AN INJURY PROFILE OF ICE HOCKEY PLAYERS IN SOUTH AFRICA

BY

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I, Donne Claire van Doesburgh, 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 Charles and Michelle, I am truly privileged to have you as parents.

This is for you.

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ABSTRACT

Background: Ice hockey is a fast paced team sport, played on an ice surface in an enclosed arena. As a result of the high contact, aggressive nature of the sport, players are susceptible to injury. Ice hockey is not a popular sport in South Africa and the environment is unique in comparison to international ice hockey countries. The playing surfaces and ice rink arenas differ across South Africa, which may affect the risk of injury in this population. Protective equipment is not easily accessible to ice hockey players in South Africa and therefore they may be at a higher risk of injury. Participation in ice hockey is developing in South Africa; however there is a paucity in the literature relating to injuries in the South African context. This study aimed to determine a profile of ice hockey injuries in South African players.

Methodology: This study was a quantitative, descriptive study that used a self-administered questionnaire. The questionnaire was administered to 187 ice hockey players (141 male and 46 female) who were registered with the South African Ice Hockey Association. Players were required to sign the letter of information and informed consent form, following which, questionnaires were distributed to the participants who met the study criteria. The researcher was present to supervise and collect all forms and completed questionnaires directly after completion. The questionnaire contained sections on demographics, injuries sustained over the previous season as well as the use of protective equipment. The results were analysed using SPSS version 24 and a p value of < 0.05 was considered statistically significant.

Results: The response rate met the minimum requirement of 138 males and 45 females. Of the 187 participants, 110 (58.8%) of the participants sustained at least one injury due to ice hockey. Age was considered to be a risk factor in this study as those participants in the youngest age group of 18-27 were at a higher risk of all injuries (χ^2 p-value < 0.0001). Although gender was not a risk factor for the total number of injuries, female players in this study were at a greater risk of head and knee injuries (χ^2 p-value = 0.0196 and χ^2 p-value = 0.0046 respectively). The most severe injury affected the head (10.2%, n = 19) and overall the knee was the most commonly affected area of injury (n = 30). The majority of the injuries were sustained during a game and resulted from contact with another player.

The results of this study showed that the use of protective equipment does not prevent all injuries in ice hockey. The type of facial protection worn was a risk factor for facial injuries and the lack of a mouthguard was a risk factor for head injuries.

Conclusion: The aim of this study was to determine a profile of ice hockey injuries in South African players. The South African demographic profile of ice hockey players showed similarities to international profiles with respect to age, gender, BMI and player position. The profile of injuries in this study was similar to international injury profiles in terms of site, type, severity, onset and mechanism of injury and regarding the majority of injuries being sustained during a game. Ice hockey players in the younger age groups were at a higher risk of injury both in South Africa and internationally. Females were at a higher risk of head injuries in comparison to males which is congruent with international literature. In South Africa, and internationally, the use of full facial protection and a mouthguard was shown to decrease the risk of facial and head injuries respectively.

The South African demographic profile differed from international findings in terms of experience level, total hours of training per week and number of games played in a season. The injury profile of South African ice hockey players showed that this population is at a higher risk of muscular injuries than international players. Larger ice surfaces and flexible boards and glass did not reduce the risk of injury in South African ice hockey players in the same way as it has internationally.

Key terms: ice hockey, injuries, quantitative profile, injury profile, risk factors

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ABBREVIATIONS

%	Percent
<	Less than
=	Equal
>	Greater than
≤	Less than or equal to
≥	Greater than or equal to
BMI	Body Mass Index
CTPL	Cape Town Premier League
DUT	Durban University of Technology
GPHL	Gauteng Premier Hockey League
IIHF	International Ice Hockey Federation
IREC	Institutional Research Ethics Committee
kg/m²	Kilograms per metres squared
km/h	Kilometres per hour
n	Sample Size
SAIHA	South African Ice Hockey Association
SPSS	Statistical Package for the Social Sciences
U.S.A.	United States of America

DEFINITIONS

Anterior	Refers to the front of the body or a position closer to the front than another (Lippert 2006).
Boards and glass	The boundaries that enclose the ice rink (Sports Definitions 2016)
Body checking	Deliberate body contact with an opposing player in order to remove the opposing player from possession of the puck (Abbott 2014)
Concussion	A mild brain injury with a complex pathophysiologic process which occurs as a result of biomechanical forces (Abbott 2014)
Confidentiality	The disassociation of names of individuals from their specific questionnaire responses (Salant and Dillman 1994)
Defence	A player who focuses on defence and plays between the goalkeeper and the forwards.
Extrinsic	External factors which act upon the athlete from the external environment; for example, player position, level of competition, exposure to activity, protective equipment, playing surface and facilities (Meeuwisse 1994)
Forwards	Players who focuses on offensive chances.
Gauteng	Gauteng is one of nine provinces in South Africa.
Goalkeeper	A player who focuses on guarding the goal.
Injury	Any physical complaint sustained by participants during an ice hockey-related activity, irrespective of medical treatment or time taken off playing ice hockey.

Intrinsic	Internal, non-modifiable factors related to the athlete; for example, age, gender, level of experience, previous injury, (Meeuwisse 1994).
Kwa-Zulu Natal	Kwa-Zulu Natal is one of nine provinces in South Africa.
Posterior	Referring to the back of the body or to a position closer to the back then another (Lippert 2006).
Puck	Black vulcanized rubber which measure 2.54cm in height and 7.62cm in diameter.
Risk factors	Any attribute, characteristic or exposure that leads to the increased likelihood of a person to develop a disease or injury (World Health Organization 2016).
Valgus	"Descriptive of any of the paired joints of the extremities with a static angular deformity in which the bone distal to the joint deviates laterally from the longitudinal axis of the proximal bone, and from the midline of the body, when the subject is in anatomical position" (Dirckx 1997: 927).
Varus	"Descriptive of any of the paired joints of the extremities with a static angular deformity in which the bone distal to the joint deviates medially from the longitudinal axis of the proximal bone, and toward the midline of the body, when the subject is in anatomical position" (Dirckx 1997: 930).
Western Province	Western Province is one of nine provinces in South Africa.

