2.6
reason for the	Fixed the hamstring, shoulder still problematic	1	2.6
above (Q35)?			
	Fixed the problem	14	35.9
	Good knowledge and speed of recovery	1	2.6
	Got rid of the pain	3	7.7
	Healed	1	2.6
	Improvement	1	2.6
	It healed up	1	2.6
	Nearly pain free (happy)	1	2.6
	Problem was diagnosed and treatment provided	1	2.6
	Started easy running two weeks after injury occurred	1	2.6
	The stretch regimen sorted out the problem	1	2.6
	Understanding of the condition	1	2.6
	Not entirely gone	1	2.6
	Practitioners don't really care, they didn't investigate to find a solution	1	2.6
	Still in pain	1	2.6
	Total	39	100.0

4.6.8.6 Treatment: discussion

Less than half the triathletes sought out Chiropractors care for the treatment of their condition (40%), and of this percentage, 75% reported satisfactory outcomes (Table 4.27). Chiropractors were the individual health care treatment of choice by 39% of triathletes who had experienced pain in the previous 12 months (Table 4.28) with 82% of triathletes being satisfied with treatment (Table 4.29).

Of the sample studied, 80% of the triathletes who were in pain at the time of the study and 92% of the triathletes who had experienced pain in the previous 12 months sought treatment from some sort of health care provider. This is slightly higher but nonetheless in agreement with Wilk's *et al.,* (1995) study of 65.3%, Clements *et al*. (1999) who found 78% and Cipriani *et al*. (1998) who found 42% of triathletes sought treatment from a variety of healthcare professionals.

The results of this study do however differ from other studies that show physiotherapists to be the health care professionals of choice, followed by medical practitioners and chiropractors (Ansell *et al.*, 2012). Clements's *et al*. (1999) study showed that triathletes sought treatment as follows: 27% from a physiotherapist; 11% from a general practitioner; 17% from a podiatrist; 6% from a chiropractor / physiotherapist combination and / or 17% from a general practitioner / chiropractor combination. Physiotherapists were reported to be the most sought after health care professionals, medical practitioners were the next most consulted, followed by chiropractors (Ansell *et al.*, 2012).

A possible explanation for Chiropractors being the practitioner of choice may be the fact that Durban University of Technology is situated in KZN and is one of two institutions in South Africa to offer chiropractic. The students are often involved in sports events and therefore athletes are exposed more to chiropractors than in other settings.

4.6.8.7 Diagnosis: discussion

The diagnoses are shown in Table 4.28. Grouped together, muscle pathology accounts for 10 of the 39 (26%) practitioners' diagnoses.

4.6.9 Objective data

4.6.9.1 Medical history

The majority (90%) of the triathletes had no history of orthopaedic surgery, all of the triathletes had a history of muscle injury and connective tissue injuries and 40% had previous fractures (Table 4.32).

Table 4.31 Medical history

Assessment data sheet			Count	Column N %
Q1.2	Any orthopaedic surgery?	Yes	1	10.0%
		No	9	90.0%
Q1.3	Previous muscle injury?	Yes	10	100.0%
		No	0	0.0%
Q1.4	Any fractures?	Yes	4	40.0%
		No	6	60.0%
Q1.5	Connective tissue injuries (tendons/ ligaments)	Yes	10	100.0%
		No	0	0.0%
Q1.6	Past sporting history?	Running	3	5.3%
		Running, Swimming, Triathlon	4	7.1%
		Swimming	1	1.8%
		Triathlon	1	1.8%
		Rugby	1	1.8%

4.6.9.2 Location of injury

Of the triathletes who currently reported triathlon-related pain and underwent the consultation, a wide range of locations were identified as painful (Table 4.33).

Table 4.32 Location of injury

Assessment data sheet		Count	Column N %
Q2 Locations of injuries related to triathlon	Neck (left and right), shoulder (right), low back (left and right)	1	1.8%
	Neck (left and right), shoulder (left)	1	1.8%
	Shoulder (right), thigh (left)	1	1.8%
	Low back (left and right)	2	3.5%
	Thigh (left)	1	1.8%
	Leg (left and right)	1	1.8%
	Thigh (right)	2	3.5%
	Foot and ankle (left and right)	1	1.8%

4.6.9.3 Mechanism of injury

All the triathletes sustained their injuries during training and 90% occurred during running (Table 4.34).

Table 4.33 Mechanism of injury

Assessment data sheet		Count	Column N %
Q3.1 During competition or training	Competition	0	0.0%
	Training	10	100.0%
Q3.2 During swimming	Not related to swim	6	60.0%
	During swimming	4	40.0%
Q3.3 During cycling	Not related to cycle	5	50.0%
	During cycling	5	50.0%
Q3.4 During running	Not related to run	1	10.0%
	During running	9	90.0%
Q3.5 Falls	Yes	2	20.0%
	No	8	80.0%
Q3.6 Other	Yes	1	10.0%
	No	9	90.0%

These results are compared favourably with the literature showing that 83.5% of injuries occurred during training versus only 16.5% during a competition (Galera *et al*., 2012). Excess training was considered the leading cause of injury in seven of the twelve anatomical areas of injury listed by Ansell *et al.* (2012). Respondents were found to sustain a musculoskeletal injury during training 75% of the time as compared with a 27.8% injury occurrence during a competition (Wilk *et al*., 1995). Most injuries (81.3%) occur during triathlon training hours compared with the 18.7% during competition (Egermann *et al.,* 2003).

4.6.9.4 Clinical presentation

80% of the injuries were chronic in nature (Table 4.35)

Table 4.34 Clinical presentation

Assessment data sheet		Count	Column N %
Q4.1	Acute	2	20.0%
	Chronic	8	80.0%
Q4.2	Sacroiliac syndrome, sacroiliac (SI) joint dysfunction	2	3.6%
	Strain	1	1.8%
	Cervical facet syndrome	1	1.8%
	Cervical facet syndrome, lumbar facet syndrome	1	1.8%
Q4.3	***Right:*** Gastrocnemius	2	3.5%
	Bilateral: Plantar muscles	1	1.8%
	Bilateral: Peroneus bilateral	1	1.8%
	Bilateral : quadratus lumborum (QL), lumbar paraspinals, gluteus medius, tensor fascia lata (TFL)	1	1.8%
	Right: levator scapula, anterior deltoid, supraspinatus, infraspinatus ***Bilateral***: scalene muscles, trapezius, quadratus lumborum	1	1.8%
	Left: Iliotibial band (ITB) ***Bilateral***: gluteus maximus, gluteus minimus, hamstrings, quadratus lumborum.	1	1.8%
	Left: Quadratus lumborum; ***Bilateral***: Iliopsoas	1	1.8%
	Left: supraspinatus, infraspinatus, levator scapula, teres minor ***Bilateral***: trapezius, posterior cervicals	1	1.8%
	Left: gracilis ***Bilateral***: trapezius, levator scapulae, infraspinatus, supraspinatus,	1	1.8%
Q5.1	Neck, upper extremity, lower extremity	1	1.8%
Location	Neck, upper extremity	1	1.8%
	Lower extremity	4	7.0%
	Low Back	3	5.3%
Q5.2	Yes	0	0.0%
Fractures	No	10	100.0%
Q5.3	Yes	0	0.0%
Other	No	10	100.0%

Table 4.34 Clinical presentation continued…

Assessment data sheet		Count	Column N %
Q6 Diagnosis	Acute non-traumatic mild gastrocnemius myofascial pain and dysfunction.	1	1.8%
	Chronic mild non-traumatic (SI) syndrome. Chronic mild non-traumatic QL myofascial pain and dysfunction.	1	1.8%
	Chronic overuse mild cervicogenic headaches. Chronic swimmers shoulder with concomitant rotator cuff myofascial paid and dysfunction.	1	1.8%
	Chronic overuse mild gastrocnemius myofascial pain and dysfunction	1	1.8%
	Chronic overuse mild peroneus myofascial pain and dysfunction.	1	1.8%
	Chronic overuse SI dysfunction with associated QL myofascial pain and dysfunction	1	1.8%
	Chronic swimmers shoulder. Subacute non-traumatic mild gracilis myofascial pain and dysfunction.	1	1.8%
	Plantar fasciitis	1	1.8%
	Subacute non-traumatic mild ITB syndrome.	1	1.8%
	Swimmers shoulder. chronic overuse cervical facet dysfunction: chronic non-traumatic mild lumbar facet syndrome.	1	1.8%

Relating to injuries, “chronic” is rarely used in triathlon literature and appears to be interchangeable with “overuse” (an example is seen in Ansell’s *et al*. (2012) questionnaire in which the question used the term interchangeably “chronic or overuse injuries”). Another example is when acute injuries are compared with overuse injuries (refer to Section 4.6.7.3 comparing international reporting of overuse and acute injuries respectively).

4.6.9.5 Diagnoses in consultation

The exact diagnosis or diagnoses for each of the ten triathletes that had an injury at the time of the study were:

1. Chronic overuse mild cervicogenic headaches
   Chronic swimmer's shoulder with concomitant rotator cuff myofascial pain and dysfunction
2. Chronic overuse sacroiliac dysfunction with associated quadratus lumborum (QL) myofascial pain and dysfunction
3. Chronic mild non-traumatic sacroiliac syndrome
   Chronic mild non-traumatic QL myofascial pain and dysfunction
4. Chronic overuse mild peroneus myofascial pain and dysfunction
5. Chronic swimmer's shoulder
   Sub-acute non-traumatic mild gracilis myofascial pain and dysfunction
6. Acute non-traumatic mild gastrocnemius myofascial pain and dysfunction
7. Chronic overuse mild gastrocnemius myofascial pain and dysfunction
8. Plantar fasciitis
9. Sub-acute non-traumatic mild iliotibial band (ITB) syndrome
10. Swimmer's shoulder
    Chronic overuse cervical facet dysfunction
    Chronic non-traumatic mild lumbar facet syndrome

4.6.9.6 Muscles with Trigger Points

From the previous section that outlined the diagnoses given to the triathletes, myofascial trigger points where noted as outlined below.

Table 4.35: Trigger point location

Left sided involvement	Bilateral involvement	Right Side involvement
Levator scapula	Posterior cervical	Levator scapula
Supraspinatus	Plantar muscles	Gastrocnemius
Infraspinatus	Scalene	Supraspinatus
Teres minor	Trapezius	Infraspinatus
Quadratus lumborum	Levator scapulae	Anterior deltoid
Iliotibial band (ITB)	Infraspinatus	
Gracilis	Supraspinatus	
	Quadratus lumborum	
	Lumbar paraspinals	
	Tensor fascia lata	
	Iliopsoas	
	Gluteus medius	
	Gluteus maximus	
	Gluteus minimus	
	Hamstrings	
	Peroneus	

No literature to date, to the researcher's knowledge has formalised trigger point mapping in triathletes.

4.7 Objective Three

Objective three was to determine the period prevalence and point prevalence of injuries in triathletes (utilizing both the self-administered questionnaire and the consultation).

4.7.1 Prevalence: results and discussion

4.7.1.1 Period prevalence

The prevalence of injuries over 12 months were 68% (Table 4.37).

Table 4.36 Period prevalence

	Frequency	Percentage
Yes	39	68.4
No	18	31.6
Total	57	100.0

The period prevalence of injuries over 12 months was 68% (Table 4.37). These results are similar to international studies which range from 47% to 91% shown in Table 4.38:

Table 4.37: Comparison of period prevalence

Authors	Year	Prevalence	Description of study population in relation to prevalence
Ansell *et al*.,	2012	86.1%	In Ironman triathletes in an Australian study.
Galera *et al*	2012	52.4%	Triathletes in a French study reporting having been injured at least once during the past season.
Ellapen *et al*	2011	90.7%	Triathlon-related musculoskeletal pain within 12 months.
Shaw *et al*.,	2004	62.0%	Triathletes in the Western Australia Triathlon Association experienced an injury in the last twelve months.
Egermann, *et al*.,	2003	74.8 %	Respondents during their active time in triathlon.
Korkia *et al*.,	1994	47%	At least one injury was reported by one of the triathlete’s in a British study.
Wilk *et al.,*	1994	75%	Miami study.
Collins *et al.,*	1989	49%	Seattle triathletes suffered a training-related injury.
O’Toole *et al.,*	1989	91%	Triathletes in a Hawaiian study reported the occurrence of at least one soft tissue, overuse injury during the previous year of training.
Massimino *et al*.,	1988	85%	Injuries sustained by Ironman triathletes in Kona, Hawaii, were non-traumatic overuse injuries.

4.7.1.2 Point prevalence

The point prevalence of current injuries was 18%. All 10 participants with pain were related to participation in a triathlon (Table 4.39).

Table 4.38 Point prevalence

Current pain	Frequency	Percentage
Yes	10	17.5
No	47	82.5
Total	57	100.0

The literature surrounding the prevalence of triathlon-related injuries reports predominantly period prevalence (O'Toole *et al*., 1989; Wilk *et al.,* 1995; Egermann *et al.,* 2003; Shaw *et al.,* 2004) and not specifically point prevalence.

4.8 Objective Four

Objective four was to identify the associations between the demographic profile and injuries in terms of diagnosis, location and severity.

4.8.1 Demographic profile: results and discussion

Table 4.40 shows that female triathletes had a significantly higher risk of injury[1] than males (*p*=0.019). Injury risk also increased with weight (*p*=0.055), number of triathlon competitions in the last 12 months (*p*=0.031), number of triathlon competitions in the last 4 months (*p*=0.009) and running distance during competition season (*p*=0.011), but decreased with increasing distance of cycle (*p*=0.061) and swimming (*p*=0.030) in the competition, and length of training in- and off-season (*p*=0.105 and *p*=0.043 respectively).

Table 4.39 Demographic profile

		Sig.	OR	95% CI for OR	
				Lower	Upper
Step 7[a] linear regression steps	Gender (female versus male)	.019	178.915	2.385	13420.874
	Weight (kg)	.055	1.200	.996	1.447
	Triathlon races in the last 12 months	.031	1.813	1.056	3.112
	Triathlon races in the last four months	.009	14.385	1.956	105.791
	Average length of a run during a race	.011	1.983	1.173	3.351
	Average length of a swim during a race	.030	.910	.836	.991
	Average length of a cycle during a race	.061	.958	.915	1.002
	Length of training in-season (weeks)	.105	.939	.871	1.013
	Length of training off-season (weeks)	.043	.752	.571	.992
	Constant	.034	.000		

To the researcher's knowledge, no studies have reported on gender bias, weight, or number of triathlon competitions in the four weeks prior to the research study with regards to overall injury rate. Ansell *et al.,* (2012) found that Body Mass Index (BMI) did not relate to injury rate and some studies have shown that body weight had no significant correlations with injury (Korkia *et al.,* 1994, Villavicencio *et al.,* 2006).

[1] Injury in section 4.8.1 refers to injury rate and not individual injuries

Conversely, however, van Gent *et al*., (2007) found that male runners with a BMI of 27.0 or higher had fewer injuries.

It is difficult to compare statistical significance to injury of each discipline's distance in a triathlon as there are conflicting associations. Therefore making the assumption that all three disciplines of a triathlon increase as the running distance increases; then injury occurrence increased with increasing running distance in a race, but conversely the injury occurrence decreased as the other two disciplines increased. However, Korkia *et al.,* (1994) showed there was no evidence of a difference between injury rates in long and sprint distance triathletes.

Ansell *et al*., (2012) demonstrated a female gender bias specific to the hip/buttock/groin area only. Notably however, other authors have not reported a gender difference in injuries (Collins *et al.,* 1989, O'Toole *et al.,* 1989, Cipriani *et al*., 1998, Burns *et al.,* 2003).

A relationship between training load and injuries has been found in some studies (O'Toole *et al,* 1989, Korkia *et al.,* 1994, Manninen and Kallinen, 1996, Vleck and Garbutt, 1998, Shaw *et al.,* 2004) but not in others (Burns *et al.,* 2003, Cipriani *et al.,* 1998, Collins *et al.,* 1989, Egermann *et al.,* 2003, Villavicencio *et al.,* 2006). Many running studies have also found that higher training loads are linked to greater risk of injury (James *et al.,* 1978 and Hreljac and Ferber, 2006).

4.8.2 Injury severity[2]: results and discussion

Table 4.41 shows that only long-slow training distance (*p*=0.006) and weight (*p*=0.006) were associated with injury severity. Weight was negatively associated with severity, the heavier the person, the less severe the injury, while as long-slow distance increased, so did severity of the injury.

Table 4.40 Injury severity

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
		B	Std. Error	B		
2	(Constant)	10.099	1.767		5.715	.000
	B5 long-slow distance	9.118E-005	.000	.411	2.933	.006
	Weight (kg)	-.071	.024	-.410	-2.930	.006

a. Dependent Variable: injury severity

Severity of injury is a measure of the impact of injury and is described on the basis of six criteria including: nature of injury, duration and nature of treatment, sporting time lost, working time lost, permanent damage and cost (van Mechelen *et al.,* 1992):

- The nature of injury has often been misreported in the triathlon literature, because the terms have commonly been used interchangeably with mechanism of injury, or including mechanisms such as categories of nature of injury refer to Section 4.6.9.4 on mechanism of injury);
- The establishment of duration of recovery and treatment of triathlon injuries is important in the context of determining injury severity, estimation of costs and its impact on injury prevention programmes. The reporting of injury treatment has been inconsistent with some studies which only report the type of, if any, health professional seen. This study determined what treatment was sought after, and the outcomes of that treatment, (refer to Section 4.6.8);
- The impact of injury in terms of sporting and work time lost and permanent damage is another key indicator of the severity of injury (This study determined

[2] The higher of C12 or C29 was used if patient reported both current and previous injury

the impact in terms of sporting time lost, both in training and for a competition, however, no triathletes reported permanent damage, refer to Section 4.6.6). Cost of injury was not determined and could be of importance for future studies.

4.8.3 Injury diagnosis: results and discussion

At the outset of this study, it was anticipated that there may be sufficient diagnoses to analyse the impact of diagnoses on training or competition as well as assess whether appropriate treatment had been obtained; however, there are too many diagnoses and too few numbers of participants with complaints, to fully analyse these outcomes.

The above was confirmed by Esterhuizen (2013) and based on the small number of the triathletes in this study and the extent of variance between the ten individuals who reported pain, there were too many individual diagnoses to use as an outcome variable and therefore correlations could not be made (Esterhuizen, 2013).

4.8.4 Injury location: results and discussion

Of the 42 triathletes who reported a current or past injury, 26 triathletes had a knee injury at some stage. The knee was found to be the most common pain site for current and past injuries. This was compared to compared to other sites combined (i.e. knee injury versus all other injury). Since the knee was the most common pain site for injuries at the time of the study as well as within the previous 12 months, the knee was used as the outcome variable compared to other sites combined (Esterhuizen, 2013).

Of the 42 reported injuries current (at time of the study) or past (within the previous 12 months), 26 had a knee injury at some stage (61.9%). Notwithstanding this high number of injuries, none of the demographic or training factors were associated with having a knee injury versus any other injury.

4.9 Key findings

The most significant findings, in relation to the objectives set out for this study, appear in the following paragraph.

In accordance with the first objective and from the demographic data gathered from the participating triathletes, it would appear as if the average amateur and semi-professional triathlete is a white male, 175cm tall and 71kg in weight. The average number of triathlon competitions participated in the previous 12 months is three. The average number of triathlon competitions participated in the previous 4 months is 1. The average length of a competition swim is 1 000m (average time 20min), average competition cycle is 25km (average time 75min) and the average of a competition run is 10km (average time 45min). The average number of years participating in a triathlon is 3. The average training regimen pre-season is six weeks, in-season is 40 weeks and off-season two weeks. Core and gym together are the two most common cross-training activities participated in by triathletes at 23%. Just over half of the triathletes (51%) have had a professional bicycle setup. Slightly more than half of the respondents (56%) have not received professional coaching while 19% of the triathletes received coaching for all three disciplines. The most common discipline to receive coaching is swimming (14%). Of the total number of triathletes, 79% preferred freestyle. The average number of rest days per week is 1, the average number of active rest days per week is also 1 and the average number of double sessions per week is 3.

In accordance with the second objective, subjective data from the self-administered questionnaire, it would appear as if the average triathlete currently has pain either in their low back or knee and have had musculoskeletal knee pain in the last 12 months. 70% of triathlete’s current injury did not prevent them from participating in a competition, and 56% were not prevented from training. In terms of injury in the last 12 months, 51% were not prevented from participating in a competition while 77% were prevented from training. The average length of time that a current injury has prevented training is 1.5 weeks, while 70% of triathletes were not prevented from racing. Of triathletes who sustained an injury in the last 12 months, 26% were not prevented from training and

49% were not prevented from racing. 70% of current injuries were described as dull sensations and a third of the injuries from the last 12 months were described as a sharp shooting sensation. The average pain severity of current injuries was 5.6 out of ten and of pain in the last 12 months at 6 out of ten. 50% of triathletes with current injuries suggested overuse aetiology, and 51% of triathletes with injuries in the last 12 months also suggest overuse in nature. 40% of triathletes with current pain sought chiropractic treatment and 75% reported satisfactory results. Of the triathletes who suffered pain during the past 12 months, 39% sought treatment from a chiropractor, 21% saw a physiotherapist, and 82% reported satisfactory results overall.