CHAPTER 1 : INTRODUCTION

1.1 Introduction

Ice hockey originated in the eastern parts of Canada in the mid-1800's and then developed and spread to the USA, England and other parts of Europe (College Sports Scholarships n.d.). Ice hockey is now one of the most popular sports in North America and northern Europe, and is increasing in popularity in Asia and the oceanic countries (Rishiraj et al. 2009). Organised ice hockey is currently played by 1.8 million people in 69 different countries of the world (Survey of players 2015).

Ice hockey is a physically demanding, high contact sport (Rishiraj et al. 2009). Players reach skating speeds of 50km/h, shoot pucks that can travel up to 160km/h in an arena enclosed by boards and glass, with metal goal posts and a hard ice surface (Pinto 1999). The sport is played by both males and females of all ages (Josse 2008).

Two opposing teams skate the ice with the aim of shooting a rubber puck into the opposing team's net to score (Cox et al. 1995). The two teams consist of 20-22 players, with each team having six players on the ice at one time: three forwards (a left wing, a right wing and a centre), two defence (left and right) and one goalkeeper (Bracko et al. 1998). The game is typically played for three 20 minute periods with a rest period that can range from 5-20 minutes between periods depending on what the facility allows (Bracko et al. 1998). The goalkeepers remain on the ice for the duration of the game however the forwards and defence compete on the ice for a short amount of time referred to as a shift, which is usually between 45 and 90 seconds (Cox et al. 1995). The players are then replaced with another line of three forwards and two defence so they are able to recover after their shift (Bracko et al. 1998).

Since ice hockey is a high velocity, high impact sport, injuries do occur (Rishiraj et al. 2009). Studies conducted in other countries concluded that the risk of injury in ice hockey is high considering the contributing risk factors (Agel et al. 2007a; Biasca et al. 2002; Wennberg and Tator 2003). The ice hockey environment in South Africa is very different to the countries in the literature therefore this study investigates the

prevalence of ice hockey related injuries in South African athletes and highlights the risk factors which influence injury rates of ice hockey players.

1.2 Aim of the study

The aim of this study was to determine a profile of ice hockey injuries in South African players.

1.2.1 The First Objective

To establish a demographic profile of ice hockey players in South Africa.

1.2.2 The Second Objective

To establish a profile of ice hockey related injuries sustained by players over the previous season.

1.2.3 The Third Objective

To determine if associations with the demographic profile and injuries sustained by ice hockey players exists.

1.2.4 The Fourth Objective

To establish if an association between injuries sustained and use of protective equipment exists.

1.3 Rationale for the study

Injuries in sport are not random occurrences and can be attributed to possible risk factors. It is helpful to identify patterns and types of injuries within a population to help identify potential risk factors (Biasca et al. 2002). It is then important to address these risk factors with a view to reducing the occurrence of the injury within the population. This will help to ensure the optimal performance of the sport population that is at risk of the injury.

Ice hockey is a high contact, fast paced sport where players are at risk of injury from collisions with other players, the boards, goal posts, sticks or pucks (Pettersson and Lorentzon 1993; Tegner and Lorentzon 1991). The unpredictable nature of the game also contributes to injury (Tegner and Lorentzon 1991; Pettersson and Lorentzon 1993; Rishiraj et al. 2009). According to LaPrade et al. (2013), ice hockey has unique injury patters when compared to other contact sports and significant medical and economic cost are associated with a sport of this nature.

Investigating the epidemiology of South African ice hockey-related injuries should assist athletes in becoming more competitive on a national and international level by highlighting potentially modifiable risk factors which may then be addressed in order to prevent injuries and therefore be able to compete more effectively for a longer period of time (Hootman et al. 2007).

Ice hockey is not a very popular sport in South Africa (van Doesburgh 2016) and because of this, medical professionals may have limited knowledge on the types of injury patterns that may arise in players. Therefore, this research will assist medical professionals, including chiropractors, in identifying common injury mechanisms and planning strategies focused on reducing injury rates, minimising interruption of play and returning athletes to competition safely (Junge et al. 2002).

The results of this study will provide a scientific understanding of ice hockey injuries in South Africa which can be used by governing bodies and players to make informed decisions regarding procedures or rules which promote safety in the sport (Josse 2008) as well as strategies to correct the factors that contribute to risk with an educational, legal and financial approach (Cusimano et al. 2011).

1.4 Outline of chapters

This chapter (Chapter One) provided the background to the study and outlined the aims and objectives. Chapter Two consists of a review of the current literature followed by the research methodology in Chapter Three. Chapter Four presents the results of the study and Chapter Five will discuss each result and how it compares with the current literature. In Chapter Six, conclusions are drawn from the results of this study, recommendations provided for future studies and limitations of this study identified.

CHAPTER 2 : LITERATURE REVIEW

2.1 Overview of the chapter

This chapter aims to provide a review of the literature regarding various ice hockey injuries. The literature review will be presented in the following headings; (i) the prevalence of ice hockey injuries, (ii) anatomical site of injuries, (iii) type of injuries, (iv) risk factors associated with ice hockey injuries and (v) mechanism of ice hockey injuries.

2.2 Prevalence of ice hockey injuries

Ice hockey has been termed the fastest and most ferocious team sport in the world involving both controlled aggression and finesse (Daly et al. 1990). The high level of intensity that the game is played at results in frequent collisions between players and direct forceful impacts with the boards, goal posts, puck, sticks and ice putting ice hockey players at a great risk of a multitude of different types of injuries (Benson et al. 1999).

Engebretsen et al. (2010) found that during the 2010 Winter Olympics, in relation to the number of athletes registered for each sport, ice hockey athletes were at the highest risk of sustaining an injury with 13-35% of all players. Tuominen et al. (2014) found that over seven years of international ice hockey world championships, in 844 games, 6666 players sustained 528 injuries equating to 52.1/1000 player-game hours. Molsa et al. (1997) also reported a high incidence of injury in ice hockey in the Finnish National League with 66/1000 player-game hours. The incidence of injury in soccer and cricket is lower with international soccer resulting in 42/1000 player-game hours and international cricket resulting in 2.8/1000 player-game hours (Posthumus and Viljoen 2008). The contact sport of rugby, however, reported a significantly higher incidence of injury in international competition with 218/1000 player-game hours (Posthumus and Viljoen 2008).

Most injuries in ice hockey occur during games due to the higher level of aggression in competition (Kuzuhara et al. 2009). Molsa et al. (1997) noted that injury rates in

practice were 1.4/1000 player-practice hours compared to 66/1000 player-game hours. The most frequent types of injuries across the literature are laceration, ligament sprains, muscle strains and fractures (Caputo and Mattson 2005; Daly et al. 1990; Rishiraj et al. 2009).

The most commonly documented mechanism of injury in ice hockey is contact with either another player or another player's equipment (Josse 2008). Injuries resulting from player impact is understandable when considering the amount of energy that is transferred from the player enforcing the body check to the receiving player who must absorb the impact, however the body's ability to absorb the forces of impact are limited and when the structure can no longer withstand the force it results in ligament, joint or bone damage (Josse 2008). Studies across the world have concluded that head and neck, shoulder and knee are commonly injured anatomical sites in ice hockey (Flik et al. 2005; Tuominen et al. 2014).

2.3 Anatomical site of injuries

In reviewing the literature it is difficult to make comparisons in anatomical location of the most common ice hockey injuries due to the differences in descriptions of anatomical location, for example in the men's collegiate ice hockey league knee internal derangement is the most common injury in games (13.5%), however this figure would be much greater if all injuries to the knee were grouped together (Agel et al. 2007a). Flik et al. (2005) found in the United States of America Eastern College Athletic Association Division I, the most commonly injured body part was the knee/leg (22%), followed by the head (19%) and shoulder (15%). A number of studies group various body parts into head and neck, upper extremity, lower extremity, back and trunk and other (Agel et al. 2007a; Hostetler et al. 2004; Tuominen et al. 2014), however there are contradicting results between the studies as to which anatomical location is more commonly injured.

2.3.1 Head, neck and face

The head, neck and face are common sites of injury in ice hockey players (Hostetler et al. 2004). Injuries include concussions, contusions, lacerations, facial fractures and cervical spine injury (Moslener and Wadsworth, 2010). Kuzuhara et al. (2009) found that over a three year period most injuries in a Japanese elite team were to the head

(13.5%) which is consistent with the findings of Pettersson and Lorentzon (1993) which showed head and neck injuries to be the most common location of injury in a Swedish elite team (30.6%) as well as the study conducted by McKay et al. (2014) following the National Hockey League in the U.S.A. showing that even on different continents of the world, head injuries have been shown to be the highest.

Cervical spine injuries have decreased over the years (Moslener and Wadsworth 2010) following a rule that was implemented by the International Ice Hockey Federation (IIHF) in 1994, prohibiting body checking from behind (Biasca et al. 2002). Concussion rates, however, continue to escalate as the players get bigger and faster and the velocity of the game increases (Wennberg and Tator 2003).

2.3.2 Shoulder

The shoulder is one of the most commonly injured sites in ice hockey due to frequent aggressive body checking which results in direct force to the shoulder girdle (Daly et al. 1990). A body check is where a player leads with their shoulder to create body contact on their opposition which can include the combined forces created by one player colliding with another player causing a collision with an unyielding surface, such as the boards, goal posts or ice, therefore the risk of shoulder injury is high (Tuominen et al. 2014).

Injuries include glenohumeral joint dislocations, acromioclavicular joint separations and clavicular fractures (Josse 2008). The energy transferred from the body checking player must be absorbed by the opposing player and when the body's ability to absorb that force is exceeded the structural integrity of that joint or bone may be compromised resulting in a joint dislocation or bone fracture (Josse 2008). The forces of impact are also sustained by the initial player that gave the body check therefore the shoulder may be injured not only in being body checked but also in delivering a body check on the opposition (Josse 2008).

2.3.3 Groin

The adductor muscle group is located along the inner thigh region and originates in the groin and inguinal area at different parts of the pubis, inserting along the medial

portion of the femur (Nicholas and Tyler 2002). The main action of the muscle group is to adduct the thigh and to stabilise the lower extremity (Nicholas and Tyler 2002).

The groin is a common site of a muscle strain injury in ice hockey due to the skating stride which requires powerful contraction of the adductor muscles to propel the player in the desired direction, causing strain at the origin of the adductor muscles in the groin region (Daly et al. 1990). The adductor muscles have been shown to have a far greater amplitude of activation relative to the abductors and external rotators of the hip, especially during forward skating which requires a forceful eccentric contraction of the adductors (Abbott 2014).

2.3.4 Knee

The knee is the most frequently injured site of the lower extremity and represents 12.0-13.0% of all ice hockey injuries (Dryden et al. 2000; McKay et al. 2014). Knee joint injuries frequently include ligament sprain, meniscus damage or cartilage injury (Hagglund et al. 2006).

The medial collateral ligament is the most commonly injured ligament in ice hockey (LaPrade et al. 2009). The hockey skating stance forces the knee into more of a valgus stress than a varus stress therefore, during a collision, the lateral collateral ligament and cruciate ligaments are less likely to sustain an injury (Moslener and Wadsworth, 2010).

2.4 Type of injuries

The ice hockey game is associated with intentional and unintentional collisions, high speed, quick changes in directions and trauma from the puck, stick and boards (Tuominen et al. 2014). As a result of the characteristics of the game, injuries include high velocity impacts, fractures, dislocations, lacerations, contusions, overuse injuries and traumatic brain injury. Lacerations, contusions, sprains and strains are the most common (Josse 2008).

Rishiraj et al. (2009) conducted an investigation into injuries of the men's ice hockey team of the University of British Columbia that participated in the Canada West University Association over a period of 6 years and found the most common types of all documented injuries were ligament sprains (20%) and muscle strains (20%)

followed by concussions (13%), contusions (11%) and lacerations (11%). These results differ slightly to an observational study conducted by Tuominen et al. (2014) which analysed the type, mechanism, incidence and severity of injuries which occurred during 41 world championship ice hockey tournaments from 2006 to 2013. This study found that 6666 players experienced 528 injuries over 844 matches. Ninety two point eight percent of the injuries were acute and this remained constant over the entire period of the study (Tuominen et al. 2014). The most frequent type of injury were lacerations (26.1%) followed by ligament strains (21.8%), contusions (15%) and fractures (14%) (Tuominen et al. 2014).