In accordance with the second objective, in which the triathlete's medical history was noted, it would appear as if 90% of the triathletes had no history of orthopaedic surgery, all of the triathletes had a history of muscle injury and connective tissue injuries and 40% had previous fractures. All the triathletes sustained their injuries during training and 90% occurred during running. A range of diagnoses has been recorded.

In accordance of the third objective, it would appear that the period prevalence during the last year of triathlon-related injuries in amateur and semi-professional triathletes in Kwa-Zulu Natal is 68%. The point prevalence was 18%.

From the data received, in order to meet the fourth objective, female triathletes had a significantly higher risk of injury than males (p=0.019). Injury risk also increased with weight (p=0.055), number of triathlon competitions in last 12 months (p=0.031), number of triathlon competitions in last 4 months (p=0.009) and running distance during competition (p=0.011), but decreased with increasing distance of cycle (p=0.061) and swimming (p=0.030) in the competition, and length of training in- and off-season (p=0.105 and p=0.043 respectively). Only long-slow training distance (p=0.006) and weight (p=0.006) were associated with injury severity. Weight was negatively associated with severity, the heavier the person, the less severe the injury, while as long-slow distance increased, so did severity of the injury. Of the 42 triathletes reporting any current or past injury, 26 triathletes had a knee injury at some stage (61.9%). None of the demographic or training factors were associated with having a knee injury versus any other injury.

4.10 Conclusion

With the results and the discussion obtained in Chapter Four, the following conclusion can be drawn with regards to the aims, objectives and null hypothesis of this study.

An injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes was investigated as per the aim of the study.

From the data received: a demographic and training profile of amateur and semi-professional KZN triathletes was developed (Section 4.5). Injuries were assessed and determined in terms of diagnosis, location and severity (Section 4.6). The period prevalence and point prevalence of injuries in triathletes was determined (Section 4.7). Associations between the demographic profile (including the training profile) and injuries in terms of diagnosis, location and severity was determined (Section 4.8).

The null hypothesis was rejected: associations between the demographic profile and injuries in terms of diagnosis, location and severity did exist for some data points (Section 4.8). Thus, in this context, Chapter Five will discuss the conclusions and limitations for this study and recommendations for further studies.

Chapter Five

Conclusion and Recommendations

5.1 Introduction

In this chapter, conclusions, based on the outcomes from the collected primary data are drawn and recommendations for further studies related to this are discussed. The data was collected from triathletes in the sample population at the time of completing the questionnaire and at the time of the consultation for triathletes with injuries.

5.2 Main findings

It has become evident that triathlon injuries are relatively frequent, concurring with the international literature on triathlon injuries. This prospective cross-sectional study (although data was predominantly retrospective in nature as a result of most of the triathletes reporting pain from the 12 months prior to the study as opposed to the triathlete reporting pain at the time of the study) determined that the knee is the most common anatomical site of injury both in triathletes with injuries at the time of the study and those who had experienced an injury in the last twelve months. Variables that increase the risk of a triathlete getting injured are: female gender may predispose triathletes to a higher risk of injury; injury risk also increased with mass; number of triathlon competitions in the previous 12 months; number of triathlon competitions in last four months and running distance during competition. Injury risk however decreased with increasing distance of cycle in a competition, increasing distance of swimming in a competition and length of training in- and off-season. It is also evident from these findings that it appears weight bearing activity has a higher injury risk than non-weight bearing activities. Chiropractors were the most commonly sought out health care professionals for treatment. Therefore, it is necessary for triathletes and triathlon groups to look at these injury-risk associations in order to ensure a better understanding of performing a specific training method and to plan their training regimens accordingly.

5.3 Limitations

- The sample was drawn from the members of the KZNTA (and limited to the greater Durban area). Although the response rate of 71% is relatively high for a study of this type (refer to Figure 4.1), it is unclear whether or how it may have impacted on the triathlon population. Future studies should aim at a broader scope of triathletes, for example a national study could be considered to ensure that the study could represent the triathlon population adequately.

- Improved sample size is always a positive consideration for future studies whether or not they are regionally demarcated.

- Although triathletes who were injured at the time of the study were treated and medical diagnoses obtained, the injuries from the previous 12 months were self-reported in the questionnaire and not confirmed by medical diagnosis. Some accuracy may have also been conceded due to retrospective recall.

- Questionnaires give an overall picture of the triathlete's personal, training and injury statistics; however it is a research tool that allows associations to be determined and not causality. The type of data obtained is widespread but should help to direct further research in this area. Therefore longitudinal studies are recommended.

- While a definition of injury was included in the questionnaire, the extent of reporting was open to interpretation by the triathletes. A global definition of injury has not been standardised in triathlon literature to date. With the questionnaire relying solely on self-reporting, the use of a standardised definition would reduce recall bias.

- The cost of injury was not determined and should be of importance as an inclusion for future studies.

- There is a research gap in the assumption that no literature to date to the researcher's knowledge has discovered trigger point mapping in triathletes. Thus, future studies could determine this and aid health practitioners in expectations and preventative protocols for treatment of triathletes.

5.4 Recommendations

- A future study could include an objective to determine why more males complete in more triathlons than females. Notwithstanding this more females reported injury. This suggests that there may be a correlation between female participation and injury.

- No literature to date, to the researcher's knowledge has explored CrossFit participation by the triathletes, which was relatively high in this research study. This would most likely be as a result of the "newness" of this training style. Therefore, further research into the combination of CrossFit into the cross-training of triathletes should be further investigated and explored.

- A future study could include an objective to determine the cost of injury.

- No literature to date, to the researcher's knowledge has formalised trigger point mapping in triathletes, this should be further investigated and explored.

References

American Chiropractic Association [http://www.acatoday.org/]

Ansell W, Rivett DA, Callister R: **Characteristics, training loads, injury patterns and stretching habits of Australian Ironman Triathletes**. *Master of Medical Science thesis.* The University of Newcastle, Department of Physiotherapy; 2012.

Asch DA, Christakis NA and Uhel PA: **Conducting physicians mail surveys on a limited budget. A randomized trial comparing $2 bill versus $5 bill incentives.** *Medical care* 1998, **36**(1):95-99.

Asplund C, St Pierre: **Knee Pain and Bicycling: Fitting Concepts for Clinicians.** *The Physician and Sports medicine* 2004*,* **32**(4).

Asplund C., Webb C, Barkdull T: ***Cycling News*-Neck and Back Pain in Bicycling** 2005 [http://www.Roadcycling.com/news-results/neck-and-back-pain-bicycling]

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

Baker A: **Medical problems in road cycling.** In *Road cycling*. 1st edition. Edited by Gregor RJ, Conconi FC, Oxford (UK): Blackwell Science; 2000:68-117.

Bentley DJ, Millet GP, Vleck VE, McNaughton LR: **Specific aspects of contemporary triathlon: Implications for physiological analysis and performance.** *Sports Medicine* 2002, **32**(6):345-359.

Bergman TF, Peterson DH, Lawrence D: *Chiropractic Technique*. U.S.A.: Churchill Livingstone Inc.; 1993.

Bernard HR: *Social research methods: Qualitative and Quantitative approaches.* California: Sage Publication, Inc.; 2000.

Bogduk N: **The anatomical basis for cervicogenic headache.** *Journal of Manipulative and Physiological Therapeutics* 1992, **15**(1):67-70.

Bonacci J, Blanch P, Chapman AR, Vicenzino B: **Altered movement patterns but not muscle recruitment in moderately trained triathletes during running after cycling.** *Journal of Sports Sciences* 2010b, **28**(13):1477-1487.

Bonacci J, Green D, Saunders PU, Blanch P, Franettovich M, Chapman AR, Vicenzino B: **Changes in running kinematics after cycling are related to alterations in running economy in triathletes.** *Journal of Science and Medicine in Sport* 2010a, **13**:460-464.

Borchers GE, Buckenmeyer PJ: **Triathlon: The swim to bicycle transition.** *Master of Science thesis*. University of Wisconsin; 1986.

Brogan J: **Athletes play through pain at their own peril** 2012 [http://www.bostonglobe.com/lifestyle/health-wellness/2012/09/30/playing-through-pain/64tamog9T1KqLbopctWL8J/story.html]

Brown G: **Injury prevention and management.** In *High-performance Cycling.* Edited by Jeukendrup AE. Champaign, IL: Human Kinetics Publishers; 2002:227-235.

Brown S: **Revisionist Theory of Bicycle Sizing** 2005 [http://www.sheldonbrown.com/frame-sizing.html]

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

Callaghan MJ: **Lower body problems and injury in cycling.** *Journal of Bodywork and Movement Therapies* 2005, **9**:226-236.

Cavallo RJ, Speer KP: **Shoulder instability and impingement in throwing athletes.** *Medicine and Science in Sports and Exercise* 1998, **30**(S1):18-25.

Chapman AR, Vicenzino B, Hodges PW, Blanch P, Hahn AG, Milner TE: **A protocol for measuring the direct effect of cycling on neuromuscular control of running in triathletes**. *Journal of Sports Sciences* 2009, **27**(7):767-782.

Cipriani DJ, Swartz JD, Hodgson CM: **Triathlon and the multisport athlete.** *Journal of Orthopaedic and Sports Physical Therapy* 1998, **27**(1):42-50.

Clements K, Yates B, Curran M: **The prevalence of chronic knee injury in triathletes.** *British Journal of Sports Medicine* 1999, **33**(3):214-216.

Coetzee, Colleen: Interviewed by C. Coetzee. 25 February 20:00. 2011.

Collins K, Wagner M, Peterson K, Storey M: **Overuse injuries in triathletes: A study of the 1986 Seafair triathlon.** The *American Journal of Sports Medicine* 1989, **17**(5):675-680.

Comfort P, Abrahamson E: *Sports Rehabilitation and injury prevention*. John Wiley & Sons, Ltd.; 2010.

Dallam GM, Jonas S, Miller TK: **Medical considerations in triathlon competition: Recommendations for Triathlon Organisers, Competitors and Coaches**. *Sports Medicine* 2005, **35**(2):143-161.

Daniels S: **The Growing Role of Chiropractic In Sports Medicine** 2010 Available [http://www.smuze.com/health/the-growing-role-of-chiropractic-in-sports-medicine/]

de Lucas RD, Balikian P, Neiva CM, Greco CC, Denadai BS: **The effects of wet suits on physiological and biomechanical indices during swimming.** *Journal of Science and Medicine in Sport* 2000, **3**(1):1-8.

Delnevo CD, Abatemarco DJ and Steinberg MB: **Physician response rates to a mail survey by speciality and timing incentive.** *American Journal of Preventative Medicine* 2004, **26**(3):234-236.

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

Dorland I: *Dorland's illustrated medical dictionary* 31st edition. W.B. Saunders Company: Philadelphia. 2007.

Dyer C: *Beginnings Research in Psychology: A practical guide to research methods and statistics.* Oxford: Blackwell Publishers Ltd.; 1997.

Egermann M, Brocal D, Lill CA, Schmitt H: **Analysis of injuries in long-distance triathletes.** *International Journal of Sports Medicine* 2003, **24**(4):271-276.

Ellapen TJ, Chetty L, Dorasami C, Abrahams S, Narsigan S, Desai FA, Van Heerden HJ: **Prevalence of triathlon-related musculoskeletal pain among Kwa- Zulu Natal tri-athletes.** *African Journal for Physical, Health Education, Recreation and Dance* 2011, **17**(1):112-123.

Esterhuizen T (Statistician): Email communication with C. Coetzee. 2012-2013.

Fawkner HJ, McMurrary NE, Summers JJ: **Athletic injury and minor life events: a prospective study.** *Journal of Science and Medicine in Sport* 1999, **2**(2):117-24.

Finch C: **A new framework for research leading to sports injury prevention.** *Journal of Science and Medicine in Sport* 2006, **9**:3-9.

Fink A, Kosekoff J: *How to conduct surveys: A Step by Step Guide – The Role You Play*. California: Sage Publications; 1985.

Galera O, Gleizes-Cervera S, Pillard F, Riviere D: **Prevalence of injuries in triathletes from a French league.** *Apunts Medicina de L'esport* 2012, **47**(173):9-15.

Gnehm P, Reichenbach S, Altpeter E, Windmer H, Hoppeler H: **Influence of different racing positions on metabolic cost in elite cyclists.** *Medicine and Science in Sports and Exercise* 1997, **29**(6):818-23.

Gosling CM, Forbes AB, McGivern J, Gabbe BJ: **A profile of injuries in athletes seeking treatment during a triathlon race series.** The *American Journal of Sports Medicine* 2010, **38**(5):1007-1014.

Gosling CM, Gabbe BJ, Forbes AB: **Triathlon related musculoskeletal injuries: the status of injury prevention knowledge.** The *American Journal of Sports Medicine* 2008, **11**(4):396-406.

Gottshcall JS, Palmer BM: **Acute Effects of Cycling on Running Step Length and Step Frequency.** *Journal of Strength and Conditioning Research* 2000, **14**:97-101.

Halpern SD, Uhel PA, Berlin JA and Asch DA: **Randomised trial of 5 dollars versus 10 dollars monetary incentives, envelope size and candy to increase physician response rate to mailed questionnaires.** *Medical care* 2002, **40**(9):834-839.

Harris KM, Henry JT, Rohman E, Haas TS and Maron BJ: **Sudden Death During the Triathlon.** *Journal of the American Medical Association* 2010, **303**(13)

Hausswirth C, Bigard AX, Guezenennec CY: **Relationships between running mechanics and energy cost of running at the end of a triathlon and a marathon.** *International Journal of Sports Medicine* 1997, **18**:330-339.

Hausswirth C, Brisswalter J: **Strategies for improving performance in long distance duration events: Olympic distance triathlon.** *Sports Medicine* 2008, **38**:881-891.

Heiden T, Burnett A: **The effect of cycling on muscle activation in the running leg of an Olympic distance triathlon.** *Sports Biomechaincs* 2003, **2**:35-49.

Holmes JC, Pruitt AL, Whalen NJ: **Iliotibial band syndrome in cyclists**. *American Journal of Sports Medicine* 1993, **21**(3):419–24.

Hope RA, Longmore JM, McManus SK, Wood-Allum CA: *Oxford Handbook of Clinical Medicine 4th ed*. UK: Oxford University Press; 1998.

Hreljac A, Ferber R: **A Biomechanical Perspective of Predicting Injury Risk in Running.** *International SportMed Journal* 2006, **7**(2):98-108.

Hyde TE, Gengenbach MS: *Conservative Management of Sports Injuries. 2nd* ed. Sudbury, MA: Jones and Bartlett Publishers; 2007.

IBM SPSS [http://www.ibm.com/us/en/]

International Triathlon Union [www.triathlon.org]

IRONMAN.com | Official Site [http://www.ironman.com/#axzz2cDNIL53a]

James SL, Bates BT, Osternig LR: **Injuries to runners.** *American Journal of Sports Medicine* 1978, **6**(2):40–50.

Jeukendrup AE, Jentjens R: **Oxidation of carbohydrate feedings during prolonged exercise: current thoughts, guidelines and directions for future research.** *Sports Medicine* 2000, **29**(6):407-24.

Jeukendrup AE, Martin J: **Improving cycling performance: how should we spend our time and money.** *Sports Medicine* 2001, **31**(7):559-69.

Jeukendrup AE, Vet-Joop K, Sturk A, Stegen JHJC, Senden J, Saris WHM, Wagenmakers AJM: **Relationship between gastro-intestinal complaints and endotoxaemia, cytokine release and the acute-phase reaction during and after a long-distance triathlon in highly trained men.** *Clinical Science* 1998, **98**(1):47-55.

Johnson C: **On the Subject of Human Subjects**. *Journal of Manipulative and Physiological Therapeutics* 2005, **28**:79-80.

Johnson L: **Training, nutrition, injury and lifestyle characteristics of shorter distance triathletes.** *Master of Science thesis.* Louisiana State University. Department of Kinesiology; 2012

Kammer S, Young CC, Niedfeldt MW: **Swimming Injuries and illness.** *The physicians and sports medicine* 1999, **27**(4):51-61.

Kerr CG, Trappe TA, Starling RD, Trappe SW: **Hyperthermia during Olympic triathlon: influence of body heat storage during the swimming stage.** *Medicine and Science in Sports and Exercise* 1998, **30**(1):99-104.

Khan KM, Cook JL, Taunton JE: **Overuse tendinosis, not tendonitis**. *Physical Sports Medicine* 2000, **28**(5):31-46.

Korkia PK, Tunstall-Pedoe DS, Maffulli N: **An epidemiological investigation of training and injury patterns in British triathletes.** *British Journal of Sports Medicine* 1994, **28**(3):191-6.

Koskella K: **Surviving the triathlon swim section** 2006 [http://www.brianmac.co.uk/articles/article010.htm]

Krosshaug T, Anderson TE, Olsen OE, Myklebust G, Bahr R: **Research approaches to describe the mechanisms of injuries in sport: limitations and possibilities.** *British Journal of Sports Medicine* 2005, **39**:330-339.

Lapane KL, Quilliam BJ, Hughes CM: **A Comparison of Two Distribution Methods on Response Rates to a Patient Safety Questionnaire in Nursing Homes.** *Journal of The American Medical Directors Association* 2007, **8**(7):446-452.

Laurenson NM, Fulcher KY, Korkia P: **Physiological characteristics of elite and club level female triathletes during running.** *International Journal of Sports Medicine* 1993, **14**(8):455-9.

Lepers R, Bigard AX, Hausswirth C, Guezennec CY: **Modélisation de l'enchaînement natation-cyclisme d'un triathlon en laboratoire. Influence sur la cinétique de la lactatémie.** *Science et Sports* 1995, **10**:131-139.

Leung GM, Johnston JM, Saing H, Tin KY, Wong JO and Ho LM: **Prepayment was superior to postpayment cash incentives in a randomised postal survey among physicians.** *Journal of Clinical Epidemiology* 2004, **57**(8):777-784.

Lippert LS: *Clinical Kinesiology and Anatomy.* 4th Edition. Philadelphia: F.A Davis Company; 2006

Main LC, Landers GJ, Grove JR, Dawson B and Goodman C: **Training patterns and negative health outcomes in triathlon: longitudinal observations across a full competitive season.** *Journal of sports medicine and physical fitness* 2010, **50**(4):475-85.

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

Massimino FA, Armstrong MA, O'Toole ML, Hiller WD, Laird RH: **Common triathlon injuries: Special considerations for multisport training.** *Annals of Sports Medicine* 1988, **4**(2):82-86.

Maughan RJ, Miller JDB: **Incidence of training-related injuries among marathon runners.** *British Journal of Sports Medicine* 1983, **17**:162–5.

McHardy A, Pollard H, Fernandez M: **Injuries: A review of the literature and discussion of potential injury mechanisms.** *Clinical Chiropractic* 2006, **9**:129-138.

Medicine of Cycling Bike Fit Task Force First Consensus Statement on Definitions and Key Concepts [http://www.medicineofcycling.com/assets/Medicine_of_Cycling_Bike_Fit_Consensus_Statement.pdf]

Migliorini S, Merlo M: **Ileotibial band syndrome in triathletes.** IV Isakos Congress. Auckland (NZ) 2003, March 10-14.

Migliorini S: **Risk factors and injury mechanism in Triathlon.** *Journal of Human Sports Exercise* 6 2011, **6**(2):309-314.

Millet GP, Vleck VE: **Physiological and biomechanical adaptations to the cycle to run transition in Olympic triathlon: review and practical recommendations for training.** *British Journal of Sports Medicine* 2000, **34**:384-390.

Mills BJ, Korporaal CM, Jones A: **An Investigation to establish an injury profile in South African cyclists and its association to bicycle set-up.** Masters thesis. Durban University of Technology. 2006.

Morgan DL: *The Focus Group Guidebook. Volume 1.* United States of America. Sage Publications. Thousand Oaks; 1998(a).

Morgan DL: *Planning Focus Groups. Volume 1*. Sage Publications. Thousand Oaks; 1998(b).

Morgan DL: *Moderating Focus Groups. Volume 1*. Sage Publications. Thousand Oaks; 1998(c).

Mouton J: *How to succeed in your masters and doctoral studies: A South African guide and resource book.* 1st ed. Van Schaik Publishers; 2001.