2.4.1 Contusions and lacerations

Kuzuhara et al. (2009) reported that 25 male elite Japanese players had 24 laceration injuries over the three year study period, 21 of which were to the face. This may be attributed to the lack of facial protection used by the players in this team, where 78.3% of players wore a half visor which extends to the tip of the nose leaving the rest of the face exposed and the remaining players wore no facial protection thereby exposing the entire face (Benson et al. 1999; Kuzuhara et al. 2009). Lacerations may still occur with full facial protection either by an impact that causes the helmet to shift up on the head or the stick moving up under the full face grid or visor (LaPrade et al. 1995). Stick contact was shown to be a major cause of facial and other lacerations which is often a result of an opposing player illegally raising their stick above shoulder height (Kuzuhara et al. 2009).

Kuzuhara et al. (2009) found contusions to the thigh, lower leg, knee, foot and hand, to be the most frequent type of injury. Contusions primarily occur from direct trauma when a player collides with an opposing player, the boards, ice or goal posts or with the puck while attempting to block a high velocity shot at the goal, causing swelling and pain as a result of the underlying haematoma (Daly et al. 1990). Contusions may result in a reduced range of motion and may take six to eight weeks to resolve, with the possibility of developing myositis ossificans (Daly et al. 1990).

2.4.2 Sprains and strains

Strains (injuries to the muscle or tendon) commonly occur in the adductors, rotator cuff, neck and lower back and may be attributed to the posture and skating motion

whilst playing (Kuzuhara et al. 2009; Pettersson and Lorentzon 1993). Muscular strains to the hip and pelvis are the most common strain injury in practices and games (Agel et al. 2007a). Agel et al. (2007a) state that the rotational stressors and body collisions of ice hockey cause structural asymmetry and muscular imbalances which increase the frequency of muscle strains in players.

Most frequent lower limb diagnosis is a strain or sprain injury (Caputo and Mattson 2005). Sprains (injury to the ligament) more frequently involve the collateral ligaments of the knee than any other ligament (Caputo and Mattson 2005; Molsa et al. 1997). Tuominen et al. (2014) reported 46.9% of all lower limb injuries affected the knee and the majority of knee injuries were grade 1 sprains of the medial collateral ligament. This may be as a result of rotational stress in combination with a valgus or varus force during the actions of skating, passing or shooting or in direct contact situations with other players, the boards or goal posts (Daly et al. 1990).

Ankle sprains are common across various different sports, however, the skate boot in ice hockey does not allow for excessive inversion of the foot and ankle and therefore ankle ligament sprains are less common in ice hockey (Daly et al. 1990)

2.4.3 Fractures

The prevalence of fracture-related injuries in ice hockey is understandable when considering the immense transfer of energy that occurs constantly while playing, from player to player or player to another unyielding object such as the puck, boards or goal posts (Josse 2008). If the forces transmitted exceed a bone's threshold of absorption, the structural tolerance will be compromised and a fracture can occur (Josse 2008).

According to Marchie and Cusimano (2003) those playing in leagues where body checking is allowed have a 12 times greater chance of sustaining a fracture than those in non-body-checking leagues. McKnight et al. (1992) reported that all fractures resulted from direct impact with the boards or puck. Fractures of the facial region are most common and may occur from direct trauma of the puck or a stick particularly if the player does not have full facial protection (Daly et al. 1990). Circumstances in which a player slides skate first in the boards can result in fractures of the tibia and fibula as a result of excessive rotational forces (Josse 2008).

2.4.4 Concussions

Sports-related concussions caused by traumatic forces to the brain are common in ice hockey and are of great concern due to the associated neurological sequelae (Flik et al. 2005; Josse 2008). The neurological symptoms following a concussion include, but are not limited to, headache, dizziness, loss of consciousness, nausea, vomiting, cognitive changes and seizure (Josse 2008). Studies on individuals that have suffered more than one concussion show objective evidence of long standing cognitive deficits (Chamard et al., 2012).

Ice hockey has one of the highest concussion rates of all contact sports (Flik et al. 2005). Concussions occur from direct contact with another player, the boards or the ice, or from the forces of acceleration after a player is illegally body checked from behind (Moslener and Wadsworth 2010). There has been a significant amount of research on concussions in ice hockey in order to identify the possible risk factors that may increase the risk of concussions (Stevens et al. 2006). These risk factors include players that are bigger and faster than in the past, new boards and glass that may be more rigid, chosen facial protection on the helmet and gender (Wennberg and Tator 2003).

Flik et al. (2005) found that concussions occurred in one of every five injuries and was responsible for nearly a quarter of all game-related injuries. Of the total 21 recorded concussions in the study, only six were considered a result of illegal body checking which shows that stricter enforcement of the rules alone could not significantly reduce concussion rates (Flik et al. 2005). During the seven year period, 9.9% of all injuries were concussions (1.4/1000 player-games) and 11.5% of those players returned to play in the same game (Tuominen et al. 2014). Premature return to play while the player is still symptomatic may put the player at further risk of severe neurological damage and a longer recovery period (Abbott 2014).

Cusimano et al. (2011) investigated the knowledge and understanding of ice hockey players, parents and coaches on concussions in Toronto and a significant number of participants were able to explain only one or no symptoms of concussions. The misconceptions and lack of knowledge of concussions may lead to serious life-long consequences for players (Cusimano et al. 2011).

2.5 Risk factors associated with ice hockey injuries

Risk factors in terms of sport are related to any factor which may increase the risk of injury (Caine et al. 2008). Injuries in sport occur due to an interaction between risk factors and therefore it is important to identify those potential risk factors within a sporting population (Biasca et al. 2002). The sports injury model described by Bahr and Holme (2003) involves multiple risk factor interaction and a sequence of events which eventually result in an injury. Risk factors do not automatically result in injury but the presence of risk factors increases the susceptibility of an athlete to injury and this model evaluates the intrinsic and extrinsic risk factors which increase the susceptibility and therefore contribute to the resultant injury (Bahr and Holme 2003).

In ice hockey, players are at a high risk of injury due to the inherently aggressive, fast-paced nature of the sport (Rishiraj et al. 2009). In order for it to be possible to reduce injury rates with intervention and prevention strategies, it is important to investigate sport specific player injury profiles and associate the profiles to the risk factors involved (Motala 2009). Ice hockey is a growing sport in South Africa (van Doesburgh 2016) and identifying and addressing the potentially modifiable risk factors in the South African ice hockey environment could assist in reducing prevalence of injuries in this population.

2.5.1 Intrinsic and extrinsic risk factors

According to Meeuwisse (1994), risk factors can be divided into intrinsic and extrinsic risk factors. Meeuwisse (1994) describes the intrinsic risk factors as those internal, non-modifiable factors which are necessary but not sufficient to cause injury. Extrinsic factors are those factors from the external environment which act upon a predisposed athlete and enable the manifestation of an injury (Bahr and Holme 2003). The presence and interaction of both internal and external risk factors leads to the susceptibility of injury, however the risk factors alone are not sufficient to cause injury (Bahr and Holme 2003; Bahr and Krosshaug 2005). Meeuwisse (1994) describes the final inciting event as the last link in the chain that causes injury in an already susceptible athlete and this inciting event is necessary for the injury to occur. The

inciting event is typically termed the mechanism of injury and is usually related to the onset of injury (Bahr and Krosshaug 2005).

2.5.1.1 Intrinsic risk factors

Intrinsic risk factors are those internal factors that are specific to the athlete and which contribute to injury (Bahr and Holme 2003). The intrinsic factors are seen as those biological and psychosocial characteristics which predispose an athlete to respond in certain way to a possible injury circumstance (Meeuwisse et al. 1994). These include age, gender, height, body mass and level of experience (Murphy et al. 2003).

2.5.1.1.1 Age

Numerous studies have linked age to injury (Murphy et al. 2003; Stevenson et al. 2000; Taimela et al. 1990) however the studies have presented contradictory results (Murphy et al. 2003). Higher risk of injury in men and women has been associated with older age among soccer players, military recruits and recreational athletes (Lindefeld et al. 1994; Ostenberg and Roos 2000).

In contrast, older players typically have an increased exposure to their sport in comparison to younger players if the older player has been playing for more years and therefore older athletes may be at greater risk of injury (Murphy et al. 2003). The degenerative changes found in older players becomes a factor in the source of injury (Taimela et al. 1990) and an increase in injury rate may be attributed to age-related changes in musculoskeletal function, such as a decrease in strength, and reduced joint mobility (Fukuchi et al. 2014). Fitzgerald et al. (1997) showed that in active females, aerobic power decreases with age. An increase in injury can, therefore, be attributed to a decrease in fitness and conditioning as a female ages (Schick 1999). Josse (2008) stated that as age increases, level of skill increases and so too does the velocity of the puck increase, which leads to an increased rate of injury.

In contrast, other studies have revealed that the incidence of injury decreases with age and more injuries occur in younger athletes (Murphy et al. 2003) with the observation being that as players move through the age groups and have been playing the game for longer they are able to avoid dangerous contact situations because of

their greater experience level (Schick 1999). Injuries that occur in the younger aged players may be due to their lack of technical and tactical ability (Peterson et al. 2000).

2.5.1.1.2 Gender

The style of game differs greatly between male and female ice hockey players (Poutiainen 2012). The most significant difference is body checking and body contact, a common cause of injury, which is a large part of the male game but is not permitted in any women's league anywhere in the world (Emery et al. 2010). A review of the literature by MacCormick et al. (2014) showed that male players were at higher risk of injury than female players at all age levels which may be attributed to the fact that body checking is prohibited in female ice hockey. Despite the difference in body contact rules, the predominant mechanism of injury for male and female was player contact (MacCormick et al. 2014). This indicates that although female players are less prone to injury due to the prohibition of body checking, body contact during the female game still can lead to an injury (MacCormick et al. 2014).

Shoulder injuries are a common finding in male ice hockey players which are predominantly a result of body checking (MacCormick et al. 2014). Because body checking is illegal in female ice hockey, shoulder injuries are an uncommon finding in female players (Agel et al. 2007b).

The injury rates to the face are significantly higher in males than females (MacCormick et al. 2014), which may be attributed to the mandatory use of full facial protection in the female game where male players are able to choose between full facial protection, half visor, or no facial protection. The lack of facial protection exposes male players' faces to possible contact with the puck, sticks, goal posts or other players (Stuart et al. 2002).

MacCormick et al. (2014) found that concussions made up 17% of the injuries sustained by female players versus 8% in male players. Agel et al. (2007b) found that the rate of concussion was 0.82/1000 player-game hours in females which exceeds the 0.72 player-game hours found in males, which they explained to be a result of the great variation in female players' ability to tolerate player contact. Some female players grow up playing with male teams where they would have been taught how to execute a body check as well as how to absorb a body check whereas other female players

may have only ever played with other females who would then not have been taught body checking, which results in players with a large variation of experience with body checking playing at the same time (Agel et al., 2007b).

2.5.1.1.3 Height and body mass

A body mass index (BMI) below 18.5 is considered underweight, 18.5-24.9 is normal, 25-29.9 is overweight and over 30 is considered obese (Pollack et al. 2008). Grant et al. (2015) investigated the risk of injury in male collegiate ice hockey players in terms of body composition and physical fitness. The results showed that the risk of injury in a player with a BMI of 25kg/m^2 or greater was 2.1 times that of a player with a body mass index of less than 25kg/m^2.

Schick (1999) found in a study of ice hockey players who weighed 73kg or more that these players are two times more at risk of shoulder injury than lighter weighted players. This may be caused by the greater force of impact that larger players are able to generate which, according to Brust et al. (1992), is 70% greater than smaller players, which puts them at a higher risk of all injuries.

2.5.1.1.4 Level of experience

According to Daly et al. (1990), the injury rates for ice hockey players range greatly depending on the level of experience of an athlete. Those inexperienced athletes who are new to the game may find themselves in high risk situations due to their limited knowledge of the concepts of the game (Schick 1999). However, as athletes become more experienced their playing level and intensity increases and the players move at higher speeds which may also contribute to injury (Agel et al. 2007a; Tegner and Lorentzon 1991).

Hostetler et al. (2004) reviewed the incidence of concussions in ice hockey players from six years of age up to elite level players and found that concussions were most common in the younger less experienced players as well as in the elite level, more experienced players. This means that ice hockey players may be more susceptible to injury if they are inexperienced or highly experienced and the level of play increases.

2.5.1.2 Extrinsic

Extrinsic factors are external to the individual athlete (Murphy et al. 2003). They are external or environmental factors that create a situation which may lead to injury (Bahr and Holme 2003). Extrinsic factors include player position, level of competition, exposure to activity, previous injury, protective equipment, playing surface and facilities (Murphy et al. 2003).