Mouton J: *Understanding social research.* 1st ed. Pretoria: J.L. van Schaik Publishers; 1996.

Novacheck TF: **The biomechanics of running.** *Gait and Posture* 1997, **7**:77-95

O'Toole ML, Hiller WDB, Smith RA, Sisk TD: **Overuse injuries in ultra-endurance triathletes.** *American Journal of Sports Medicine* 1989, **17**(4):514-518.

Pollard H, Fernandez M: **Spinal musculoskeletal injuries associated with swimming: a discussion of technique.** *Chiropractic and Osteopathy* 2004, **12**(2):72-80.

Portney LG, Watkins MP: *Foundations of clinical research: Applications to practice*. 2nd ed. New Jersey: Prentice Hall Health. 2000.

Pribicevic M, Pollard H: **Rotator cuff impingement.** *Journal of Manipulative and Physiological Therapeutics* 2004, **27**(9):580-590.

Qiugley EJ, Richards JG: **The effects of cycling on runningmechanics.** *Journal of Applied Biomechanics* 1996, **12**:470-479.

Reid DC: *Sports Injury Assessment and Rehabilitation.* U.S.A.: Churchill Livingston Inc. 1992.

Rimmer T and Coniglione T: **A Temporal Model for Nonelite Triathlon Race Injuries.** *Clinical Journal of Sport Medicine* 2012, **22**:249-253.

Robertson J, Walkoin EJ and Mc Gettigan P: **Response rates and representativeness: A lottery incentive improves physician survey return rates.** *Pharmacopeidemiology and drug safety* 2005, **14**(8):571-577.

Salant P, Dillman D: *How to conduct your own survey*. United States of America: John Wiley and Sons Inc. 1994.

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

Satterthwaite P, Norton R, Larmer P, Robinson E: **Risk factors for injuries and other health problems sustained in a marathon.** *British Journal of Sports Medicine* 1999, **33**(2):22-26.

Scarfe A: **From theory to practice: Running kinematics of triathletes.** Doctor of Philosophy Thesis. The University of Birmingham. 2011.

Schafer RC, Faye LJ: *Motion palpation and Chiropractic Technique 1st edition.* The Motion Palpation Institute. C.A.: Huntington Beach. 1989.

Schoenbach VJ, Rosamond WD: *Understanding the Fundamentals of Epidemiology: an evolving text.* Department of Epidemiology. School of Public Health. University of North Carolina at Chapel Hill; 2000.

Seymour A: **Focus Groups: An Important Tool for Strategic Planning** 2004. [http://www.justicesolutions.org/art_pub_focus_groups.htm]

Shamus E, Shamus J: Sports Injury Prevention and Rehabilitation. New York: McGraw-Hill Medical Publishing Division. 2001.

Shaw T, Howat P, Trainor M, Maycock B: **Training patterns and sports injuries in triathletes.** *Journal of Science and Medicine in Sport* 2004, **7**(4):446-450.

Sheets CG, Hochschuler SH: *The Spine in Sport.* Philadelphia: Hanley & Belfus. 1990.

Simons DG, Travell JG, Simons LS: *Myofascial Pain and Dysfunction, The Trigger point Manual,* 2nd Edition. U.S.A.: Williams and Wilkins. 1999.

Souza T: **The Bicyclist, Part 2**. 1996 [http://www.dynamicchiropractic.com/pdf_out/DynamicChiropractic.com-The-Bicyclist-Part-II-1374838188.pdf].

Strock GA, Cottrell ER, Lohman JM: **Triathlon.** *Physical Medicine & Rehabilitation Clinics of North America* 2006, **17**(3):553-564.

Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD: **A Prospective study of running injuries: the Vancouver Sun Run "In Training" clinics.** *British Journal of Sports Medicine* 2003, **37**:239-244.

Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD: **A retrospective case-control analysis of 2002 running injuries.** *British Journal of Sports Medicine* 2002, **36**(2):95–101.

Tew GA: **The effect of cycling cadence on subsequent 10km running performance in well-trained triathletes.** *Journal of Sports Science and Medicine* 2005, **4**:342-353.

Thomas JR, Nelson JK, Silverman SJ: *Research Methods in Physical Activity.* 6th ed. 2011.

Thompson M, Rivara FP: **Bicycle related Injuries.** American Family Physician 2001, **63**(10):2007-2015.

Trappe TA, Starling RD, Jozsi AC, Goodpaster BH, Trappe SW, Nomura T, Obara S, Costill DL: **Thermal responses to swimming in three water temperatures: influence of a wetsuit.** *Medical Science Sports Exercise* 1995, **27**(7):1014-1021.

Triathlon South Africa [http://www.triathlonsa.co.za/]

van Gent RN, van Middlekoop M, van Os AG, Bierma-Zeinstra SMA, Koes BW: **Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review.** *British Journal of Sports Medicince 2007,* **41**:469-480.

van Mechelen W, Hlobil H, Kemper HCG: **Incidence, severity, aetiology and prevention of sports injuries. A review of concepts.** *Sports Medicine* 1992, **14**(2):82-99.

Villavicencio AT, Burneikiene S, Hernandez TD, Thramann J: **Back and nack pan in triathletes**. *Neurosurgical Focus* 2006, **21**(4):E7

Vleck VE, Bentley DJ, Millet GP, Cochrane T: **Triathlon event distance specialization: Training and Injury Effects.** *Journal of Strength and Conditioning Research* 2010, **24**(1):30.

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

Wilk BR, Fisher KL, Rangelli D: **The incidence of musculoskeletal injuries in an amateur triathlete racing club***.* *Journal of Orthopaedic and Sports Physical Therapy* 1995, **22**(3):108-12.

Appendix A: Institutional Research Ethics Committee (IREC) full approval of proposal

DURBAN UNIVERSITY *of* TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

20 June 2012

IREC Reference Number: **REC 31/12**

Mr C W Coetzee
39 Vincent Gardens Road
Vincent Heights
East London
5247

Dear Mr Coetzee

An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes

I am pleased to inform you that Full Approval has been granted to your proposal REC 31/12.

The ethical requirements have been met by the researcher however; the following recommendations have been made for consideration:

1. Objective 3: Only prevalence may be determined in this study, not incidence. Incidence would require a cohort/ longitudinal study. Incidence cannot be determined in a cross sectional study.
2. It is recommended that the student familiarise himself further with statistical approaches underpinning this topic, i.e. univariate analysis is followed by bivariate (chi-squared or t-tests) and then by logistic regression (unadjusted and adjusted for potential covariates or confounders).
3. Note that in the original submission, the budget was restricted by the HOD to R5000 only; the revised version does not reflect this note by the HOD. Please amend accordingly.

The Proposal has been allocated the following Ethical Clearance number IREC 017/12. 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.

Note that final approval is subject to IREC review of the final data collection tools (post expert group & pilot); in the interim questionnaire validation can take place.

Please submit the amended proposal and final data collection tool with a cover letter to the IREC administrator. Please note that research on the proposed project may not proceed until you receive Final Approval from the IREC.

Yours Sincerely

[redacted]

Dr D. F. Naude
Chairperson: IREC

Appendix B: IREC questionnaire approval

DURBAN UNIVERSITY of TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

20 August 2012

IREC Reference Number: **REC 31/12**

Mr C W Coetzee
39 Vincent Gardens Road
Vincent Heights
East London
5247

Dear Mr Coetzee

An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathlete

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the questionnaire has been APPROVED; you may now proceed with data collection on the proposed project.

Yours Sincerely

[redacted]

Dr D. F. Naude
Chairperson: IREC

Appendix C: IREC approval of amendment to proposal

DURBAN UNIVERSITY *of* TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

6 March 2013

Mr C W Coetzee
39 Vincent Gardens Road
Vincent Heights
East London
5247

Dear Mr Coetzee

Application for Amendment of Approved Research Proposal

An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes

I am pleased to inform you that your application for amendment to the methodology of your research proposal has been approved.

Yours Sincerely,

[redacted]

Dr D. F. Naude
Chairperson: IREC

Appendix D: Permission letter from Mr. Terry Ellapen to use his questionnaire

UNIVERSITY OF KWAZULU-NATAL

FACULTY OF HEALTH SCIENCES

SCHOOL OF PHYSIOTHERAPY, SPORT SCIENCE AND OPTOMETRY

DISCIPLINE OF SPORT SCIENCE

2011

Specialization: Biokinetics

To Whom It May Concern:

I hereby give my written consent to Cuan Coetzee for the use of a modified version of my musculoskeletal pain questionnaire in his research.

Yours truly,
Dr Terry Ellapen

Appendix E: Expert group letter of information

Dear Participant,

I would like to welcome you into the expert group of my study, the title of my research project is: **An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes.**

Name of supervisors:	Dr C. Korporaal (M.Tech:Chiropractic, CCFC, CCSP, ICSSD) and Dr G. Haswell (M.Tech:Chiropractic)
Name of Research Student:	Cuan Coetzee (0741295777)
Name of Institution:	Durban University of Technology

The purpose of this expert group is to validate the use of the Musculoskeletal Pain Questionnaire in terms of gathering information from triathletes. You are asked to assist in the development of the questionnaire through the use of this expert group, by means of discussing the questions and their ability to answer the research question as indicated under the title above. The discussions will expert on the changes that are necessary in order to alter the Musculoskeletal Pain Questionnaire in order to convert the questionnaire into a more accurate tool.

The validation of the questionnaire is a two-step process, the first being the collection of the data with the invalidated questionnaire and the second being critical analysis of the information in terms of what actually happens in the fraternity of triathlon. Discussions will focus on the main trends that have been found through the analysis of the data. You are at any point permitted to disagree with the findings if such is the case, however please give your reasons for disagreement as this will help in the research process. Your participation in this study is much appreciated and you are assured that your comments and contributions to the discussion will be kept confidential. The results of the discussion will only be used for research purposes. If you have any further questions please feel free to contact my supervisor/ co-supervisor or myself.

Thank you for your participation. Yours truly,

Cuan Coetzee	Dr. C. Korporaal	Dr. G. Haswell
(Researcher)	(Research supervisor)	(Research supervisor)

Appendix F: Informed consent form (members of the expert group)

Date:

The Title: **An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes.**

Name of supervisors:	Dr G. Haswell (M.Tech:Chiropractic) and Dr C. Korporaal (M.Tech:Chiropractic, CCFC, CCSP, ICSSD)
Name of Research Student:	Cuan Coetzee (0741295777)
Name of Institution:	Durban University of Technology

Please circle yes or no (as is appropriate for yourself):

1. Have you read the patient information sheet? Yes / No
2. Have you had time to ask questions about the study? Yes / No
3. Have you received satisfactory answers to your questions? Yes / No
4. Have you had an opportunity to discuss this study? Yes / No
5. Have you received enough information about this study? Yes / No
6. Who have you spoken to regarding this study? _______________
7. Do you understand the implications of your involvement in this study? Yes / No
8. Do you understand that you are free to drop out of this study at any time? Yes / No
9. Do you agree to voluntarily participate in this study? Yes / No

If you have answered NO to any of the above, please obtain the necessary information from the researcher and / or supervisor before signing. Thank You.

<u>Please print in block letters</u>

Participant ________________________________ Signature_____________ Date_____________

Witness's name____________________________ Signature_____________ Date_____________

Researcher's name___________________________ Signature_____________ Date_____________

Supervisor's name___________________________ Signature_____________ Date_____________

Appendix G: Code of conduct (members of the expert group)

This form needs to be completed by every member of the Expert group prior to commencement of the expert group.

As a member of this committee I agree to abide by the following conditions:

1. All information contained in the research documents and any information discussed during the expert group meeting will be kept private and confidential.
2. None of the information shall be communicated to any other individual or organisation outside of this specific expert group as to the decisions of this expert group.
3. The information of this expert group will be made public in terms of journal publication, which will in no way identify any participants of this research.

Member Represents	Member's Name	Signature	Contact Details

Appendix H: Confidentiality statement

IMPORTANT: This form is to be completed and understood before the expert group commences.

1. All information contained in the research documents and any information discussed during the expert group meeting will be kept private confidential.
2. The patient files will be coded and kept anonymous in the research process.
3. None of the information shall be communicated to any other individual or organisation outside of this specific expert group as to the decisions of this expert group.
4. The information of this expert group will be made public in terms of journal publication, which will in no way identify any participants of this research.

Member Represents	Member's Name	Signature	Contact Details

Appendix I: Pre – expert group questionnaire

An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes.						
Please mark an X indicating your choice where applicable. Some questions are open-ended and will entail a more detailed answer						
<u>Section A - Personal Details</u>						
Name:				Telephone		
Age:			Gender	Male	Female	
Ethnicity	African	Coloured	Indian	White	Other	
Height	m		Body mass	kg		
How many competitions have you participated in the previous 12 months?	1-2	3-4	5-6	7-8	>9	
How many competitions have you participated in the previous 4 months?	1-2	3-4	5-6	7-8	>9	
What is the average length (in kilometres) of a competition?	Swimming kms	Cycling kms	Running kms			
What is the average length (in time) of a competition?	Swimming Time: min	Cycling Time: min	Running Time: min			
<u>Section B - Training Schedule</u>						
1.	For how long have you been participating in triathlons?	<1 year	1-2 years	3-4years	5-6 years	
		7-8 years	9-10 years	>10 years		
2	How long (in weeks) are your training regiments during:	Pre-season	In-season	Off-season		
3	What cross-training activities do you participate in?	Boot Camp	CrossFit	Functional Training	Gym	
		Other Sports (please specify)				
4	How often do you cross-train in the:	*Phases of training*	*Sessions per week*	*Duration (minutes)*		
		Pre-season				
		In-season (competition phase)				
		Off-season				
5	What type of running training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes)*	
		Long Slow Distance				
		Fartlek Training				
		Tempo Training				
		Interval Training				
		Sprint Training				
		Other, please Specify 1 2				
6	What type of cycle training do you perform?	*Type of training*	*Sessions per week*	*Distance (km)*	*Duration (minutes)*	
		Endurance				
		Sprint				
		Spinning Classes				
		Other, Please Specify 1 2				

7	What type of swim training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes)*
		Endurance			
		Sprint			
		Other, Please Specify 1 2 3			

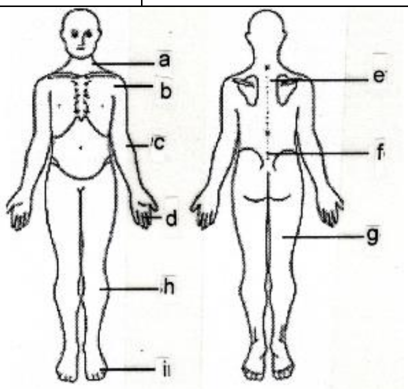
8	What is your preferred swimming stroke:	Freestyle	Butterfly	Backstroke	Breaststroke
9	How many rest days do you have a week during:	Pre-season	In-season	Off-season	

Section C – Pain appraisal

The definition of musculoskeletal pain is a sensation of agony that inhibited you from participating in triathlon or practice for a minimum of 24 hours (adapted from van Heerden, 1996). Please report on triathlon related musculoskeletal pain and not musculoskeletal pain contracted from other activities.

1	Have you experienced any musculoskeletal pain within the last 12 months?	Yes	No

2.1	Identify the anatomical sites which experience musculoskeletal pain **currently** :	**A**	**F**
		B	**G**
		C	**H**
		D	**I**
		E	



2.2	Identify the anatomical sites which experienced musculoskeletal pain within the **last 12 months**:	**A**	**F**	2.3	Identify the anatomical sites which have ever experienced musculoskeletal pain **in your lifetime:**	**A**	**F**
		B	**G**			**B**	**G**
		C	**H**			**C**	**H**
		D	**I**			**D**	**I**
		E				**E**	

In terms of your current pain

3	What activity precipitates the onset of pain?	Swimming	Running	Cycling	Swimming and Running	Swimming and Cycling
		Running and Cycling	All three	None	Other (specify)	
4	What type of pain have you experienced?	Dull	Sharp Shootin g	Aching	Radiating	Pins and Needles

5	How long does the pain last / persist?	Years	Months	Days	Hours	Minutes	Seconds	

6	How would you rate this pain from 0 – 10 (0 no pain and 10 is worst pain)										
	0	1	2	3	4	5	6	7	8	9	10

7	When did this musculoskeletal pain occur?	Pre-season	In-season	Off-season	Not related to sport

8	Did the musculoskeletal pain prevent you from participating in competition and/or training?						Yes	No
9	How long did it prevent you from training?	No loss	1 Day	> 1 Day	> 7 Days	> 1 Month	> 12 months	
10	How long did it prevent you from participating?	No loss	1 Day	> 1 Day	> 7 Days	> 1 Month	> 12 months	
11	Is the pain experienced constant or recurring (only with activity)?				Constant	Recurring	Not applicable	
12	How long have you experienced the recurring pain?			Hours	Minutes	Seconds	Not applicable	
13	How did you sustain the musculoskeletal pain?	Traumatic incident during a triathlon race			Traumatic incident during triathlon training		Over-training	
		Incident during Cross-training (Cross-training includes Crossfit, Functional Training, Boot Camp, Gym, other sports etc)			If not stated here, please specify:		Unknown	
14	Which type of training produces the most pain?	Swim	Run	Cycle	Swimming and Running	Swimming and Cycling	Running and Cycling	
		All three	Cross training	None	Other (specify)			
15	When you sustained the musculoskeletal pain which medical practitioner did you seek treatment from?	Biokineticist	Chiropractor		General Practitioner	Orthopaedic Surgeon		
		Pharmacist	Physiotherapist		Other (Please Specify)			
16	What was the specific diagnosis of your injury given by the above medical practitioner?							

THANK YOU FOR TIME AND EFFORT IN COMPLETING THIS QUESTIONNAIRE!!!

Appendix J: Researcher's assessment data sheet

Assessment data sheet (For researcher)

1	**PATIENT CARE:**	New condition		Continuation of care	
	PREVIOUS INJURY?	Any orthopaedic surgery?	YES	NO	
		Previous muscle injury?	YES	NO	
		Any fractures?	YES	NO	
		Connective tissue injuries (tendons/ligaments)	YES	NO	
		Past sporting history?	RUNNER	SWIMMER	
			TRI-ATHLETE	RACQUET SPORTS	
			RUGBY	SOCCER	
			PADDLING		
			OTHER (please specify____________________)		
2	**LOCATION OF INJURY RELATED TO TRIATHLON:**				
	HEAD / CONCUSSION				
	NECK	L / R	Upper / Middle / Lower		
	SHOULDER	L / R	ELBOW	L / R	
	FOREARM	L / R	WRIST	L / R	
	HAND	L / R	THUMB	L / R	
	FINGERS	L / R	THORACIC	L / R	
	RIBS	L / R	LOW BACK	L / R	
	BUTTOCKS	L / R			
3	**MECHANISMS OF INJURY:**				
	COMPETITION		TRAINING		
	DURING SWIM	IMMEDIATELY AFTER SWIM		10 MINUTES AFTER SWIM	
		1 HOUR AFTER SWIM		NEXT DAY	
	DURING CYCLE	IMMEDIATELY AFTER SWIM		10 MINUTES AFTER SWIM	
		1 HOUR AFTER SWIM		NEXT DAY	
	DURING RUN	IMMEDIATELY AFTER SWIM		10 MINUTES AFTER SWIM	
		1 HOUR AFTER SWIM		NEXT DAY	
	FALLS		Other		
4	**CLINICAL PRESENTATION**:				
	ACUTE		CHRONIC		
	CONTUSION	LACERATION	BLISTER	HEAT STROKE	
	EXHAUSTION	SPRAIN	STRAIN	DISLOCATION	
	C / FACET	T/FACET	L / FACET	SI SYNDROME	
	PFPS	TENDONITIS	CIRCULATORY	JOINT DYSFUNCTION	
	NEUROLOGICAL	MYOFASCIAL: specify			
5	**LOCATION**				
	Neck	Upper extremity	Lower extremity	Upper back	
	Middle back	Lower back			
	FRACTURE specify:				
	OTHER, Specify:				

Appendix K: Corrections from the expert group

Changes as per expert group. The numbers refer to number on the **pre-expert** group questionnaire (Appendix I).

1 Remove name and telephone number options

2 Number questions in section A

3 Include a box for the researcher's code

4 Add "triathlon" before the word "competition" in the following section A question "How many competitions have you participated in the previous 12 months?"