2.5.1.2.1 Vulnerability of injury of the various player positions

The position on the ice also affects exposure to activity (Poutiainen 2012). In a study on a Japanese elite team, Kuzuhara et al. (2009) reported that 65.8% of all injuries occurred in forwards (three per team), 29.5% in defence (two per team) and 4.7% in goalkeepers (one per team). Tuominen et al. (2014) found that in the World Championships over 7 years, injuries according to player position were equally distributed for forwards and defence. Goalkeepers were injured the least of all positions, even though goalkeepers remain on the ice for the entire game (Tuominen et al. 2014).

McKnight (1992) found that goalkeepers had the lowest rate of injury compared to the other positions which may be due to the added protective equipment goalkeepers use, the limited area of ice that this position allows for and the rules prohibiting body contact on goalkeepers.

McKay et al. (2014) found a higher risk of injury in defence which may be attributed to the aggressive style of play, shot blocking and physical contact associated with the position. In contrast to those results, McKnight (1992) and Kuzuhara et al. (2009) noted that forwards have the highest rate for all direct impact injuries which may be explained by the ‘dump and chase’ strategy used by most ice hockey teams whereby the puck is ‘dumped’ into the offensive zone to gain territory, the forwards ‘chase’ down the puck which will typically lie close to the board, putting that forward at a greater risk of contact injury from body checking.

Flik et al. (2005) found that player position is an important factor in concussion rates where forwards suffered 76% of all concussions followed by defence at 24% and none in goalkeepers, which means when adjusted to represent the number of players on

the ice at one time (3 forwards and 2 defence) forwards are 2.1 times more at risk of concussion than defence. Although these findings correlate with the results of a similar study conducted on a similar league in North America (Pinto et al. 1999), they are very different to the findings of a Finnish National Hockey League study conducted by Molsa et al. (1997) which showed that goalkeepers sustained 5 out of the 9 concussions which occurred in 1 season. The differences in these findings may be explained by the fact that the North American style of ice hockey is more physical than the European style of game and therefore places the attacking players at a higher risk of concussion (Flik et al. 2005).

2.5.1.2.2 Level of competition

Although most of the rules of ice hockey are the same across all the senior leagues or divisions, intentional body checking is the one rule that differs depending on what level the player is competing at (Caputo and Mattson 2005; Dryden et al. 2000). Body checking has been described as the most common mechanism of injury in ice hockey (Flik et al. 2005; Tuominen et al. 2014).

A number of studies have reported the incidence of injuries during games being 52.1/1000 player-game hours in international men's world championships and 49.4/1000 player-game hours in the largest league worldwide, National Hockey League of North America (McKay et al. 2014; Tuominen et al. 2014). The incidence of injury is significantly higher in these leagues where body checking is permitted in comparison to 12.2/1000 player-game hours in a men's recreational non-body checking league in Canada and 12.1/1000 player-game hours in the collegiate women's league in the United States of America (Agel and Harvey 2010; Caputo and Mattson, 2005). Players competing in more physical leagues are therefore at increased risk of injury (Dryden et al. 2000).

2.5.1.2.3 Exposure to activity

Injury rates during games have been found to be higher than during practices (Kuzuhara et al. 2009; Pelletier et al. 1993; Pettersson and Lorentzon 1993; McKnight et al. 1992). Rishiraj et al. (2009) reported that injury rate for games was 7.5 times higher than the rate of injury during practices in the American University leagues over six years. Pettersson and Lorentzon (1993) investigated injury rates in the Swedish

Elite team and results showed the 68.9% of injuries occurred in games. This corresponded with the injury rates that occurred in a Japanese elite team, where 59.9% of all injuries occurred during games (Kuzuhara et al. 2009).

The difference between the number of injuries in games versus practice could be due to more aggressive and competitive play during games, where there is more body contact and a higher intensity of play (Emery et al. 2006; Agel et al. 2007a; Kuzuhara et al. 2009).

2.5.1.2.4 Previous injury

Across many sports and activities, a history of previous injury has proved to be the most common risk factor contributing to muscular injury and as it is a non-modifiable risk factor and there are no preventative strategies to decrease the risk it may also be termed an intrinsic risk factor (Arnason et al. 2004; Bennell et al. 1996; Maffey and Emery 2007).

Caputo and Mattson (2005) found that in recreational ice hockey players, 89% of injured players had a history of previous injury and 28% of those players reinjured the same body part. A number of other authors have stated that a previous injury is the greatest predictor of future injury as a result of changes along the kinematic chain which include lack of proprioception, scar tissue formation, reduced range of motion or extreme flexibility (Hagglund et al. 2006; Croisier 2004; Gabbe et al. 2006).

Hagglund et al. (2006) suggests that recurrent injuries may be attributed to poor rehabilitation or returning to play too early after the initial injury. Whatever the case it is somewhat evident that certain injuries, regardless of adequate rest and rehabilitation, increase the risk of re-injury which may be a result of remaining deficits in the joint or muscle.

2.5.1.2.5 Facilities

According to Wennberg (2004) the area of ice surface differs across the world which causes more collisions in the games played on ice surfaces with a small area. Wennberg (2004) found that in the National Hockey League in North America, in the World Junior Championships and in the Winter Olympics of 2002, significantly more collisions occurred on the smaller ice surfaces compared to the larger international

sized ice rinks. Thus, the standardised usage of larger international rinks could reduce injury rates and head impacts by decreasing the number of collisions (Benson and Meeuwisse 2005; Wennberg 2004).

The difference in concussion rates found when comparing North American studies (Flik et al. 2005) with Finland studies (Molsa et al. 1997) could be explained by the smaller ice surfaces used in North America which increase the number of contact situations (Benson and Meeuwisse 2005; Flik et al. 2005; Wennberg 2004).

Impact with the boards and glass enclosing the ice hockey arena has been identified as a mechanism of injury in various studies (Pettersson et al. 1993; Pinto et al. 1999; Agel et al. 2007a). Tuominen et al. (2014) revealed, in a seven year study of International Ice Hockey Federation World Championships, that arenas with flexible boards and glass reduced the risk of injury by 29%. The games played at arenas with traditional boards and glass had a shoulder injury rate of 2.2/1000 player-games. This significantly decreased to 0.9/1000 player-games in those arenas with flexible boards and glass. In addition to this, there was a decrease in all other types of injuries at arenas with flexible boards and glass, including fewer concussions (Tuominen et al. 2014). Flexible boards and glass allow for the forces transmitted when a player collides with the boards and glass to be absorbed to some degree, which will ultimately cause less damage to the offended body part (Tuominen et al. 2014).

2.6 Mechanism of ice hockey injuries

In a seven year study period, Tuominen et al. (2014) found that body checking (27.2%) and stick contact (21.1%) caused the most injuries followed by puck contact (12.3%). Flik et al. (2005) showed a similar result in that contact with an opponent was also the highest cause of injury (32.8%), however, the study showed that contact with the boards was the second highest cause of injury (18.6%) with overuse injuries contributing to a smaller number of injuries (8%). Pettersson and Lorentzon (1993) conducted a study that investigated the Swedish elite ice hockey teams for four years and found the most common mechanism of injury to be stick contact (26.1%), player contact (23.9%), puck contact (16%) and contact with the boards (7.2%), with overuse accounting for 15.4% of all injuries. Studies investigating women's ice hockey mechanisms of injury showed that player contact was responsible for 46.8% of all

injuries followed by contact with the boards and ice combined (31.9%) and stick and puck contact combined (9.5%) (Agel et al. 2007b). The majority of injuries in men's ice hockey due to puck or stick contact is to the facial region therefore in women's ice hockey these figures may be lower due to the mandatory use of full facial masks in women's ice hockey rules, preventing any facial contact with the stick or puck (Agel et al. 2007b).

2.7 Protective equipment

Over the past decades, protective equipment has evolved to minimise injury from the equipment while maintaining protective function for example manufacturers have covered the hard plastic shells of elbow and shoulder pads in an attempt to lessen forces of impact on an opposing player (Wennberg 2004). As equipment improves in quality and the area of body coverage increases some players get a sense of invincibility while wearing their protective equipment because they feel safer than what they actually are (Josse 2008). This may lead to players engaging in more aggressive play and excessive risky behaviour due to the belief that any impact will be deflected or absorbed by their equipment (Biasca et al. 2002; Josse 2008; Tator et al. 1998).

The proper maintenance and replacement of equipment is often ignored and players use outdated and broken equipment which may lead to injury of themselves and opposing players that make contact with their equipment (Josse, 2008). When equipment becomes old and deteriorates, the padding gets thinner and more rigid and therefore the absorption capacity of the padding is reduced, causing increased forces to be transmitted to the body (SmartPlay 2015). The hard plastic becomes brittle and is unable to withstand forceful impacts with hard surfaces such as the boards, ice, sticks or the puck (Proactive Health Group 2016). Thus, the use of old equipment can lead to otherwise preventable injuries.

Ice hockey equipment can be expensive in relation to other sports that require less equipment therefore affordability becomes a factor when purchasing equipment (Stamper 2014). As a result, players may choose entry level items which are manufactured with inferior materials in order to be produced for a lesser cost and as a result provide reduced protection against injury (Wozniak 2015). An example of this can be seen in the helmets where a top of the range helmet can reduce the incidence

of concussion by six times compared to that of an entry level or intermediate helmet (Rowson et al. 2015).

Additional concerns regarding equipment include the correct fit, for instance, shin pads that are too small will expose the ankle and lower leg however shin pads that are too big may shift when a player falls and therefore cause further damage to the knee (Cook 2015). Similarly, shoulder pads that are too small or too big will not sit correctly on the shoulder and will therefore not provide adequate protection in an intentional or accidental contact situation (Josse 2008).

Players do not always choose to wear all the protective equipment. For example, Caputo and Mattson (2005) found that in the male leagues in the United States of America where body checking is illegal and it is not compulsory to wear all the protective equipment such as shoulder pads, 50% of those players who suffered shoulder injuries were not wearing shoulder pads and the injuries were due to unintentional collision with the boards. In the same study it was noted that there was a lack of protective equipment in 38% of all injuries suggesting that stricter enforcement on wearing full protective equipment at all times would possibly reduce the injury rates in ice hockey leagues where it is not compulsory (Caputo and Mattson 2005).

2.7.1 Helmet and visor

In 1963, the compulsory use of hockey helmets began in Sweden, since then no deaths during ice hockey from a head injury have been documented in Sweden (Tegner and Lorentzon 1996). The helmet can be effective in preventing fatal injuries, however it cannot protect the brain against all injury especially those that occur with higher impact forces where there is movement of the brain and skull in response to the impact (Tegner and Lorentzon 1996).

Full facial protection includes a metal grid or plastic shield that extends down to cover the player's chin (Biasca et al. 2002). Half facial protection is a clear plastic visor that extends over half the face to the tip of the player's nose (Benson et al. 1999). A study by Stuart et al. (2002) of 282 Junior A League ice hockey players in North America analysed the association between the number of injuries and the level of facial protection used: full, half or no facial protection. As the level of facial protection

decreased, the rate of injury increased. Only 16 injuries were documented for players wearing full facial protection as opposed to 45 injuries for those with a half visor and 52 injuries in players with no protection.

Studies have noted an increase in concussion rates as well as greater time loss in playing in those players wearing half visors (Daly et al. 1990; Stuart et al. 2002). An explanation for this may be that players wearing half visors often push their helmet backwards on their heads in attempt to see under the visor and get a better view of the ice therefore reducing the amount of protective padding of the helmet on the forehead (Benson et al. 1999).

Josse (2008) refers to protective equipment as a “double-edged sword” where players wearing full facial protection develop a false sense of security and invincibility and believe that they are exempt from injury, therefore players enter into contact with more force and speed. Woods et al. (2007) stated that 69% of the participants in their study were able to play with more aggression while wearing full facial protection. This could explain the conflicting results of other studies which found higher rates of concussions in players wearing full facial protection (Asplund et al. 2009).

It has also been speculated that the extra weight of a helmet with a full face visor may increase the rotational acceleration of the head after impact which produces greater neuronal shear forces and therefore increase the severity of a concussion (Asplund et al. 2009).

2.7.2 Mouthguard

Mouthguards were originally used in the 1930’s by boxers in order to protect the mandible, mouth and teeth and to act as a cushion to absorb the effects of forceful knocks to the jaw (Hawn et al. 2002). There are typically two types of mouthguards used by athletes which are the “boil and bite” shop bought version and the custom made version that is moulded to the player’s teeth by an orthodontic professional (Hawn et al. 2002).