5 Section B question 3 put options into alphabetical order

6 Swimming option was given in km's, change to m's

7 Add in "number" in brackets to make question better understood (Section A, Section B questions 1 and 9)

8 Remove "in weeks" from section B question 2 and add "wks" after the options provided

9 Add "per session" after "duration" option Section B questions 4, 5, 6, 7

10 "age" change to "Date of birth"

11 Add "open water" as option for Section B question 7

12 Add question "What coaching do you receive?" With options Swim, Cycling, Running, None.

13 Add question "How many days per week do you perform double sessions?"

14 Add question "Have you had a professional bicycle setup?" options yes or no.

15 Add question "How many active rest days do you have per week?"

16 Remove the options from the following questions and leave open ended
Section A 2 questions; Section B 1, 9; Section C 9, 10,

17 Emphasize the words "not musculoskeletal pain contracted from other activities" in the definition of musculoskeletal pain

18 Add question as Section C question 1 "Is your current pain related to triathlon?" with options yes or no

19 After the new question 1 above, split the table into 2 identical questionnaires. Left side for CURRENT pain only (Questions 4-18) and right side for PAIN WITHIN LAST 12 MONTHS only.(questions 21-35)

20 Amend all relevant grammar with regards to past or present tense

21 Amend all relevant numbering to the changes to entire document

22 Change “their pain” to “the severity of the pain”

23 Move section C questions 8, 9 and 10 after question 3

24 Split section C question 8 into 2 separate questions, one pertaining to competition and the other to training

25 Remove section C questions 11, 12 and 14

26 Section C question 10, change “participating” to “competing”

27 Section C question 13 change “musculoskeletal pain” to “injury that caused the pain”

28 Move section C question 13 after question 7

29 Provide an option for “None” to section C question 15

30 Add question to section C “Were you happy with the treatment you received?” yes or no

31 Add question to section C “What is your reason for the above”

Appendix L: Letter of information and informed consent (pilot study)

Dear Participant,

Thank you for showing an interest in my study. Please read this information carefully.

Title: An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes.

Name of supervisors:	Dr G. Haswell (M.Tech:Chiropractic) and Dr C. Korporaal (M.Tech:Chiropractic, CCFC, CCSP, ICSSD)
Name of Research Student:	Cuan Coetzee (0741295777)
Name of Institution:	Durban University of Technology

Purpose of the study

The purpose of this study is to determine the demographic profile, incidence and prevalence of injuries in triathletes and to assess and determine injuries in terms of diagnosis, location and severity.

Procedure

The two free consultations will take place at The Durban University of Technology's Chiropractic Day Clinic consisting of: a) One free Initial visit-case history, physical and regional in which time you will complete the questionnaire. b) One free treatment for the injury diagnosed in the initial visit. Should you require further treatments these will be charged at relevant year Chiropractic rates.

Participants

Presently there are 80 active tri-athletes registered with KZNTA. This research will include all of those tri-athletes, over the age of 18 years old, who are active members of the KZNTA. (Total Population n = 80.)

Benefits

Should you be suffering from any injuries during the course of your participation in this research, you are offered 1 optional free Chiropractic treatment at the Chiropractic Day Clinic at the Durban University of Technology. Also, the results of this research can be distributed to other Triathlon Associations to allow for improved recommendations regarding training, strength and conditioning. This research will also assist in the general improvement of the state of triathletic performance in the province.

AS A VOLUNTARY PARTICIPANT IN THIS RESEARCH STUDY, YOU ARE FREE TO WITHDRAW FROM THE STUDY AT ANY TIME, WITHOUT GIVING A REASON.

Risks/ Discomforts and Costs

There are no risks, discomforts or costs involved with your participation in this study. Patients may feel slight stiffness related to treatment.

New findings: You will be made aware of any new findings during the course of this study.

Remuneration: You will not receive a travel allowance in order to attend your appointment at the Chiropractic Day Clinic.

Confidentiality

All the information is confidential and the results will be used for research purposes only.
Participation is voluntary and failure to participate will not result in any adverse consequences.
Persons to contact should you have any problems or questions: Should you have any questions that you would prefer being answered by an independent individual, feel free to contact my supervisors on the above numbers. If you are not satisfied with a particular area of this study feel free to forward any concerns to the Durban University of Technology Research and Ethics Committee (031 373 2900).

Please circle yes or no (as is appropriate for yourself):

1. Have you had time to ask questions about the study? Yes / No
2. Have you received satisfactory answers to your questions? Yes / No
3. Have you had an opportunity to discuss this study? Yes / No
4. Have you received enough information about this study? Yes / No
5. Who have you spoken to regarding this study? _________________
6. Do you understand the implications of your involvement in this study? Yes / No
7. Do you understand that you are free to drop out of this study at any time? Yes / No
8. Do you agree to voluntarily participate in this study? Yes / No

If you have answered NO to any of the above, please obtain the necessary information from the researcher and / or supervisor before signing. Thank You.

<u>Please print in block letters</u>

Participant ________________________________ Signature_____________ Date___________

Witness's name_____________________________ Signature_____________ Date__________

Researcher's name___________________________ Signature_____________ Date_________

Supervisor's name___________________________ Signature_____________ Date__________

Appendix M: Post-expert group questionnaire

An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes.						
Please mark an X indicating your choice where applicable. Some questions are open-ended and will entail a more detailed answer						
<u>Section A - Personal Details</u>				**<u>CODE</u>** (for researcher use only):		
1	Date of Birth (YY/MM/DD)		2	Gender	Male	Female
3	Ethnicity	African	Coloured	Indian	White	Other
4	Height	m	5	Body mass		Kg
6	How many triathlon competitions (number) have you participated in the previous 12 months?					
7	How many competitions have you participated in the previous 4 months?					
8	What is the average length (in kilometres) of a competition?		Swimming m	Cycling km	Running km	
9	What is the average length (in time) of a competition?		Swimming Time: min	Cycling Time: min	Running Time: min	

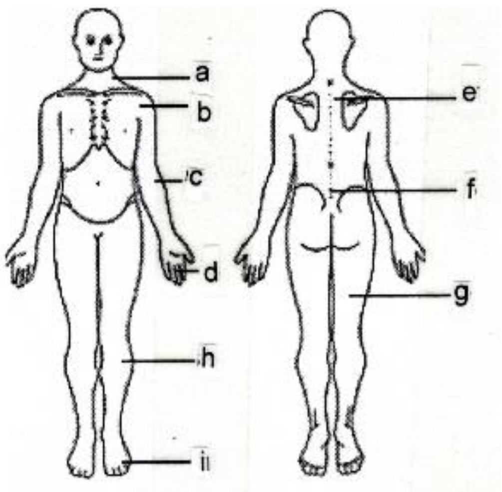
<u>Section B - Training Schedule</u>					
1.	How many years (number) have you been participating in triathlon?				
2	What is the length of your training regiment?	Pre-season wks	In-season (competition phase) wks	Off-season wks	
3	What, if any, cross-training activities do you participate in?	Core Strengthening	CrossFit	Functional Training (includes bootcamp and kettlebells)	Gym
		None	Other Sports (please specify)		
4	How often do you cross-train in the:	*Phases of training*	*Sessions per week*	*Duration (minutes) per session*	
		Pre-season			
		In-season			
		Off-season			
5	What type of running training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes) per session*
		Long Slow Distance			
		Fartlek Training			
		Tempo Training			
		Interval Training			
		Sprint Training			
		Other, please Specify 1 2			
6	What type of cycle training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes) per session*
		Endurance			
		Sprint			
		Spinning Classes			
		Other, Please Specify 1 2			
7	What type of swim training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes) per session*
		Endurance			
		Sprint			
		Open-water			
		Other, Please Specify 1 2			
8	Have you had a professional bicycle setup?	Yes	No		
9	What coaching do you receive?	Swim	Cycling	Running	None
10	What is your preferred swimming stroke:	Freestyle	Butterfly	Backstroke	Breaststroke
11	How many rest days do you have per week?				
12	How many active rest days do you have per week?				
13	How many days per week do you perform double sessions?				

Section C – Pain appraisal

The definition of musculoskeletal pain is a sensation of agony that inhibited you from participating in triathlon or practice for a minimum of 24 hours (adapted from van Heerden, 1996). Please report on triathlon related musculoskeletal pain and **not musculoskeletal pain contracted from other activities**.

1	**Is your current pain related to triathlon?**	**Yes**	**No**

In terms of your current pain				In terms of your pain within the last 12 months Please select injury which **most effected your participation**			
2	Are you currently experiencing any musculoskeletal pain?	Yes	No	19	Have you experienced any musculoskeletal pain within the last 12 months?	Yes	No
3	Identify the anatomical sites which experience musculoskeletal pain **currently** :			**20**	Identify the anatomical sites which experienced musculoskeletal pain within the **last 12 months**:		



Current		Last 12 months	
A	B	A	B
C	D	C	D
E	F	E	F
G	H	G	H
I		I	

In terms of your current pain **ONLY answer 4-18**						
4	What activity precipitates the **onset** of pain?	Swim	Run	Cycle	Swim and Run	Swim and Cycle
		Run and Cycle	All three	None	Other (specify)	
5	What activity precipitates the **most** of pain?	Swim	Run	Cycle	Swim and Run	Swim and Cycle
		Run and Cycle	All three	None	Other (specify)	
6	Did the pain prevent you from participating in competition?	Yes	No			
7	Did the pain prevent you from participating in training?	Yes	No			
8	How long did it prevent you from training?					
9	How long did it prevent you from competing?					
10	What type of pain have you experienced?	Dull	Sharp Shooting	Aching		
		Radiating	Pins and Needles			
11	How long does the pain last / persist?	Years	Months	Days		
		Hours	Minutes	Seconds		
12	How would you rate the severity of the pain from 0 – 10 (0 no pain and 10 is worst pain)					
	0	1	2	3	4	5
		6	7	8	9	10

In terms of your pain within the last 12 months **ONLY answer 21-35**						
21	What activity precipitated the **onset** of pain?	Swim	Run	Cycle	Swim and Run	Swim and Cycle
		Run and Cycle	All three	None	Other (specify)	
22	What activity precipitated the **most** of pain?	Swim	Run	Cycle	Swim and Run	Swim and Cycle
		Run and Cycle	All three	None	Other (specify)	
23	Did the pain prevent you from participating in competition?	Yes	No			
24	Did the pain prevent you from participating in training?	Yes	No			
25	How long did it prevent you from training?					
26	How long did it prevent you from competing?					
27	What type of pain have you experienced?	Dull	Sharp Shooting	Aching		
		Radiating	Pins and Needles			
28	How long does the pain last / persist?	Years	Months	Days		
		Hours	Minutes	Seconds		
29	How would you rate the severity of the pain from 0 – 10 (0 no pain and 10 is worst pain)					
	0	1	2	3	4	5
		6	7	8	9	10

In terms of your current pain (continued)					In terms of your pain within the last 12 months (continued)				
13	When did this musculoskeletal pain occur?				30	When did this musculoskeletal pain occur?			
	Pre-season	In-season	Off-season	Not related to sport		Pre-season	In-season	Off-season	Not related to sport
14	How did you sustain the injury that caused the pain?				31	How did you sustain the injury that caused the pain?			
	Traumatic incident during a triathlon race	Traumatic incident during triathlon training		Over-training		Traumatic incident during a triathlon race	Traumatic incident during triathlon training		Over-training
	Incident during Cross-training (Cross-training includes Crossfit, Functional Training, Boot Camp, Gym, other sports etc)	If not stated here, please specify		Unknown		Incident during Cross-training (Cross-training includes Crossfit, Functional Training, Boot Camp, Gym, other sports etc)	If not stated here, please specify		Unknown
15	When you sustained the pain which medical practitioner did you seek treatment from?				33	When you sustained the pain which medical practitioner did you seek treatment from?			
	Biokineticist	Chiropractor	General Practitioner	Orthopaedic Surgeon		Biokineticist	Chiropractor	General Practitioner	Orthopaedic Surgeon
	Pharmacist	Physiotherapist		None		Pharmacist	Physiotherapist		None
	Other (Please Specify)					Other (Please Specify)			
16	What (if anything) did the above practitioner diagnose?				34	What (if anything) did the above practitioner diagnose?			
17	Were you happy with the treatment you received?		Yes	No	35	Were you happy with the treatment you received?		yes	No
18	What is your reason for the above?				36	What is your reason for the above?			

THANK YOU FOR TIME AND EFFORT IN COMPLETING THIS QUESTIONNAIRE!!!

Appendix N: Corrections from the pilot study

Changes as per pilot study. Numbers refer to number on post-expert group questionnaire (Appendix M).

1	Add “triathlon” before the word “competition” in Section A question 7
2	Include “only” after the “swim”, “run” and cycle” options to section C questions 4, 5, 21 and 22
3	Include the words “LEFT HAND SIDE” and “RIGHT HAND SIDE” to the relevant statements after Section C question 1 simply to reintegrate which side of the questionnaire to fill out for current or past pain respectively.

Appendix O: Letter from Mrs. Lee Storm (secretary of KZNTA)

KWA-ZULU NATAL TRIATHLON ASSOCIATION
11 HOWARDS END
8 TUNZINI ROAD
HILLCREST
3610

TELEPHONE: 031 765 8974
FAX: 031 765 8974
CELL: 083 289 0923
E-mail: lstorm@icon.co.za

RESEARCH INVOLVING KZNTA TRIATHLETES

TO WHOM IT MAY CONCERN

This is to certify that Cuan Coetzee, operating in conjunction with DUT, is hereby granted permission to access KZNTA triathletes for research purposes, provided ethical approval is obtained.

For further information please contact the under signed.

Regards

LEE STORM
SECRETARY KZNTA

Appendix P: Letter of information and informed consent form (research procedure)

Dear Participant,

Thank you for showing an interest in my study. Please read this information carefully.

Title: An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes.

Name of supervisors:	Dr C. Korporaal (M.Tech: Chiropractic, CCFC, CCSP, ICSSD) and
	Dr G. Haswell (M.Tech: Chiropractic)
Name of Research Student:	Cuan Coetzee (0741295777)
Name of Institution:	Durban University of Technology

Purpose of the study

The purpose of this study is to determine the demographic profile, incidence and prevalence of injuries in triathletes and to assess and determine injuries in terms of diagnosis, location and severity.

Procedure

All participants are required to fill out the questionnaire. Two free consultations will take place at The Durban University of Technology's Chiropractic Day Clinic **for those participants currently experiencing pain**, consisting of: a) One free Initial visit-case history, physical and regional in which time you will complete the questionnaire. b) One free treatment for the injury diagnosed in the initial visit. Should you require further treatments these will be charged at relevant year Chiropractic rates.

Participants

Presently there are 80 active tri-athletes registered with KZNTA. This research will include all of those tri-athletes, over the age of 18 years old, who are active members of the KZNTA. (Total Population n = 80.)

Benefits

Should you be suffering from any injuries during the course of your participation in this research, you are offered 1 optional free Chiropractic treatment at the Chiropractic Day Clinic at the Durban University of Technology. Also, the results of this research can be distributed to other Triathlon Associations to allow for improved recommendations regarding training, strength and conditioning. This research will also assist in the general improvement of the state of triathletic performance in the province.

AS A VOLUNTARY PARTICIPANT IN THIS RESEARCH STUDY, YOU ARE FREE TO WITHDRAW FROM THE STUDY AT ANY TIME, WITHOUT GIVING A REASON.

Risks/ Discomforts and Costs

There are no risks, discomforts or costs involved with your participation in this study. Patients may feel slight stiffness related to treatment.

New findings: You will be made aware of any new findings during the course of this study.

Remuneration: You will not receive a travel allowance in order to attend your appointment at the Chiropractic Day Clinic.

Confidentiality: All the information is confidential and the results will be used for research purposes only. Participation is voluntary and failure to participate will not result in any adverse consequences.

Persons to contact should you have any problems or questions: Should you have any questions that you would prefer being answered by an independent individual, feel free to contact my supervisors on the above numbers. If you are not satisfied with a particular area of this study feel free to forward any concerns to the Durban University of Technology Research and Ethics Committee (031 3732900).

Please circle yes or no (as is appropriate for yourself):

1. Have you had time to ask questions about the study? Yes / No
2. Have you received satisfactory answers to your questions? Yes / No
3. Have you had an opportunity to discuss this study? Yes / No
4. Have you received enough information about this study? Yes / No
5. Who have you spoken to regarding this study? __________________
6. Do you understand the implications of your involvement in this study? Yes / No
7. Do you understand that you are free to drop out of this study at any time? Yes / No
8. Do you agree to voluntarily participate in this study? Yes / No

If you have answered NO to any of the above, please obtain the necessary information from the researcher and / or supervisor before signing. Thank You.

<u>Please print in block letters</u>

Participant_______________________________Signature_________________Date_________________

Witness _______________________________ Signature_________________Date_________________

Researcher_______________________________ Signature_________________Date_________________

Supervisor _______________________________ Signature_________________Date_________________

Appendix Q: Questionnaire (research procedure)

An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes.						
Please mark an X indicating your choice where applicable. Some questions are open-ended and will entail a more detailed answer						
<u>Section A - Personal Details</u>				**<u>CODE</u>** (for researcher use only):		
1	Date of Birth (YY/MM/DD)		2	Gender	Male	Female
3	Ethnicity	African	Coloured	Indian	White	Other
4	Height	M	5	Body mass	Kg	
6	How many triathlon competitions (number) have you participated in the previous 12 months?					
7	How many triathlon competitions have you participated in the previous 4 months?					
8	What is the average length (in kilometres) of a competition?		Swimming m	Cycling km	Running km	
9	What is the average length (in time) of a competition?		Swimming Time: min	Cycling Time: min	Running Time: min	

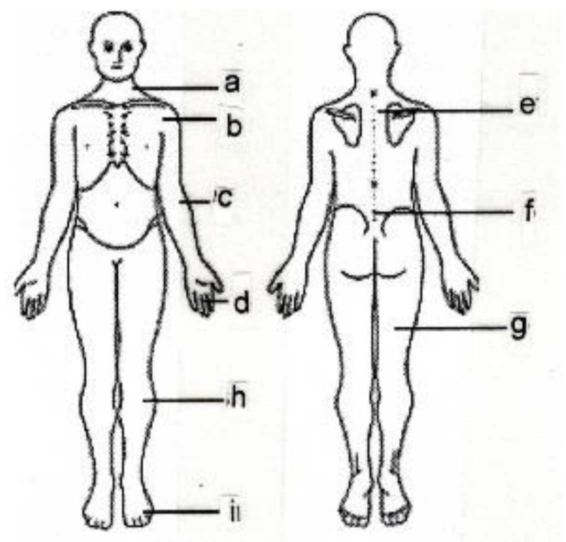
<u>Section B - Training Schedule</u>						
1.	How many years (number) have you been participating in triathlon?					
2	What is the length of your training regiment?	Pre-season wks	In-season (competition phase) wks	Off-season wks		
3	What, if any, cross-training activities do you participate in?	Core Strengthening	CrossFit	Functional Training (includes bootcamp and kettlebells)	Gym	
		None	Other Sports (please specify)			
4	How often do you cross-train in the:	*Phases of training*	*Sessions per week*	*Duration (minutes) per session*		
		Pre-season				
		In-season				
		Off-season				
5	What type of running training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes) per session*	
		Long Slow Distance				
		Fartlek Training				
		Tempo Training				
		Interval Training				
		Sprint Training				
		Other, please Specify 1 2				
6	What type of cycle training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes) per session*	
		Endurance				
		Sprint				
		Spinning Classes				
		Other, Please Specify 1 2				
7	What type of swim training do you perform?	*Type of training*	*Sessions per week*	*Distance (m)*	*Duration (minutes) per session*	
		Endurance				
		Sprint				
		Open-water				
		Other, Please Specify 1 2				
8	Have you had a professional bicycle setup?		Yes	No		
9	What coaching do you receive?	Swim	Cycling	Running	None	
10	What is your preferred swimming stroke:	Freestyle	Butterfly	Backstroke	Breaststroke	
11	How many rest days do you have per week?					
12	How many active rest days do you have per week?					
13	How many days per week do you perform double sessions?					

Section C – Pain appraisal

The definition of musculoskeletal pain is a sensation of agony that inhibited you from participating in triathlon or practice for a minimum of 24 hours (adapted from van Heerden, 1996). Please report on triathlon related musculoskeletal pain and **not musculoskeletal pain contracted from other activities**.

1	**Is your current pain related to triathlon?**	**Yes**	**No**

In terms of your current pain (LEFT HAND SIDE)				In terms of your pain within the last 12 months (RIGHT HAND SIDE) Please select injury which **most effected your participation**			
2	Are you currently experiencing any musculoskeletal pain?	Yes	No	19	Have you experienced any musculoskeletal pain within the last 12 months?	Yes	No
3	Identify the anatomical sites which experience musculoskeletal pain **currently** :			**20**	Identify the anatomical sites which experienced musculoskeletal pain within the **last 12 months**:		



Current		Last 12 months	
A	B	A	B
C	D	C	D
E	F	E	F
G	H	G	H
I		I	

In terms of your current pain ONLY answer 4-18							**In terms of your pain within the last 12 months ONLY answer 21-35**						
4	What activity precipitates the **onset** of pain?	Swim only	Run only	Cycle only	Swim and Run	Swim and Cycle	21	What activity precipitated the **onset** of pain?	Swim only	Run only	Cycle only	Swim and Run	Swim and Cycle
		Run and Cycle	All three	None	Other (specify)				Run and Cycle	All three	None	Other (specify)	
5	What activity precipitates the **most** of pain?	Swim only	Run only	Cycle only	Swim and Run	Swim and Cycle	22	What activity precipitated the **most** of pain?	Swim only	Run only	Cycle only	Swim and Run	Swim and Cycle
		Run and Cycle	All three	None	Other (specify)				Run and Cycle	All three	None	Other (specify)	

6	Did the pain prevent you from participating in competition?	Yes	No	23	Did the pain prevent you from participating in competition?	Yes	No
7	Did the pain prevent you from participating in training?	Yes	No	24	Did the pain prevent you from participating in training?	Yes	No
8	How long did it prevent you from training?			25	How long did it prevent you from training?		
9	How long did it prevent you from competing?			26	How long did it prevent you from competing?		

10	What type of pain have you experienced?	Dull	Sharp Shooting	Aching	27	What type of pain have you experienced?	Dull	Sharp Shooting	Aching
		Radiating	Pins and Needles				Radiating	Pins and Needles	
11	How long does the pain last / persist?	Years	Months	Days	28	How long does the pain last / persist?	Years	Months	Days
		Hours	Minutes	Seconds			Hours	Minutes	Seconds

12	How would you rate the severity of the pain from 0 – 10 (0 no pain and 10 is worst pain)						29	How would you rate the severity of the pain from 0 – 10 (0 no pain and 10 is worst pain)					
	0	1	2	3	4	5		0	1	2	3	4	5
		6	7	8	9	10			6	7	8	9	10

<table>
<tr><th colspan="5">In terms of your current pain (continued)</th><th colspan="5">In terms of your pain within the last 12 months (continued)</th></tr>
<tr><td rowspan="2">13</td><td colspan="4">When did this musculoskeletal pain occur?</td><td rowspan="2">30</td><td colspan="4">When did this musculoskeletal pain occur?</td></tr>
<tr><td>Pre-season</td><td>In-season</td><td>Off-season</td><td>Not related to sport</td><td>Pre-season</td><td>In-season</td><td>Off-season</td><td>Not related to sport</td></tr>
<tr><td rowspan="3">14</td><td colspan="4">How did you sustain the injury that caused the pain?</td><td rowspan="3">31</td><td colspan="4">How did you sustain the injury that caused the pain?</td></tr>
<tr><td>Traumatic incident during a triathlon race</td><td colspan="2">Traumatic incident during triathlon training</td><td>Over-training</td><td>Traumatic incident during a triathlon race</td><td colspan="2">Traumatic incident during triathlon training</td><td>Over-training</td></tr>
<tr><td>Incident during Cross-training (Cross-training includes Crossfit, Functional Training, Boot Camp, Gym, other sports etc)</td><td colspan="2">If not stated here, please specify</td><td>Unknown</td><td>Incident during Cross-training (Cross-training includes Crossfit, Functional Training, Boot Camp, Gym, other sports etc)</td><td colspan="2">If not stated here, please specify</td><td>Unknown</td></tr>
<tr><td rowspan="4">15</td><td colspan="4">When you sustained the pain which medical practitioner did you seek treatment from?</td><td rowspan="4">33</td><td colspan="4">When you sustained the pain which medical practitioner did you seek treatment from?</td></tr>
<tr><td>Biokineticist</td><td>Chiropractor</td><td>General Practitioner</td><td>Orthopaedic Surgeon</td><td>Biokineticist</td><td>Chiropractor</td><td>General Practitioner</td><td>Orthopaedic Surgeon</td></tr>
<tr><td>Pharmacist</td><td colspan="2">Physiotherapist</td><td>None</td><td>Pharmacist</td><td colspan="2">Physiotherapist</td><td>None</td></tr>
<tr><td colspan="2">Other (Please Specify)</td><td colspan="2"></td><td colspan="2">Other (Please Specify)</td><td colspan="2"></td></tr>
<tr><td>16</td><td colspan="2">What (if anything) did the above practitioner diagnose?</td><td colspan="2"></td><td>34</td><td colspan="2">What (if anything) did the above practitioner diagnose?</td><td colspan="2"></td></tr>
<tr><td>17</td><td colspan="2">Were you happy with the treatment you received?</td><td>Yes</td><td>No</td><td>35</td><td colspan="2">Were you happy with the treatment you received?</td><td>yes</td><td>No</td></tr>
<tr><td>18</td><td colspan="2">What is your reason for the above?</td><td colspan="2"></td><td>36</td><td colspan="2">What is your reason for the above?</td><td colspan="2"></td></tr>
<tr><td colspan="10">THANK YOU FOR TIME AND EFFORT IN COMPLETING THIS QUESTIONNAIRE!!!</td></tr>
</table>

Appendix R: Researcher's assessment data sheet

Assessment Data Sheet (For researcher)

1	**PATIENT CARE:**	New condition		Continuation of care
	PREVIOUS INJURY?	Any orthopaedic surgery?	YES	NO
		Previous muscle injury?	YES	NO
		Any fractures?	YES	NO
		Connective tissue injuries (tendons/ligaments)	YES	NO
		Past sporting history?	RUNNER	SWIMMER
			TRI-ATHLETE	RACQUET SPORTS
			RUGBY	SOCCER
			PADDLING	
			OTHER (please specify____________________)	
2	**LOCATION OF INJURY RELATED TO TRIATHLON:**			
	HEAD / CONCUSSION			
	NECK	L / R	Upper / Middle / Lower	
	SHOULDER	L / R	ELBOW	L / R
	FOREARM	L / R	WRIST	L / R
	HAND	L / R	THUMB	L / R
	FINGERS	L / R	THORACIC	L / R
	RIBS	L / R	LOW BACK	L / R
	BUTTOCKS	L / R		
3	**MECHANISMS OF INJURY:**			
	COMPETITION		TRAINING	
	DURING SWIM	IMMEDIATELY AFTER SWIM	10 MINUTES AFTER SWIM	
		1 HOUR AFTER SWIM	NEXT DAY	
	DURING CYCLE	IMMEDIATELY AFTER SWIM	10 MINUTES AFTER SWIM	
		1 HOUR AFTER SWIM	NEXT DAY	
	DURING RUN	IMMEDIATELY AFTER SWIM	10 MINUTES AFTER SWIM	
		1 HOUR AFTER SWIM	NEXT DAY	
	FALLS		Other	
4	**CLINICAL PRESENTATION**:			
	ACUTE		CHRONIC	
	CONTUSION	LACERATION	BLISTER	HEAT STROKE
	EXHAUSTION	SPRAIN	STRAIN	DISLOCATION
	C / FACET	T/FACET	L / FACET	SI SYNDROME
	PFPS	TENDONITIS	CIRCULATORY	JOINT DYSFUNCTION
	NEUROLOGICAL	MYOFASCIAL: specify		
5	**LOCATION**			
	Neck	Upper extremity	Lower extremity	Upper back
	Middle back	Lower back		
	FRACTURE specify:			
	OTHER, Specify:			

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:____ Date: __________

File #: ____________ Age: __________

Sex : __________ Occupation: ____________________________

Intern: ____________________________ Signature ______________________

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature:

Case History:

Examination:

Previous:

Current:

X-Ray Studies:

Previous:

Current:

Clinical Path. lab:

Previous:

Current:

CASE STATUS:

PTT: Signature: Date:

CONDITIONAL:

Reason for Conditional:

Signature: Date:

Conditions met in Visit No: Signed into PTT: Date:

Case Summary signed off: Date:

Intern's Case History:

1. Source of History:

2. Chief Complaint: (patient's own words):

3. Present illness:

	Complaint 1	**Complaint 2**
< Location		
< Onset : Initial:		
Recent:		
Cause:		
< Duration		
< Frequency		
< Pain (Character)		
< Progression		
< Aggravating Factors		
< Relieving Factors		
< Associated S & S		
< Previous Occurrences		
< Past Treatment		
a) Outcome:		

4. Other Complaints:

5. Past Medical History:

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalizations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. x-rays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:
< Tobacco

< Alcohol

< Social Drugs

7. Immediate Family Medical History:

< Age
< Health
< Cause of Death
< DM
< Heart Disease
< TB
< Stroke
< Kidney Disease
< CA
< Arthritis
< Anaemia
< Headaches
< Thyroid Disease
< Epilepsy
< Mental Illness
< Alcoholism
< Drug Addiction
< Other

8. Psychosocial history:

< Home Situation and daily life
< Important experiences
< Religious Beliefs

9. Review of Systems:

< General

< Skin

< Head

< Eyes

< Ears

< Nose/Sinuses

< Mouth/Throat

< Neck

< Breasts

< Respiratory

< Cardiac

< Gastro-intestinal

< Urinary

< Genital

< Vascular

< Musculoskeletal

< Neurologic

< Haematologic

< Endocrine

< Psychiatric

Appendix T: DUT senior/ research physical examination

DURBAN UNIVERSITY of TECHNOLOGY

Durban University of Technology
PHYSICAL EXAMINATION: SENIOR

DURBAN UNIVERSITY of TECHNOLOGY

Patient Name : **File no :** **Date :**
Student : **Signature :**

VITALS:						
Pulse rate:				Respiratory rate:		
Blood pressure:	R	L		Medication if hypertensive:		
Temperature:				Height:		
Weight:	Any recent change? Y / N			If Yes: How much gain/loss		Over what period

GENERAL EXAMINATION:		
General Impression		
Skin		
Jaundice		
Pallor		
Clubbing		
Cyanosis (Central/Peripheral)		
Oedema		
Lymph nodes	Head and neck	
	Axillary	
	Epitrochlear	
	Inguinal	
Pulses		
Urinalysis		

SYSTEM SPECIFIC EXAMINATION:
CARDIOVASCULAR EXAMINATION
RESPIRATORY EXAMINATION
ABDOMINAL EXAMINATION
NEUROLOGICAL EXAMINATION
COMMENTS

Clinician: **Signature :**

Appendix U: DUT cervical spine regional examination

CHIROPRACTIC PROGRAMME

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

DUT DURBAN UNIVERSITY OF TECHNOLOGY

1 REGIONAL EXAMINATION – CERVICAL SPINE

Patient: .... File

Date: .... Student: ....

Clinician: .... Sign: ....

OBSERVATION:

Posture

Swellings

Scars, discolouration

Hair line

Body and soft tissue contours

Shoulder position

Left:

Right:

Shoulder dominance (hand):

Facial expression:

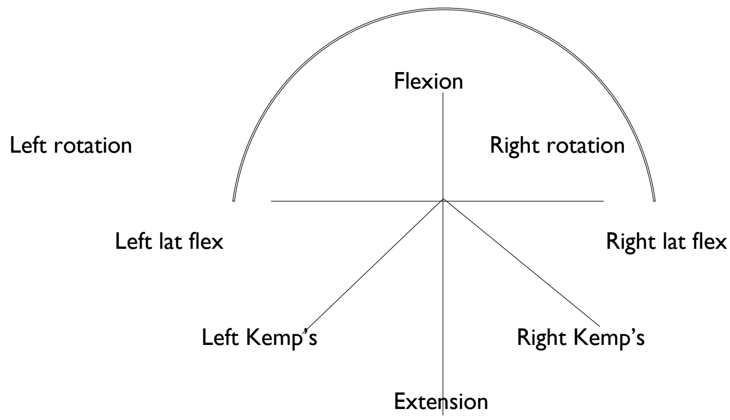
RANGE OF MOTION:

Extension (70°):

L/R Rotation (70°):

L/R Lat flex (45°):

Flexion (45°):



PALPATION:

Lymph nodes

Thyroid Gland

Trachea

MYOFASCIAL ASSESSMENT

Tenderness		Right	Left
Trigger Points:	SCM		
	Scalenii		
	Post Cervicals		
	Trapezius		
	Lev scapular		

ORTHOPAEDIC EXAMINATION:

	Right	Left		Right	Left
Adson's test			Halstead's test		
Brachial plexus test			Hyper-abduction test		
Cervical compression			Kemp's test		
Cervical distraction			Lateral compression		
Costoclavicular test			Lhermitte's sign		
Dizziness rotation test			Shoulder abduction test		
Doorbell sign			Shoulder compression test		
Eden's test					

NEUROLOGICAL EXAMINATION:

Dermatones	**Left**	**Right**	**Myotomes**	**Left**	**Right**	**Reflexes**	**Left**	**Right**
C2			C1			C5		
C3			C2			C6		
C4			C3			C7		
C5			C4					
C6			C5					
C7			C6					
C8			C7					
T1			C8					
			T1					

Cerebellar tests:	Left	Right
Dysdiadochokinesis		

VASCULAR:	**Left**	**Right**		**Left**	**Right**
Blood pressure			Subclavian arts.		
Carotid arts.			Wallenberg's test		

MOTION PALPATION & JOINT PLAY:

Left: Motion Palpation:
Joint Play:

Right: Motion Palpation:
Joint Play:

BASIC EXAM: SHOULDER:

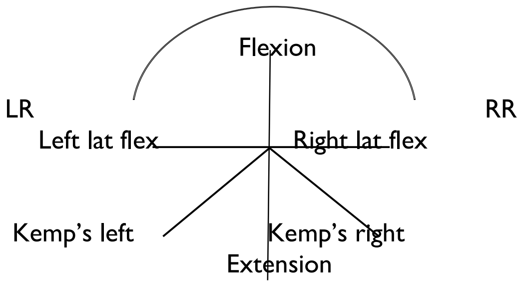
Case History:

ROM: Active:
Passive:
RIM:
Orthopaedic:
Neuro:
Vascular:

BASIC EXAM: THORACIC SPINE:

Case History:

ROM:



Motion Palpation:	
Orthopaedic:	
Neuro:	
Vascular:	
Observ/Palpation:	
Joint Play:	

Appendix V: DUT thoracic spine regional examination

DUT DURBAN UNIVERSITY OF TECHNOLOGY | FACULTY OF HEALTH SCIENCES | CHIROPRACTIC DEPARTMENT

THORACIC SPINE REGIONAL EXAMINATION

Patient:____File:__________ Date:_______________

Student:__________________________________Signature:__________________________

Clinician: _______________________________________Signature:__________________________

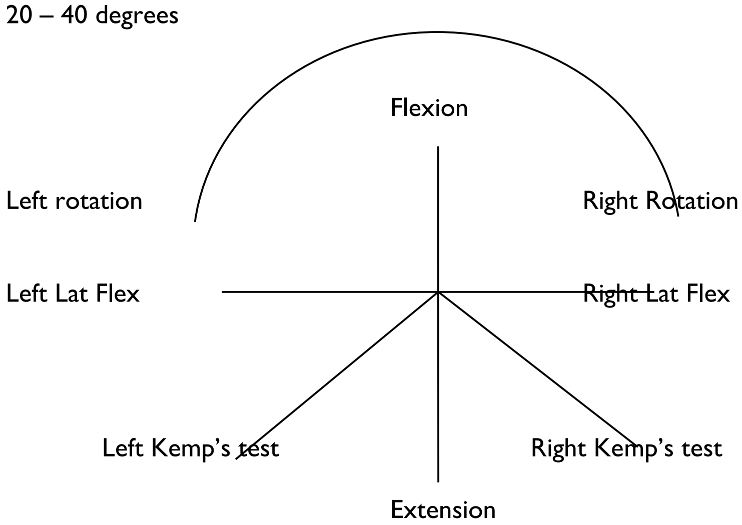
STANDING:

Posture (incl. L/S & C/S)
Muscle tone
Skyline view – Scoliosis
Spinous Percussion
Breathing (quality, rate, rhythm, effort)
Deep Inspiration

Scars
Chest deformity
(pigeon, funnel, barrel)

RANGE OF MOTION:

Forward Flexion	20 – 45 degrees (15cm from floor)
Extention	25 – 45 degrees
L/R Rotation	35 – 50 degrees
L/R Lat Flex	20 – 40 degrees



RESISTED ISOMETRIC MOVEMENTS: (in neutral)

Forward Flexion
Extension
L/R Rotation
L/R Lateral Flexion

SEATED:

Palpate Auxillary Lymph Nodes
Palpate Ant/Post Chest Wall
Costo vertebral Expansion (3 – 7cm diff. at 4th intercostal space)
Slump Test (Dural Stretch Test): LOCAL PAIN (T/S) DISTAL PAIN (L/S) DISTAL PAIN (LEG)

SUPINE:

Rib Motion (Costo Chondral joints)
SLR
Soto Hall Test (#, Sprains)
Palpate abdomen

PRONE:

Passive Scapular Approximation
Facet Joint Challenge

Vertebral Pressure (P-A central unilateral, transverse)
Active myofascial trigger points:

	Latent	Active	Radiation Pattern		Latent	Active	Radiation Pattern
Rhomboid Major				Rhomboid Minor			
Lower Trapezius				Spinalis Thoracic			
Serratus Posterior				Serratus Superior			
Pectoralis Major				Pectoralis Minor			
Quadratus Lumborum							

COMMENTS:____

NEUROLOGICAL EXAMINATION:

DERMATOMES												
	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T 10	T 11	T 12
Left												
Right												

Basic LOWER LIMB neuro:

Myotomes	T11	T12	L1	L2	L3	L4	L5	S1	S2	S3
Dermatomes	T11	T12	L1	L2	L3	L4	L5	S1	S2	S3
Reflexes	Patella – Left					Achilles – Left				
	Patella - Right					Achilles – Right				

MOTION PALPATION:

			Right	Left
Thoracic Spine				
Ribs	Calliper (Costo-transverse joints)			
	Bucket Handle	Opening		
		Closing		
Lumbar Spine				
Cervical Spine				

BASIC EXAM	History	ROM	Neuro/Ortho
LUMBAR			
CERVICAL			

Appendix W: DUT lumbar spine regional examination

DUT DURBAN UNIVERSITY OF TECHNOLOGY — DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

REGIONAL EXAMINATION
LUMBAR SPINE AND PELVIS

Patient: ______________________________ File#: ______________ Date: __________

Student: ______________________________ Clinician: __________________

• STANDING:

Posture– scoliosis, antalgia, kyphosis
Body Type
Skin
Scars
Discolouration

Minor's Sign
Muscle tone
Spinous Percussion
Schober's Test (6cm)
Bony and Soft Tissue Contours

• GAIT:

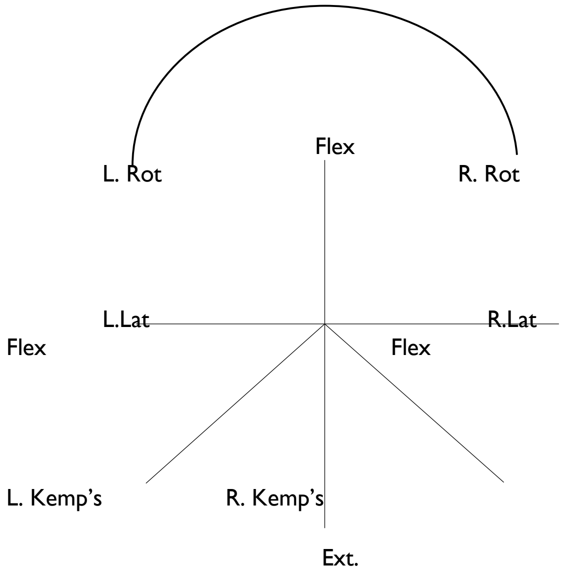
Normal walking
Toe walking
Heel Walking
Half squat

• ROM:

- **Forward Flexion = 40-60° (15 cm from floor)**

Extension = 20-35°
L/R Rotation = 3-18°
L/R Lateral Flexion = 15-20°

- **Which movement reproduces the pain or is the worst?**
- Location of pain
- Supported Adams: Relief? (SI)
- Aggravates? (disc, muscle strain)



SUPINE:

Observe abdomen (hair, skin, nails)
Palpate abdomen\groin
Pulses - abdominal
- lower extremity
Abdominal reflexes

		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
SLR	**L**										
	R										

	L	**R**
Bowstring		
Sciatic notch		
Circumference (thigh and calf)		
Leg length: actual -		
apparent -		
Patrick FABERE: pos\neg – location of pain?		
Gaenslen's Test		
Gluteus max stretch		
Piriformis test (hypertonicity?)		
Thomas test: hip \ psoas \ rectus femoris ?		
Psoas Test		

- SITTING:

Spinous Percussion Valsalva
Lhermitte

		Degree	LBP?	Location	Leg pain	Buttock	Thigh	Calf	Heel	Foot	Braggard
TRIPOD SI, +, ++	•										
	•										
	•										
SLUMP 7 TEST	•										
	•										

LATERAL RECUMBENT: • **L** • **R**

• **Ober's**	•	•
• **Femoral n. stretch**	•	•
SI Compression	•	•

PRONE: • **L** **R**

Gluteal skyline		
Skin rolling		
Iliac crest compression		
Facet joint challenge		
SI tenderness		
SI compression		
Erichson's		
Pheasant's		

• **MF tp's**	**Latent**	**Active**	**Radiation**
QL			
Paraspinal			
Glut Max			
Glut Med			
Glut Min			
Piriformis			
Hamstring			
TFL			
Iliopsoas			
Rectus Abdominis			
Ext/Int Oblique muscles			

- NON ORGANIC SIGNS:

Pin point pain Axial compression Trunk rotation Burn's Bench test Flip Test Hoover's test
Ankle dorsiflexion test Repeat Pin point test

NEUROLOGICAL EXAMINATION

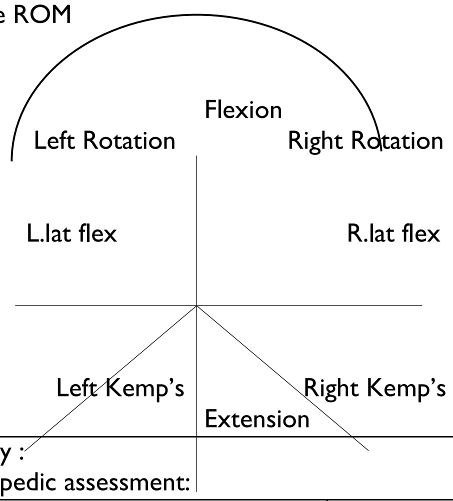
Fasciculations						
Plantar reflex						
level	**Tender?**	**Dermatomes**		**DTR**		
		L	**R**		**L**	**R**
T12				Patellar		
L1				Achilles		
L2						
L3				Proprioception		
L4						
L5						
S1						
S2						
S3						

- **MYOTOMES**

Action	Muscles	Levels	L	R	
Lateral Flexion spine	Muscle QL				
Hip flexion	Psoas, Rectus femoris				5+ Full strength
Hip extension	Hamstring, glutes				4+ Weakness
Hip internal rotation	Glutmed, min, TFL, adductors				3+ Weak against grav
Hip external rotation	Gluteus max, Piriformis				2+ Weak w\o gravity
Hip abduction	TFL, Glut med and minimus				1+ Fascic w\o gross movt
Hip adduction	Adductors				0 No movement
Knee flexion	Hamstring,				
Knee extension	Quad				W - wasting
Ankle plantarflexion	Gastrocnemius, soleus				
Ankle dorsiflexion	Tibialis anterior				
Inversion	Tibialis anterior				
Eversion	Peroneus longus				
Great toe extensor	EHL				

- BASIC THORACIC EXAM

Passive ROM



History :

Orthopedic assessment:

- BASIC HIP EXAM

History

ROM: Active

Passive: Medial rotation:

A) Supine (neutral) If reduced
- hard \ soft end feel

B) Supine (hip flexed):
- Trochanteric bursa

MOTION PALPATION AND JOINT PL	L	R
Thoracic Spine		
Lumbar Spine		
Sacroiliac Joint		

Appendix X: **DUT temporomandibular joint regional examination**

CHIROPRACTIC PROGRAMME

DUT DURBAN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

TMJ REGIONAL EXAMINATION

Patient:	File no:	Date:
Student:	Signature:	
Clinician:	Signature:	

OBSERVATION			
Posture of C-spine and head (bipupital, otic and occlusive lines parallel)			
Facial symmetry		Paralysis	
Malocclusion (cross bite or overbite)			
Deviation of mandible on opening or closing mouth			
Normal bulging of masseters when patient bites down			
Normal movement of tongue			

PALPATION		RIGHT	LEFT
Cervical spine	Facet joints		
	Muscles		
	Lymph Nodes		
Mandibular condyles: Tenderness			
Mandible			
Hyoid bone (normal movement on swallowing)			
Mastoid processes			
Movement (palpate with fingers in EAM)	Smooth		
	Symmetrical		
	Pain / tenderness		
Masseters			
Temporalis			
Thyroid cartilage and gland			
Parotid gland			
Teeth and gums			

ACTIVE MOVEMENTS				
Cervical spine:	Flexion		Extension	
	Lateral flexion (L)		Rotation (L)	
	Lateral flexion (R)		Rotation (R)	

Opening the mouth: Deviation?	
Functional opening (2-3 flexed PIP joints)	
Closing the mouth: Deviation?	
Resting position / Freeway Space (2-4mm)	
Protrusion of mandible:	
Retraction of mandible:	
Lateral deviation of mandible:	
RESISTED ISOMETRIC MOVEMENTS (PERFORM WITH TMJ IN RESTING POSITION)	
Opening (depression)	
Closing (elevation, occlusion)	
Lateral deviation	
Joint Play Movements	
Inferior distraction (tissue stretch)	
SPECIAL TESTS	
Chovstek Test (facial nerve pathology)	
Auscultation of TMJ's	
REFLEX	
Jaw reflex (CN 5)	

Appendix Y: DUT shoulder regional examination

CHIROPRACTIC PROGRAMME

DUT DURBAN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

1. SHOULDER REGIONAL EXAMINATION

Patient: ____________________________________ File No: ____________ Date: ____________

Student: ____________________________________ Signature: ____________________________

Clinician: ____________________________________ Signature: ____________________________

Observation

Posture		S-C Joints	
Skin		Clavicles	
Swelling		A-C Joints	
Shoulder levels		Scapulae	
Comments			

2. Palpation

S-C Joint:		SCM:		Scalenes:	
Sternum:		Ribs and costal cartridge:			
Clavicle:		Coracoid process:			
A-C Joint:		Acromion:			
Greater Tuberosity:					
Lesser Tuberosity:					
Intertubercular (bicipital groove):					
Trapezius:		Deltoid:			
Biceps:		Triceps:			
Supraspinatus insertion:					
Musculotendinous portion of supraspinatus:					
Axilla:	Lymph nodes:				
	Brachial artery:				
	Serratus anterior (medial wall):				
	Pectoralis major (anterior wall):				

	Lattisimus dorsi (posterior wall):			
Scapula	Borders:		Spine:	
	Supraspinous fossa:			
	Infraspinous fossa:			
Cervico-thoracic spine:				

Active Movements (note ROM and pain)

Elevation through abduction (170-180°):			
Painful arc with abduction:			
Elevation through forward flexion (160-180°):			
Elevation through scapula plane (170-180°):			
Lateral rotation (80-90°):		Medial rotation (60-100°):	
Extension (50-60°):		Adduction (50-75°):	
Horizontal adduction/abduction (130°):			
Circumduction (200°):			
Apley's Scratch:			

Passive movements (note end-feel, ROM and pain)

Elevation through abduction (bone to bone or tissue stretch)

Elevation through forward flexion (tissue stretch)

Lateral rotation (tissue stretch)

Medial rotation (tissue stretch)

Extension (tissue stretch)

Adduction (tissue approximation)

Horizontal adduction (tissue stretch or approximation)

Horizontal abduction (tissue stretch)

Quadrant Test

Resisted Isometric Movements (note strength and pain)

Flexion		Medial rotation	
Extension		Lateral Rotation	
Adduction		Elbow flexion	
Abduction		Elbow extension	

Joint Play Movements (and motion palpation)

SC Joint	Supero-inferior (shrug shoulder with arm at side):	
	Horizontal add/abduction (arm abducted 90°):	
AC Joint	A-P Shear:	
	Supero-inferior shear:	
Scapula	Normal scapulo-humeral rhythm?:	
	General mobility of scapula:	

3. Glenohumeral Joint

Lateral movement of humeral head		
Inferior movement of humeral head (Caudal glide)(50°)		
Anterior movement of humeral head (P-A glide) (25°)		
Posterior shear of humeral head (A-P glide) **>50%**	At 10° flexion	
	At 90° flexion	
Backward glide of humeral head in abduction		
Long-axis distraction of humeral head in abduction		
Downward and backward (S-I and A-P)		
Outward and backward (med-lat and A-P		
External rotation of humeral head		
Internal rotation of humeral head		

4. <u>Instability Tests</u>

1. Anterior Instability Tests	**R**			**L**		
	Pos	Neg	n/a	Pos	Neg	n/a
Anterior drawer Test						
Rowe Test						
Fulcrum Test						
Apprehension (crank) Test						
Clunk Test (tear of labrum)						
Rockwood Test						
2. Posterior Instability Tests						
	Pos	Neg	n/a	Pos	Neg	n/a
Posterior Apprehension Test						
Norwood Stress Test						
Push-pull Test						
Jerk Test						
3. Inferior and Multi-directional instability tests						
	Pos	Neg	n/a	Pos	Neg	n/a
Inferior Shoulder Instability Test						
Feagin Test (antero-inferior instability)						

<u>A-C Joint Stress Test:</u>____

<u>S-C Joint Stress Test:</u>____

Tests for Muscle or Tendon Pathology

5.	Gilchrest Sign (bicipital tendonitis)	
6.	Speed's Test (bicipital tendonitis)	
7.	Hawkins-Kennedy Impingement Test (supraspinatus tendonitis)	
8.	Supraspinatus Test (supraspinatus tendonitis)	
9.	Drop –arm Test (rotator cuff tear)	
10.	Impingement Test	

11.	Ludington's Test (rupture of long head of biceps)	
12.	Pectoralis Major Contracture Test	

Tests for neurological function

Brachial Plexus Tension Test	Radial Nerve	
	Median Nerve	
Tinel's Sign (Scalene triangle)		

Dermatones	C4		C5		C6		C7		C8		T1		T2	

Reflexes	Biceps(C5/6)		Triceps (C7/8)	

Thoracic Outlet Syndrome Tests

Adson's Test		Halstead's Test	
Costoclavicular Test		Eden's Test (cervical rib)	
Hyperabduction Test		Roos Test	
Allen's Test			

Appendix Z: DUT elbow regional examination

CHIROPRACTIC PROGRAMME

ELBOW REGIONAL EXAMINATION

Patient______________________File no:___________Date:____________

Student:____________________________Sign:______________________

Clinician:___________________________Sign:______________________

OBSERVATION

Posture and willingness to move______________________________
Carrying angle (anatomical position)___________________________
Swelling____
Bony and soft tissue contours_________________________________
Position of function (triangle sign)____________________________
Colour and texture of skin _________________________________

PALPATION

Anterior aspect		***Medial aspect***	
Cubital fossa		Medial epicondyle	
Biceps tendon		Medial collateral ligament	
Bicep & brachialis muscle		Ulnar nerve	
Coronoid process & radial head			
Brachial artery			
Lateral aspect		***Posterior aspect***	
Lateral epicondyle		Olecranon process and olecranon bursa	
Lateral collateral ligament		Triceps muscle	
Radial head & Annular ligament			
Supracondylar ridge (ECRL)			

ACTIVE MOVEMENTS		**PASSIVE MOVEMENTS**	
Flexion (140-150°)		Flexion (tissue approximation)	
Extension (0-10°)		Extension (bone to bone)	
Supination (90°)		Supination (tissue stretch)	
Pronation (80-90°)		Pronation (tissue stretch)	

RESISTED ISOMETRIC MOVEMENTS (elbow at 90° flexion and supinated**)**	**R**	**L**
Flexion		
Extension		
Supination		
Pronation		
Wrist flexion		
Wrist extension		
Upward glide of radial head on ulna		
Downward glide of radial head on ulna		
Rotation of radial head		
Medial to lateral side tilt		
Lateral to medial side tilt		
Distraction of olecranon process on the humerus (90º) flexion		

JOINT PLAY MOVEMENTS	R	L
Upward glide (I-S) of radial head of ulna		
Downward glide (S-I) of radial head of ulna		
Rotation of radial head of ulna		
Medial to lateral side tilt		
Lateral to medial side tilt		
Distraction of olecranon process on the humeral head (90°)		

FUNCTIONAL ASSESSMENT

____

SPECIAL TESTS	L	R
Ligamentous instability test (valgus / varus)		
Cozen's test		
Mill's test		
Lateral epicondyle test		
Medial epicondyle test		
Tinel's sign		
Wartenberg's sign		
Elbow flexion test		
Pronator teres syndrome		
Pinch grip test		

NEUROLOGICAL

Reflexes and cutaneous distribution					R	L
1. Reflexes	a. Biceps = C5-6					
	b. Triceps = C7-8					
	c. Brachioradialis = C5-6					
		R	L		R	L
2. Dermatomes	C4			C5		
	C6			C7		
	C8					
	T1			T2		

2. MYOFASCIAL DYSFUNCTION SYNDROMES

	3. Active	4. Latent	5. Not Present
Brachialis	6.	7.	8.
Brachioradialis	9.	10.	11.
Extensor carpi radialis brevis	12.	13.	14.
Extensor carpi radialis longus	15.	16.	17.
Supinator	18.	19.	20.
Extensor carpi ulnaris	21.	22.	23.
Flexor carpi radialis	24.	25.	26.
Flexor carpi ulnaris	27.	28.	29.
Flexor digitorum superficialis	30.	31.	32.
Flexor digitorum profundus	33.	34.	35.
Coracobrachialis	36.	37.	38.
Biceps	39.	40.	41.
Triceps	42.	43.	44.

Appendix AA: DUT hand and wrist regional examination

CHIROPRACTIC PROGRAMME

1. Hand and Wrist Regional Examination

Patient:______________________________ File no:__________ Date:

Student:______________________________ Signature:

Clinician:______________________________ Signature:

Observation:

		Right	Left
2.	Bony and soft tissue contours		
3.	Hand posture		
4.	Vasomotor changes		
5.	Scars, skin creases, and muscle wasting		
6.	Fingernails		
7.	Dominant hand		

Palpation:

Posterior surface			Right	Left
1.	Anatomical snuff box			
2.	Carpal bones			
3.	Metacarpal bones			
4.	Phalanges			
5.	Pulses and capillary refill			
6.	Radial styloid			
7.	Radial (Lister's) tubercle			
8.	Ulnar styloid			
9.	6 extensor tendon tunnels		Right	Left
	i.	Abductor pollicus longus		
		Extensor pollicus brevis		
	ii.	Extensor carpi radialis brevis		
		Extensor carpi radialis longus		
	iii.	Extensor pollicus longus		
	iv.	Extensor digitorum		
		Extensor indicus		
	v.	Extensor digiti minimi		
	vi.	Extensor carpi ulnaris		

Anterior surface			Right	Left
1.	Tendons (Lat to med)			
	a.	Flexor carpi radialis		
	b.	Flexor pollicus longus		
	c.	Flexor digitorum superficialis		
	d.	Flexor digitorum profundus		
	e.	Palmaris longus		
	f.	Flexor carpi ulnaris		
2.	Palmar fascia and intrinsic muscles			

8. Active movements / Passive movements

		Right	Left		Right	Left
1.	Pronation (85-90°)			Tissue stretch		
2.	Supination (85-90°)			Tissue stretch		
3.	Ulnar deviation (15°)			Bone		
4.	Radial deviation (30-45°)			Bone		
5.	Wrist flexion (80-90°)			Tissue stretch		
6.	Wrist extension (70-90°)			Tissue stretch		
7.	Finger movements					
8.	Thumb movements					

9. Resisted isometric movements

			Right	Left
1.	Extension			
2.	Flexion			
3.	Radial deviation			
4.	Ulnar deviation			
5.	Finger	Opposition		
		Adduction		
		Abduction		

10. Functional movements

		Right	Left		Right	Left
1.	Fist grip			Pinch		
2.	Cylinder grip			Chuck		
3.	Hook grip			Key		
4.	Sphere grip					
5.	Gross Grip Strength			Precision Grip Strength		

11. Special tests

		Right	Left
1.	Allen's test		
2.	Bunnel littler test		
3.	Finkelstein's test		
4.	Froment's sign		
5.	Ligament stability		
6.	Lunatotriquetral ballottment test		
7.	Phalan's test		
8.	Reverse phalan's test		
9.	Scaphoid compression test		
10	Tight retinacular test		
11	Tinel's test		
12	Watson's test		

12. Joint play movements

Hand and fingers			Right	Left
1.	MCP and PIP + DIP	Long axis extension		
		AP, PA glide		
		Rotation		
		Side glide		
2.	Distal inter-metacarpals	AP, PA glide		
		Rotation		

Wrist			Right	Left
1.	Long axis extension			
2.	AP glide			
3.	Carpal extension			
4.	Carpal flexion			
5.	Ulnar deviation			
6.	Radial deviation			
7.	Ulna-meniscoid-triquetrum AP+ PA glide			
8.	Inferior rad-ulnar rotation	AP, PA glide		
		Rotation		

Appendix BB: DUT hip regional examination

DUT DURBAN UNIVERSITY OF TECHNOLOGY — DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

- **CHIROPRACTIC PROGRAMME**
- **HIP REGIONAL EXAMINATION**

Patient: ______________________________ File no: __________ Date:________

Student: ______________________________ Signature: ______________________

Clinician: _____________________________ Signature: ______________________

Hip with complaint: Right ☐ Left: ☐

OBSERVATION

- Gait: ________________________________
- Posture: ________________________________
- Weight-bearing symmetry: ________________________________
- Balance and proprioception (Stork-standing test): ________________________________
- Bony / soft tissue contours: Buttock contour ________________________________
  Hip flexion contracture ________________________________
  Lumbar lordosis ________________________________
  Scoliosis ________________________________
  - Skin: ________________________________
  - Swelling: ________________________________

PALPATION

· **Anterior aspect**			**Right**	**Left**
1.	Iliac crests			
2.	Greater trochanter			
3.	Pubic symphysis and tubercle			
4.	Femoral head			
5.	Femoral triangle	Femoral artery		
		Lymph nodes		
6.	ASIS's			
7.	Inguinal ligament			
8.	Inguinal hernia			
9.	Muscles -	Quadriceps		
		Adductors		
		Abductors		
		Psoas		

· **Posterior aspect**			**Right**	**Left**
1.	Iliac crests posteriorly			
2.	Ischial tuberosity			
3.	Muscles	Piriformis		
		Gluteals		
		Hamstrings		
4.	PSIS's			
5.	Sciatic notch			
6.	SI joints			
7.	Lumbar Spine			
8.	Sacrum + coccyx			

ACTIVE MOVEMENTS (*note rom and pain*)		**Right**	**Left**
1.	Flexion (110-120°)		
2.	Extension (10-15°)		
3.	Adduction (30°)		
4.	Abduction (30-50°)		
5.	Medial rotation (30-40°)		

		Right	Left
6.	Lateral rotation (40-60°)		
PASSIVE MOVEMENTS (*note end-feel, rom and pain*)		**Right**	**Left**
1.	Flexion (tissue stretch or approximation)		
2.	Extension (tissue stretch)		
3.	Adduction (tissue stretch or approximation)		
4.	Abduction (tissue stretch)		
5.	Medial rotation (tissue stretch)		
6.	Lateral rotation (tissue stretch)		
RESISTED ISOMETRIC MOVEMENTS (*note strength and pain*)		**Right**	**Left**
1.	Hip Flexion		
2.	Hip Extension		
3.	Adduction		
4.	Abduction		
5.	Medial rotation		
6.	Lateral rotation		
7.	Knee flexion		
8.	Knee extension		
REFLEXES		**Right**	**Left**
1.	Patella		
2.	Achilles		
DERMATOMES (*indicate deficits by level and location*)			
1.	Level		
2.	Location		
JOINT PLAY MOVEMENTS		**Right**	**Left**
1.	Caudal glide (long axis traction superior – inferior)		
2.	Compression @ 90° (inferior – superior)		
3.	Medial ➢ lateral @ 180° / @ 90°		
4.	Lateral ➢ medial @ 180° / @ 90°		
5.	Internal rotation		
6.	External rotation		
7.	Anterior ➢ posterior		
8.	Posterior ➢ anterior		
9.	Quadrant (scouring) test		
SPECIAL TESTS		**Right**	**Left**
1.	Patrick FABER Test		
2.	Trendelenberg's Test		
3.	Craig's Test		
4.	Leg Length – Actual		
	Leg Length – Apparent		
5.	Sign of the Buttock		
6.	Thomas Test (hip flexion contracture)		
7.	Rectus Femoris Contracture Test		
8.	Iliopsoas contracture Test		
9.	Ely's Test (rectus femoris hypertonicity)		
10.	Ober's Test (ITB contracture)		
11.	Noble Compression Test (ITB Friction Syndrome)		
12.	Piriformis Test		
13.	Hamstrings – Hamstring Contracture Test		
	Hamstrings – Tripod Test		

Appendix CC: DUT knee regional examination

DUT DURBAN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

KNEE REGIONAL EXAMINATION

Patient:______________________________ File:_________Date:

Student:_______________________Signature: _______________________

Clinician:______________________Signature: _______________________

2 OBSERVATION (Standing, Seated and during gait cycle).

A. Anterior view

Genu Varum:
Genu Recurvatum:
Genu Valgum:
Patella Alta:
Patellar position:
Patella Baja:
Tibial Torsion:
Skin:
Skin
Swelling:

C. Posterior view

Swellin
Skin:

D. General

Movement symmetry:
Structures symmetry:

E. ACTIVE MOVEMENTS

Flexion (0 – 135°)
Extension (0 – 15°)
Medial Rotation (20 – 30°)
Lateral rotation (30 – 40°)
Patellar movement

F. PASSIVE MOVEMENTS

Tissue approx
Bone-bone
Tissue stretch
Tissue stretch

3 RESISTED ISOMETRIC MOVEMENTS

Knee: Flexion:
Extension:
Internal rotation:
External rotation:

Ankle: Plantarflexion
Dorsiflexion

4

5 LIGAMENTOUS ASSESSMENT

One-Plane Medial Instability

Valgus stress (abduction)
Extended
Extended
Resting Position
Resting Position

One-Plane Anterior Instability

Lachman Test (0-30°)
Posterior "sag" Sign
Anterior Drawer Sign
Posterior Drawer Test

Anterolateral Rotatory Instability

Slocum Test
Slocum Test
Macintosh Test

Posterolateral Rotatory Instability

Jacob
Hughston's Drawer Sign
Reverse pivot shift test

Hughston's Drawer Sign

6 TESTS FOR MENISCUS INJURY

McMurray
"Bounce Home"

Anderson med-lat grind
Appley's

7 PLICA TESTS

Mediopatellar Plica
Plica "Stutter"

Hughston's Plica

8 TESTS FOR SWELLING

Brush/Stroke Test

Patellar Tap Test

9 TESTS FOR PATELLA FEMORAL PAIN SYNDROME

Clarke's Sign
Waldron test

Passive patella tilt test

10 OTHER TESTS

Wilson's
Fairbank's
Noble Compression

Quadriceps Contusion Test
Leg Length Discrepancy

11 JOINT PLAY

Movement of the tibia on the femur P to A: A to P:
Translation of the tibia on the femur M to L:
L to M:
Long axis distraction of the tibiofemoral joint
Inf, sup, lat, + med glide of the patella
Movement of the inf. tibiofibular joint A to P: P to A:
Movement of the sup. tibiofibular joint A to P: P to A:
Movement of the sup. tibiofibular joint S to I : I to S:

12 PALPATION

Tenderness
Joint line
Ligaments
Patella / Patella tendon:
Popliteal artery:

Swelling
Nodules/exostoses
Muscles: Thigh:
Leg:
Bursae:

13 REFLEXES AND CUTANEOUS DISTRIBUTION

	R	L
Patellar Reflex (L3,L4)		
Medial Hamstring Reflex (L5,S1)		

14 DERMATOMES

	R	L		R	L
L2			S1		
L3			S2		
L4			S3		
L5					

Appendix DD: DUT foot and ankle regional examination

DUT DURBAN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CHIROPRACTIC AND SOMATOLOGY

CHIROPRACTIC PROGRAMME

FOOT AND ANKLE REGIONAL EXAMINATION

Patient:____________________File number__________________Date

Student________________________________Signature:________________
Clinician:________________________________Signature:______________

Observation
Gait analysis (antalgic limp, toe off, arch, foot alignment, tibial alignment).

Swelling — Heloma dura / molle
Skin — Nails
Shoes — Contours (Achilles tendon, bony prominences)

Active movements

Weight bearing:	**R**	**L**	***Non weight bearing:***	**R**	**L**
Plantar flexion			50°		
Dorsiflexion			20°		
Supination					
Pronation					
Toe dorsiflexion			40°(mtp)		
Toe plantar flexion			40° (mtp)		
			Big toe dorsiflexion (mtp) (65-70°)		
			Big toe plantar flexion (mtp) 45°		
			Toe abduction + adduction		
			5° first ray dorsiflexion		
			5° first ray plantar flexion		

Passive movement motion palpation (Passive ROM quality, ROM overpressure, joint play)	**R**	**L**		**R**	**L**
Ankle joint: *Plantarflexion*			Subtalar joint: *Varus*		
Dorsiflexion			*Valgus*		
Talocrural: *Long axis distraction*			Midtarsal:*A-P glide*		
First ray: *Dorsiflexion*			*P-A glide*		
Plantarflexion			*rotation*		
Circumduction of forefoot on fixed rearfoot			Intermetatarsal glide		
			Tarso metatarsal joints: *A-P*		
Interphalangeal joints: *L-A dist*			Metatarsophalangeal dorsiflexion (with associated plantar flexion of each toe		
A-P glide					
lat and med glide					
rotation					

Resisted Isometric movements	**R**	**L**		**R**	**L**
Knee flexion			Pronation (eversion)		
Plantar flexion			Toe extension (dorsiflexion)		
Dorsiflexion			Toe flexion (plantar flexion)		
Supination (inversion)					

Neurological	**R**	**L**
Dermatomes		
Myotomes		
Reflexes		
Balance/proprioception		

Special tests	**R**	**L**
Anterior drawer test		
Talar tilt		
Thompson test		
Homan sign		
Tinel's sign		
Test for rigid/flexible flatfoot		
Kleiger test (med. deltoid)		

Alignment	**R**	**L**
Heel to ground		
Feiss line		
Tibial torsion		
Heel to leg (subtalar neutral)		
Subtalar neutral position:		
Forefoot to heel (subtalar & Midtarsal neutral)		
First ray alignment		
Digital deformities		
Digital deformity flexible		

Palpation	**R**	**L**
Anteriorly		
Medial malleoli		
Med tarsal bones, tibial (post) artery		
Lat. malleolus, calcaneus, sinus tarsi, and cuboid bones		
Inferior tib/fib joint, tibia, mm of leg		
Anterior tibia, neck of talus, dorsalis pedis artery		
Posteriorly		
Calcaneus, Achilles tendon, Musculotendinous junction		
Plantarily		
Plantar muscles and fascia		
Sesamoids		

Appendix EE: SOAPE note

DURBAN UNIVERSITY OF TECHNOLOGY

Patient Name:			***File #:***	***Page:***
Date:	***Visit:***	***Intern:***		
Attending Clinician:			***Signature:***	
S: *Numerical Pain Rating Scale (Patient)* *Least* ***0 1 2 3 4 5 6 7 8 9 10*** *Worst*		***Intern Rating*** [ ]	***A:***	
0:			***P:***	
			E:	
Special attention to:			***Next appointment:***	
Date:	***Visit:***	***Intern:***		
Attending Clinician:			***Signature:***	
S: *Numerical Pain Rating Scale (Patient)* *Least* ***0 1 2 3 4 5 6 7 8 9 10*** *Worst*		***Intern Rating*** [ ]	***A:***	
O:			***P:***	
			E:	
Special attention to:			***Next appointment:***	
Date:	***Visit:***	***Intern:***		
Attending Clinician:			***Signature***	
S: *Numerical Pain Rating Scale (Patient)* *Least* ***0 1 2 3 4 5 6 7 8 9 10*** *Worst*		***Intern Rating*** [ ]	***A:***	
O:			***P:***	
			E:	
Special attention to:			***Next appointment:***	

Appendix FF: Expert group audiovisual DVD (for the use of the examiners only due to the confidentiality agreement)

COVER LETTER

Chiropractic Programme
Durban University of Technology
P.O.Box 1334
Durban, 4000
South Africa
26 August 2013

To
The Editor: Chiropractic and Osteopathy

<u>Re : An injury profile of Amateur and Semi-professional Kwa-Zulu Natal triathletes: a cross sectional study</u>

When, considering the mandate of your journal, in which it states that it is "ready to receive manuscripts on all aspects of evidence-based information that is clinically relevant to chiropractors, manual therapists and related health care professionals" and that it incorporates a broad "diagnostic practice and treatment scope, emphasizing the structure and function of the body's musculoskeletal framework"; we also note that your journal extends to all manual therapists, who would benefit from publishing the attached submission. Therefore we have decided to submit the attached manuscript to you for consideration in this light.

We believe that this manuscript should be published in your journal, as the research offers an up to date injury profile in the popular and growing sport of triathlon. The study was also unique in the fact that no recent epidemiological study on triathlon has utilized a consultation with the triathletes as a research tool, and this being a chiropractic consultation.

The authors clearly state that there have no competing interests in submitting and publishing this article.

We also submit as requested the details of four peer reviewers for your consideration:

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Thank you for your time and consideration

Kind regards,
Charmaine Korporaal (corresponding author) and Cuan Coetzee

An injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes: a cross sectional study

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Abstract

Background: A triathlon comprises of a combination of swimming, cycling and running. Triathlons are usually classified as sprint distance, Olympic distance, and Ironman or ultra-distance. It was popularized in the 2000 Summer Olympic Games and, despite this, there is insufficient data relating to injuries in the South African context. This study aimed to determine the injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes.

Methods: This IRB approved, cross sectional study, included 80 active members of the Kwa-Zulu Natal Triathlon Association. All triathletes completed a questionnaire on training and injury profiles; with only those having had a musculoskeletal complaint additionally completing a clinical consultation. In order to assess associations between presence of injury and explanatory variables, binary logistic regression using backward selection based on likelihood ratios was used. Data was described using frequency tables for categorical data and summary statistics for continuous data. Odds ratios was reported and p value <0.05 was considered statistically significant. For triathletes reporting injuries, linear regression was used for factors associated with injury severity.

Results: Fifty seven triathletes responded giving a response rate of 71.25% (68.4% male, 31.6% female). The point and period (year) prevalence of triathlon-related musculoskeletal pain was 17.5% and 68.4% respectively. The ranking of the most common site of injury in the last 12 months included the knee (64.1%), low back (20.5%) and thigh (17.9%); with females having had a significantly higher risk of injury than males (p=.019). Additionally, injury risk also increased with weight (p=.055), number of triathlons undertaken in the previous year (p=.031), number of triathlons in the last 4 months (p=.009) and running distance during competition times (p=.011). Injury risk decreased with increasing distance of cycling (p=.061) and swimming (p=.030) in a competition, and length of training in- and off-season (p=.105 and p=.043 respectively). Strong trends were demonstrated between injury severity and long-slow training distance (p=.006) and weight (p=.006). By contrast to risk of injury, injury severity was negatively associated with weight, while a long-slow distance was positively associated with the severity of the injury. Of all the health professions, chiropractic was the most utilized health profession.

Conclusion and recommendations: The results concur with previous research, but add insights into factors predisposing to injury. The most common injuries require investigation to develop preventative interventions to reduce injuries in triathletes. Health professionals require education to improve preventative and curative interventions.

Key terms: Triathlon-related, triathletes, injury profile, chiropractic, musculoskeletal injuries, prevalence

Background

Triathlon is a multidisciplinary sport that consists of three uninterrupted disciplines of swimming, cycling and running [1]. Triathlon has become a popular international recreational and professional sport which made its debut in the 2000 Summer Olympic Games [2]. McHardy, Pollard and Fernandez [3] reported that the popularity of triathlon is due to the variety within the sport. Nevertheless, Vleck and Garbutt [4] and Clements, Yates and Curran [5] suggest this variety contributes to triathlon-related musculoskeletal pain and/or injury. Participants in triathlon events experience a wide range of racing conditions and physiological demands that are more than those found in an individual sport of similar duration [6]. Consequently, a wide range of plausible medical issues or complications must be taken into account when preparing for such a race [6].

The prevalence of musculoskeletal pain and/or injury among triathletes is noted to vary from 37% to 91% [7,8,9,10]. However, the extent to which these results may be reflective of reality, are restricted by the commonality of terminology used for different body regions injured. According to McHardy *et al.,* [3], systematic issues exist in triathlon injury surveillance literature with respect to injury site and injury type and whether reporting these was done either as grouped sites or types [7,9]. This lack of consensus between studies makes comparisons and determining injury profiles in the triathlon arena difficult [3].

Of the papers identified in Gosling's *et al.* [2] review, seven studies provided diagnostic information self-reported by triathletes; however only two studies to the researcher's knowledge have used confirmed diagnoses by medical or allied health practitioners. Formal validation of self-reported nature and types of injuries has not yet been carried out in any triathlon-related injury profile study. Therefore, the triathlete's self-reporting of injuries and its difficulty is recognized, and as a result the data collection would be deduced with attention to the limitations [11]. In this context, prospective studies would limit recall bias and give more accurate injury information [2,12].

Thus, it is clear from Gosling's *et al*. [2] review of triathlon-related musculoskeletal injuries that there is a significant knowledge gap between the triathlon literature that describes injury incidence, injury profiles and suggestions for preventative measures of injuries in triathlon participants. Thus, more research is required [2].

Therefore, this manuscript presents the findings based on its primary aim, which was to investigate the injury profile of amateur and semi-professional Kwa-Zulu Natal triathletes. The primary objective outcomes were to develop a demographic profile and to determine the incidence, period prevalence and point prevalence of injuries in amateur and semi-professional Kwa-Zulu Natal triathletes. The secondary objective outcomes were to assess and determine these injuries in terms of diagnosis, location and severity, and to identify the associations between the demographic profile and injuries in terms of diagnosis, location and severity.

Methods

This research was a cross-sectional, retrospective/prospective study which documented triathlon-related musculoskeletal pain, as approved by the Durban University of Technology's Institutional Research and Ethics Committee. The study employed a quantitative and descriptive design [13]. Participation was by voluntary informed consent.

Data was obtained from:

1) A self-administered questionnaire, and
2) A consultation at the Durban University of Technology (DUT) Chiropractic Day Clinic.

Prior to the use of the self-administered questionnaire, this questionnaire was developed from the literature, even though it was based on the design of Ellapen et al. [14] Once developed the questionnaire was subjected to an expert group [15,16,17] and a pilot study [13]. These processes collectively assisted in determining face validity [18], construct and criterion validities [15,16,17,19]. This then enabled the researcher to develop a research tool with collective input in order to attain the most appropriate questionnaire in order to achieve the objectives set out for this research.

Triathletes who suffered with triathlon-related musculoskeletal pain at the time of the study, underwent a clinical consultation and were also requested to complete the questionnaire. By contrast, triathletes that were not suffering from a triathlon-related musculoskeletal pain at the time of the study only answered the questionnaire (and were not required to undergo the clinical consultation, as the aim of the clinical consultation was to verify the diagnosis of the athletes' presenting complaint.

The population sample was the 80 active tri-athletes registered with Kwa-Zulu Natal Triathlon Association (KZNTA), the only one in the province. Permission to access these triathletes was obtained from the KZNTA. Triathletes were required to be based in the greater Durban area and be members of the KZNTA, voluntarily sign the letter of information and informed consent, to be 18 years of age or older and to be an amateur or semi-professional triathlete.

IBM SPSS version 20 was used to analyse the data [20]. The data was analyzed descriptively, (mean, mode, frequency and percentages). Thus data were described using frequency tables for categorical data and summary statistics such as mean and standard deviation for continuous data, and inferentially, (regression analysis and crudes odd ratios). The probability was set at $p \leq 0.05$ (a p value <0.05 was considered as statistically significant).

In order to assess associations between presence of injury and explanatory variables, binary logistic regression using backward selection was used based on the likelihood ratios. Odds ratios and 95% confidence intervals were reported. For the participants who reported current or past injuries, linear regression for factors associated with injury severity was used. Forward/stepwise selection was employed, and coefficients and p values are reported. With the use of the Crudes odds ratios, data gathered from the questionnaire would be compared against the data gathered from the consultation which is, in order to assess the association between variables in each of these data tools. This would be done to define relationships but not imply causality.

Results

DEMOGRAPHICS AND TRAINING

Fifty seven triathletes responded to the invitation to participate, giving a response rate of 71.25%. Nearly two thirds (68%) of the sample were male. The weight of the athletes ranged from 43 kg to 97 kg. The mean average mass was 71.0 kg.

The mean average of triathlon competitions participated in by the triathletes in the twelve months prior to this research study was three and in the four months prior to this study an average of one triathlon had been completed by the triathletes. The average amateur and semi-professional triathlete in Kwa-Zulu Natal (KZN) competes in distances between sprint and Olympic distance triathlon races. Three years was the average number of years that a triathlete had participated in the sport.

The most frequent type of running training was “long-slow sessions” with a mean average of one session per week and an average of one hour per session. Half (50.9%) of the triathletes have had a professional bicycle setup, even though the majority of the triathletes did not receive any form of coaching (56.1%). The average number of rest days per week was one, the average number of active rest days per week was also one and the average number of double training sessions per week was three.

INJURIES

The most common anatomical sites of the pain (experienced at the time of the study) was low back and knee (both at 40%). Some respondents reported more than one site affected. The most common anatomical site of pain in the 12 months prior to the study was the knee at 64.1%. Other sites of pain were low back (20.5%) and thigh (17.9%). Many reported pain in more than one site over this 12-month period.

Running precipitated onset of pain in 30% of triathletes and the resulted in the most pain in 40% of triathletes. Running was also the predominant cause of onset and most severe pain in the last 12 months, 43.6% and 68.4% respectively. Of the triathletes seen during the study consultation, 90% had experienced pain during running.

Just over half (55.6%) of the triathletes suffering with pain at the time of the study were prevented from participating in training and 30% were prevented from participating in competition.

Pre-season and in-season are the two regimens that incurred the most injury of triathletes in pain at the time of the study (both 40%) and 50% of triathletes suggested over-training as the cause of their injury; whereas 20% attributed their injury to traumatic incidences. By contrast, in-season was the regimen that incurred the most injury of triathletes with pain in the 12-months prior to the study (66.7%) and 51.3% of the triathletes suggested over-training as the cause of their injury (15.4% suggested traumatic incidences).

Chiropractors were the most commonly sought out health care profession for treatment by 40% of triathletes who were in pain at the time of the study with 75% of these triathletes having reported satisfactory outcomes. Chiropractors were the individual treatment of choice by 38.5% of triathletes who had experienced pain in the prior 12 months with 82.1% of these triathletes being satisfied with treatment. Muscle pathology accounted for 10 of the 39 (25.6%) diagnoses from practitioners, as reported by the triathletes.

CONSULTATION

All the new complaints / injuries (viz. those triathletes with pain at the time of the study) were seen at the Chiropractic Day Clinic. The majority (90%) of the triathletes had no history of orthopaedic surgery, all of the triathletes had history of muscle injury and connective tissue injuries and 40% had previous fractures. All the triathletes sustained their injuries during training. The majority (80%) of the injuries were chronic in nature.

Discussion

The response rate of this study was substantially better than global studies which have achieved 21.23% [21], 45% [22], 48% [8], 49.4% [23], 55% [24] and 55% [10]. Although the response rate of this study was lower than Vleck *et al.,* [25], who attained 75% (Olympic distance triathletes) and 95% (Ironman triathletes), the numbers of participants in this study was more than double of those analysed in the Vleck *et al.,* [25] study. The results are not dissimilar to the gender and ethnicity data of triathlete samples described and presented in previous survey research studies both in South Africa [14] and internationally (O'Toole *et al*., [7] in Hawaii, Collins *et al*., [22] in Seattle (United States of America (USA)), Wilk *et al*., [8] in Miami (USA), Cipriani *et al*., [26] in Ohio (USA), Clements *et al.,* [5] in the United Kingdom, Burns *et al.,* [11] in Australia, Shaw *et al.*, [10] in Australia, Korkia *et al*., [21] in Britain, Manninen and Kallinen., [24] in Japan, Villavicencio *et al*., [27] in Colorado (USA), Johnson *et al*., [28] in Louisiana (USA), Galera *et al.,* [23] in France and Ansell *et al*., [29] in Australia).

The triathlete sample surveyed in this study was marginally taller than the anthropometric data of triathlete samples described in a previous survey research study in South Africa (67.86 kg and 172 cm) [14] and an international study done in Japan (61 kg and 167.7 cm) [24]. However, the weight and height of these respondents were nearly identical (174 cm (68.47 inches) and 70 kg (155.58 lbs)) to an international epidemiological study done in USA by Wilk *et al.* [8].

By comparison, the number of triathlons participated in, were lower than that of Wilk *et al.* [8] who showed the mean number of triathlons in the year prior to his study was five. The projected results of this study are higher than that of Collins *et al.* [22] who reported that 50.6% of triathletes had only participated in 1-3 triathlons in their lifetime and only 49.4% participated in more than four. The differences in these results may be attributed to the locality within which each of the studies was conducted as well as the time of the year in which the studies were conducted. Miami (USA) is known for its outdoor weather most of the year round [8], giving the opportunity for more triathlon events to occur in this locality. Whereas, Seattle (USA), has reduced opportunity to host such events based on the longer and harsher winter period [22]. Additionally, it would seem that triathlons may not have been as well supported in 1989 [22] as compared to 1995 [8]. These discussions fall in line with the results in this study where the Kwa-Zulu Natal climate fluctuates between the Miami and Seattle weather (allowing an average number of events). In addition, triathlon participation has been impacted positively since 1995 in terms of growth, but has been negatively impacted (in the past) by the relatively recent development of triathlon as a specific and sponsored, supported discipline in South Africa.

Length of triathlon from this study are shorter than that shown by Manninen and Kallinen, [8] in Japan who stated over half (57%) of the triathletes trained for half and full Ironman distance events and the remainder (43%) trained for Olympic distance and sprint events. Manninen and Kallinen [8] surveyed members from triathlon clubs where members are more active (viz. organised more opportunities for the Ironman distances (full and half)), as compared to KZN, where no Ironman events are hosted, resulting in all the events being either sprint or Olympic distance. In addition, the KZNTA offers a greater variety of off-road triathlon events (as opposed to the ironman events), which typically have random distances usually somewhere between sprint and Olympic distances.

The majority of the athletes surveyed in this study were relatively new to the sport with the average triathlete competing for about three years. This was marginally less than other survey studies [5,7,8,21,24,28]. When comparing published literature to this study, it is evident that there is commonality in that the average triathlete has been participating for a relatively small period in time, with some extreme exceptions. In the South African context this may be due to the relative “newness” of triathlon as a discipline, but may also be due to the late entry of athletes into this discipline (with an increased average age). This may additionally be re-inforced by the fact that most South African participants are amateur and semi-professional triathletes.

The relatively high reporting of CrossFit participation by the triathletes in this study (21.2% reported CrossFit as one of their cross-training activities) has not previously been documented in other triathlon studies. This would most likely be as a result of the “newness” of this training style.

The most frequent type of running training is “long-slow sessions” with a mean average of one session per week and an average of one hour per session. Only one study to the researcher’s knowledge has shown the number of sessions per week of the various types of training sessions [25]. The results of this research study are similar in trend but lower than the British study reported by Vleck *et al.,* [25], who found that “long-runs” averaged at 0.7-1 session per week at an average duration of 1.3-1.6 hours per session.

The difference could be accounted for in that Vleck *et al.* [25] surveyed members of the British National team in contrast to this study portrayed professional triathletes.

The sites of injury reported in the current study were consistent with previous reports regardless of whether data was collected prospectively or retrospectively [1]. The triathlon injury literature states that the knee is a common site for injury: 21.9% [4], 22% [30], 25% [22], 25% [26], 32% [10], 32.9% [14], 33% [24], 34% [28], 35.1% [29], 42.7% [9], 44% (in ironman triathletes) [25]. Similarly, some studies classified injuries per region (e.g. lower limb), and these results indicate a dominance of knee injuries in that category: 19% [11] and 68.8% [23].

The results also correspond with studies which showed a dominance of low back injuries as the common site of pain: 17.9% (in Olympic distance triathletes) [25], 28% [24], 31.2% [9] and 72% [7]. Studies by Ellapen *et al*. [14] and Ansell *et al*. [29] similarly showed the low back to be a common site of pain at 16.9% and 34.1% respectively.

Although there is a marked variation in injury rates between these studies, the knee and low back are consistently stated to be the most commonly injured sites. This has implications for further research and for educating health professionals and triathletes, particularly to assist them in the prevention and management of injury in this sport [29].

Running caused the most injury. In congruence with this, the predisposing over-use factors producing triathlon-related musculoskeletal pain reported by the triathletes in a South African study were [14]: running (61.54%), swimming (19.23%) and cycling (19.23%).

In support of Ellapen's *et al.,* [14] study, most results confirm that the most frequent injuries in triathlon training occur during running: 53% [29], 54.1% [1], 58% [30], 62% [22], 65.2% (Olympic distance only) and 60% (Ironman) [25], 65% [21], 71-73% [11], 72% [5] and 72.5% [23].

This study also revealed that competition interruption was considerably less than training interruption, which was similar to Wilk's *et al*. [8] study showing that scheduled triathlon competition interruption was reported by 33.3% of their triathletes. However, the results were higher than Korkia's *et al*. [21] British study, where only 17% of the injured research cohort missed a planned competition.

Approximately 51.% of the triathletes suggested overtraining as the cause of their injury (15.4% suggested traumatic incidences). These results are comparable with several studies reviewed by the researcher that confirmed that triathlete injuries are mostly non-traumatic in nature and occurred due to overuse activity (41% to 94%): [7,8,9,14,21,22,23,25,29,30].

Less than half the triathletes sought out Chiropractors care for the treatment of their condition (40%), and of this percentage, 75% reported satisfactory outcomes. Chiropractors were the individual health care treatment of choice by 38.5% of triathletes who had experienced pain in the previous 12 months with 82.1% of triathletes being satisfied with treatment. 80% of the triathletes who were in pain at the time of the study and 92.3% of the triathletes who had experienced pain in the previous 12 months sought treatment from some sort of health care provider. This is slightly higher but nonetheless in agreement with Wilk's *et al.,* [8] study of 65.3%, Clements *et al*. [5] who found 78% and Cipriani *et al*. [26] who found 42% of triathletes sought treatment from a variety of healthcare professionals.

The results of this study do however differ to other studies that show physiotherapists to be the health care professionals of choice, followed by medical practitioners and chiropractors [29]. A possible explanation for Chiropractors being the practitioner of choice may be the fact that Durban University of Technology is situated in KZN and is one of two institutions in South Africa to offer chiropractic. The students are often involved in sports events and therefore athletes are exposed more to chiropractors than perhaps other health care professionals. Another reason is that this study was done by a chiropractic student and bias could have affected the triathlete's responses.

The diagnoses from injuries in the last 12 months are shown in Table 1. Grouped together, muscle pathology accounts for 10 of the 39 (25.6%) practitioners' diagnoses.

Objective data: All the injuries were new complaints. The majority (90%) of the triathletes had no history of orthopaedic surgery, all of the triathletes had a history of muscle injury and connective tissue injuries and 40% had previous fractures. All the triathletes sustained their injuries during training and 90% occurred during running. 80% of the injuries were chronic in nature.

The diagnoses from the consultation are shown in Table 2. Myofascial trigger points were noted as outlined in Table 3. No literature to date, to the researcher's knowledge has reported trigger point mapping in triathletes.

The period prevalence of injuries over 12 months was 68.4% (Table 4). These results are similar to international studies which range from 49% to 91% [7,8,9,10,14,21,22,23,29,30]. The point prevalence of current injuries was 17.5%. All 10 participants with pain were related to participation in a triathlon (Table 5). The literature surrounding the prevalence of triathlon-related injuries reported predominantly period prevalence [7,8,9,10] and not specifically point prevalence.

Female triathletes had a significantly higher risk of injury than males (*p*=0.019). Injury risk also increased with weight (*p*=0.055), number of triathlon competitions in the last 12 months (*p*=0.031), number of triathlon competitions in the last 4 months (*p*=0.009) and running distance during competition season (*p*=0.011), but decreased with increasing distance of cycle (*p*=0.061) and swimming (*p*=0.030) in the competition, and length of training in- and off-season (*p*=0.105 and *p*=0.043 respectively).

To the researcher's knowledge, no studies have reported on gender bias, weight, or number of triathlon competitions in the four weeks prior to the research study with regards to overall injury rate. Ansell *et al.,* [29] found that Body Mass Index (BMI) did not relate to injury rate and some studies have shown that body weight had no significant correlations with injury [21,27]. Conversely, however, van Gent *et al*., [31] found that male runners with a BMI of 27.0 or higher had fewer injuries.

It is difficult to compare statistical significance to injury of each discipline's distance in a triathlon as there are conflicting associations. Therefore making the assumption that all three disciplines of a triathlon increase as the running distance increases; then injury risk increases with increasing running distance in a race, but conversely the injury risk decreases as the other two disciplines increase. However, Korkia *et al.,* [21] showed there was no evidence of a difference between injury rates in long and sprint distance triathletes.

Ansell *et al*., [29] demonstrated a female gender bias specific to the hip/buttock/groin area only. Notably however, other authors have not reported a gender difference in injuries [7,11,22,26].

A relationship between training load and injuries has been found in some studies [4,7,10,21,24] but not in others [9,11,22,26,27]. Many running studies have also found that higher training loads are linked to greater risk of injury [32, 33].

Long-slow training distance (p=0.006) and weight (p=0.006) were associated with injury severity. Weight was negatively associated with severity, the heavier the person, the less severe the injury, while as long-slow distance increased, so did severity of the injury.

Conclusion

It has become evident that triathlon injuries are relatively frequent, concurring with the international literature surrounding triathlon injuries. This prospective cross-sectional study determined that the knee is the most common anatomical site of injury both in triathletes with injuries at the time of the study and those who had experienced an injury in the last twelve months. Variables that increase the risk of a triathlete getting injured are: female gender may predispose triathletes to a higher risk of injury; injury risk also increased with mass; number of triathlon competitions in the previous 12 months; number of triathlon competitions in last four months and running distance during competition. Injury risk however decreased with increasing distance of cycle in a competition, increasing distance of swimming in a competition and length of training in- and off-season. It is also evident from these findings that it appears weight bearing activity has a higher injury risk than non-weight bearing activities. Chiropractors were the most commonly sought out health care professionals for treatment. Therefore, it is necessary for triathletes and triathlon groups to look at these injury-risk associations in order to ensure a better understanding of performing a specific training method and to plan their training regimes accordingly.

List of abbreviations

BMI: Body mass index

DUT: Durban University of Technology

KZN: Kwa-Zulu Natal

KZNTA: Kwa-Zulu Natal Triathlon Association

USA: United States of America

Competing interests

None

Authors' contributions

CC conceived of the study, CK supervised and assisted in coordination and drafting the manuscript. CC carried out the data collection process including both the questionnaire and the consultation.

Both authors participated in the proposal development and read and approved the final manuscript.

Authors' information

CK - senior lecturer, research supervisor, clinician at the chiropractic day clinic (DUT) and senior researcher having authored and co-authored over 100 masters theses at the university. CK's qualifications: M.Tech Chiropractic (SA) CCFC (SA), CCSP (USA), ICSSD (USA).

CC holds an M.Tech Chiropractic (SA) and busy compiling his ICSSD (USA). A former South African triathlete, duathlete and biathlete, nominated as the Chirosport SA Student representative for DUT.

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References

1. Gosling CM, Forbes AB, McGivern J, Gabbe BJ: **A profile of injuries in athletes seeking treatment during a triathlon race series.** The *American Journal of Sports Medicine* 2010, **38**(5):1007-1014.
2. Gosling CM, Gabbe BJ, Forbes AB: **Triathlon related musculoskeletal injuries: the status of injury prevention knowledge.** The *American Journal of Sports Medicine* 2008, **11**(4):396-406.
3. McHardy A, Pollard H, Fernandez M: **Injuries: A review of the literature and discussion of potential injury mechanisms.** *Clinical Chiropractic* 2006, **9**:129-138.
4. Vleck VE, Garbutt G: **Injury and training characteristics of male elite, development squad, and club triathletes.** *International Journal of Sports Medicine* 1998, **19**(1):38-42.
5. Clements K, Yates B, Curran M: **The prevalence of chronic knee injury in triathletes.** *British Journal of Sports Medicine* 1999, **33**(3):214-216.
6. Dallam GM, Jonas S, Miller TK: **Medical considerations in triathlon competition: Recommendations for Triathlon Organisers, Competitors and Coaches**. *Sports Medicine* 2005, **35**(2):143-161.

7. O'Toole ML, Hiller WDB, Smith RA, Sisk TD: **Overuse injuries in ultra-endurance triathletes.** *American Journal of Sports Medicine* 1989, **17**(4):514-518.
8. Wilk BR, Fisher KL, Rangelli D: **The incidence of musculoskeletal injuries in an amateur triathlete racing club.** *Journal of Orthopaedic and Sports Physical Therapy* 1995, 22(3):108-12.
9. Egermann M, Brocal D, Lill CA, Schmitt H: **Analysis of injuries in long-distance triathletes.** *International Journal of Sports Medicine* 2003, **24**(4):271-276.
10. Shaw T, Howat P, Trainor M, Maycock B: **Training patterns and sports injuries in triathletes.** *Journal of Science and Medicine in Sport* 2004, **7**(4):446-450.
11. Burns J, Keenan AM, Redmond AC: **Factors associated with triathlon-related overuse injuries.** *Journal of Orthopaedic & Sports Physical Therapy* 2003, **33**(4):177-184.
12. Mouton J: *Understanding social research.* 1st ed. Pretoria: J.L. van Schaik Publishers; 1996.
13. Fink A, Kosekoff J: *How to conduct surveys: A Step by Step Guide – The Role You Play*. California: Sage Publications; 1985.
14. Ellapen TJ, Chetty L, Dorasami C, Abrahams S, Narsigan S, Desai FA, Van Heerden HJ: **Prevalence of triathlon-related musculoskeletal pain among Kwa- Zulu Natal tri-athletes.** *African Journal for Physical, Health Education, Recreation and Dance* 2011, **17**(1):112-123.
15. Morgan DL: *The Focus Group Guidebook. Volume 1.* United States of America. Sage Publications. Thousand Oaks; 1998(a).
16. Morgan DL: *Planning Focus Groups. Volume 1*. Sage Publications. Thousand Oaks; 1998(b).
17. Morgan DL: *Moderating Focus Groups. Volume 1*. Sage Publications. Thousand Oaks; 1998(c).
18. Bernard HR: *Social research methods: Qualitative and Quantitative approaches.* California: Sage Publication, Inc.; 2000.

19. Salant P, Dillman D: *How to conduct your own survey*. United States of America: John Wiley and Sons Inc. 1994.
20. Esterhuizen T (Statistician): Email communication with C. Coetzee
21. Korkia PK, Tunstall-Pedoe DS, Maffulli N: **An epidemiological investigation of training and injury patterns in British triathletes.** *British Journal of Sports Medicine* 1994, **28**(3):191-6.
22. Collins K, Wagner M, Peterson K, Storey M: **Overuse injuries in triathletes: A study of the 1986 Seafair triathlon.** The *American Journal of Sports Medicine* 1989, **17**(5):675-680.
23. Galera O, Gleizes-Cervera S, Pillard F, Riviere D: **Prevalence of injuries in triathletes from a French league.** *Apunts Medicina de L'esport* 2012, **47**(173):9-15.
24. Manninen JSO, Kallinen M: **Low back pain and other overuse injuries in a group of Japanese triathletes.** *British Journal of Sports Medicine* 1996, **30**:134-139.
25. Vleck VE, Bentley DJ, Millet GP, Cochrane T: **Triathlon event distance specialization: Training and Injury Effects.** *Journal of Strength and Conditioning Research* 2010, **24**(1):30.
26. Cipriani DJ, Swartz JD, Hodgson CM: **Triathlon and the multisport athlete.** *Journal of Orthopaedic and Sports Physical Therapy* 1998, **27**(1):42-50.
27. Villavicencio AT, Burneikiene S, Hernandez TD, Thramann J: **Back and nack pan in triathletes**. *Neurosurgical Focus* 2006, **21**(4):E7
28. Johnson L: **Training, nutrition, injury and lifestyle characteristics of shorter distance triathletes.** *Master of Science thesis.* Louisiana State University. Department of Kinesiology; 2012
29. Ansell W, Rivett DA, Callister R: **Characteristics, training loads, injury patterns and stretching habits of Australian Ironman Triathletes**. *Master of Medical Science thesis.* The University of Newcastle, Department of Physiotherapy; 2012.

30. Massimino FA, Armstrong MA, O'Toole ML, Hiller WD, Laird RH: **Common triathlon injuries: Special considerations for multisport training.** *Annals of Sports Medicine* 1988, **4**(2):82-86.
31. van Gent RN, van Middlekoop M, van Os AG, Bierma-Zeinstra SMA, Koes BW: **Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review.** *British Journal of Sports Medicince 2007,* **41**:469-480.
32. James SL, Bates BT, Osternig LR: **Injuries to runners.** *American Journal of Sports Medicine* 1978, **6**(2):40–50.
33. Hreljac A, Ferber R: **A Biomechanical Perspective of Predicting Injury Risk in Running.** *International SportMed Journal* 2006, **7**(2):98-108.

Tables and captions

Table 1: Treatment of pain and diagnosis given for pain during last 12 months

Questionnaire Section C		Count	Column N %
Q33 When you sustained the pain which medical practitioner did you seek treatment from?	Biokineticist	0	0.0%
	Chiropractor	15	38.5%
	GP	2	5.1%
	Orthopaedic surgeon	0	0.0%
	Pharmacist	0	0.0%
	Physiotherapist	8	20.5%
	None	3	7.7%
	Other	0	0.0%
	Biokineticist and physiotherapist	1	2.6%
	Chiropractor and physiotherapist	2	5.1%
	Biokineticist and chiropractor	2	5.1%
	Biokineticist and GP	1	2.6%
	Biokineticist, Chiropractor, orthopaedic surgeon, and physiotherapist	1	2.6%
	Orthopaedic surgeon and physiotherapist	2	5.1%
	Chiropractor, orthopaedic surgeon, GP, physiotherapist	1	2.6%
	Biokineticist, chiropractor and pharmacist	1	2.6%
Q34 What (if anything) did the above practitioner diagnose?	Breaks	1	2.6
	Cartilage (damage)	1	2.6
	Dropped left arch (foot biomechanics)	1	2.6
	Hamstring tendinosis	1	2.6
	ITB	1	2.6
	ITB issue	1	2.6
	Joint sprain	1	2.6
	Liquid in knee	1	2.6
	Low back, hip flexor and hamstring	1	2.6
	Muscle strain (non-specified)	5	12.8
	Muscle strain (calf)	1	2.6
	Muscle strain (hamstring and calf)	1	2.6
	Muscle tear	2	5.1
	Muscle tear (calf)	1	2.6
	Nothing	1	2.6
	Osteoarthritis	1	2.6
	Patella tendonitis with slight tear in meniscus	1	2.6
	Patellofemoral pain syndrome	4	10.3
	Pinched nerve	2	5.1
	Shin splints	2	5.1
	Strained shoulder with a leg imbalance	1	2.6
	Tendonitis	1	2.6
	Torn cartilage	1	2.6
	Torn ligaments	1	2.6
	Total	39	100.0

Table 2: Diagnoses obtained from the consultation with triathletes currently reporting musculoskeletal pain

Triathlete	Diagnosis
1	Chronic overuse mild cervicogenic headaches Chronic swimmer's shoulder with concomitant rotator cuff myofascial paid and dysfunction
2	Chronic overuse sacroiliac dysfunction with associated quadratus lumborum (QL) myofascial pain and dysfunction
3	Chronic mild non-traumatic sacroiliac syndrome Chronic mild non-traumatic QL myofascial pain and dysfunction
4	Chronic overuse mild peroneus myofascial pain and dysfunction
5	Chronic swimmer's shoulder Sub-acute non-traumatic mild gracilis myofascial pain and dysfunction
6	Acute non-traumatic mild gastrocnemius myofascial pain and dysfunction
7	Chronic overuse mild gastrocnemius myofascial pain and dysfunction
8	Plantar fasciitis
9	Sub-acute non-traumatic mild iliotibial band (ITB) syndrome
10	Swimmer's shoulder Chronic overuse cervical facet dysfunction Chronic non-traumatic mild lumbar facet syndrome

Table 3: Trigger point location identified during the consultation with the triathletes

Left sided involvement	**Bilateral involvement**	**Right Side involvement**
Levator scapula	Posterior cervical	Levator scapula
Supraspinatus	Plantar muscles	Gastrocnemius
Infraspinatus	Scalene	Supraspinatus
Teres minor	Trapezius	Infraspinatus
Quadratus lumborum	Levator scapulae	Anterior deltoid
Iliotibial band (ITB)	Infraspinatus	
Gracilis	Supraspinatus	
	Quadratus lumborum	
	Lumbar paraspinals	
	Tensor fascia lata	
	Iliopsoas	
	Gluteus medius	
	Gluteus maximus	
	Gluteus minimus	
	Hamstrings	
	Peroneus	

Table 4: Period prevalence of injuries in previous 12 months

	Frequency	Percentage
Yes	39	68.4
No	18	31.6
Total	57	100.0

Table 5: Point prevalence of injury at time of the study

Current pain	Frequency	Percentage
Yes	10	17.5
No	47	82.5
Total	57	100.0

Preparing additional files

None