The “boil and bite” mouthguards are commercially available and are relatively inexpensive (Biasca et al. 2002). They are easy to mould, by melting in hot water and then formed around the teeth by the player using finger and biting pressure until the

mould is formed (Newsome et al. 2001). These mouthguards may however be too bulky on the periphery and uncomfortable, and lack retention requiring a constant biting pressure by the player (Newsome et al. 2001). DeYoung et al. (1994) reported a loose fitting mouth guard in 42% of 'boil and bite' mouthguards compared to none in the custom made type.

Custom made mouth guards are produced on a model of the player's upper teeth by an orthodontic professional and, although more expensive, provide a better fit allowing ease of breathing and speaking as well as greater comfort (Newsome et al. 2001).

Many players are resistant to using a mouthguard as they complain of difficulties in speaking clearly and breathing effectively (Hawn et al. 2002). The majority of 'boil and bite' mouthguards are incorrectly fitted and therefore effect normal respiration (Hawn et al. 2002). Francis and Brasher (1991) tested the physiological effects of mouthguard use on respiratory ventilation and gaseous exchange during high-intensity exercise and found that although the use of a mouthguard significantly reduces forced expiratory volume and peak expiratory flow, it may improve tissue oxygenation and lower metabolic expense. These findings suggest that high-intensity exercise or sport performance will not be hindered by the use of mouthguards (Francis and Brasher 1991).

The use of mouthguards in ice hockey is highly recommended due to their ability to absorb the forces to mouth, jaw and teeth in contact situations (Tran et al. 2001). Mouthguards may also be a factor in reducing the severity of concussions (Biasca et al. 2002). Asplund et al. (2009) found that although mouthguards did not decrease the number of concussions in ice hockey, they did show an earlier return to playing suggesting that the use of mouthguards does absorb some of the forces through the head so the severity of the concussion is less. A properly fitted mouthguard alters the position of the temporomandibular joint which reduces the transmitted forces from the mandible to the occiput (Hawn et al. 2002).

2.7.3 Shoulder pads

Shoulder pads used in ice hockey typically consist of a padded vest with a front panel, back panel, hard shelled caps covering the shoulders, upper arm pads and Velcro straps to keep the pads secure (Biasca et al. 2002). Shoulder pads should provide

protection over the chest and upper abdomen, upper and mid back region, shoulders, acromioclavicular joints and upper arms (LaPrade et al. 2009).

2.7.4 Elbow pads

Elbow pads consist of a hard cup which covers and protects the posterior elbow joint, especially from contact with the ice and boards after falling (Biasca et al. 2002). Elbow pads also have padded extensions over the upper and lower arm and adjustable Velcro straps to keep the pads in place (Deemer 2010).

2.7.5 Pants

Ice hockey pants are well padded pants that provide protection for the lower back, lower abdomen, hips, groin, and thighs and include a hard covering over the thigh and lower back region as added protection against possible injury from stick or puck contact (Deits et al. 2010).

2.7.6 Pelvic protector

The genital region must be protected to avoid serious injury from being struck with a stick or puck (Quinn 2016). Male ice hockey players typically use a padded, hard shelled, plastic cup fitted into a strap or shorts that cover the genital region and females use a similar garment comprised of a hard shell which protects the genitalia and lower pelvis from contact injury (Quinn 2016).

2.7.7 Skates

Ice hockey skates incorporate a rigid boot, blade holder and a sharpened steel blade with a rigid toe cap and hard heel and Achilles tendon protectors (Biasca et al. 2002). Every year improvements are made by manufactures to make equipment lighter and more comfortable for players to use, especially when it comes to skates (Agel et al. 2010).

In order to achieve a much lighter design, newer skates have significantly less material over the front portion including the skate tongue, which covers the anterior part of the foot and ankle, and both side walls of the skate which may increase the risk of injury

to the foot and ankle due to direct contact because there is less protective covering (Agel et al. 2010).

2.7.8 Shin pads or leg pads

2.7.8.1 Shin pads

Shin pads, used by forwards and defence, consist of a thick hard plastic shell on the front and soft padding on the inside and provide protection for the anterior portion of the knee and shin from contact with stick, skate blades, the goal posts and direct falls onto the ice or boards (LaPrade et al. 2009).

2.7.8.2 Leg pads

Leg pads are only used by goalkeepers and are thick, wide and flat pads covering the top of the skate, shin and knee in order to block the shots from entering the goal net as well as providing adequate protection (LaPrade et al. 2013).

2.7.9 Gloves or mitt and blocker

2.7.9.1 Gloves

Forwards and defence use gloves which have thick padding on the posterior portion covering the lower parts of the forearm, wrist and hand (Daly et al. 1990). The palmer surface consists of thin, soft leather to allow the stick to be felt in the hand (Cummings 2016). Gloves provide protection to the hand, wrist and lower arm from injury as a result of being struck by an opposing player's stick or the puck (Molsa et al. 1997).

2.7.9.2 Mitt and blocker

Goalkeepers use a 'mitt' on one hand which is used to catch the puck and on the other hand, a 'blocker' which is used to deflect the puck away from the goal net (Cummings 2016). The 'mitt' has a thick padded leather covering the entire hand and wrist which provides adequate protection when catching the puck and the 'blocker' is a soft leather glove with a hard, rectangular shaped pad on the back allowing the puck to be deflected away without causing injury to the hand or wrist (Cummings 2016).

2.8 Ice hockey in the South African context

The South African ice hockey environment proves its own unique circumstances that alter and influence the extrinsic factors affecting ice hockey injuries. The extrinsic factors may differ from those in the rest of the world.

The level of competition has been shown to have an effect on injury rates in ice hockey, where those teams playing in higher leagues or at higher standards sustain significantly more injuries than those in lower leagues (Caputo and Mattson 2005; Dryden et al. 2000; Flik et al. 2005). The South African Ice Hockey men's and women's team are internationally ranked fortieth and thirty-second respectively, which means their experience and speed of play greatly differs from the level found in countries where other studies were performed (International Ice Hockey Federation 2015). Therefore, the injuries found in South African athletes may be significantly different to injuries seen in previous studies performed in higher ranked countries.

The two club leagues within South Africa are the Cape Town Premier League (CTPL) and the Gauteng Premier Hockey League (GPHL). Players competing in these two leagues participate in 15 games in a regular season in comparison to the National Hockey League of North America that play a minimum of 80 games in a regular season (McKay et al. 2014). There is no organized club league in Kwa-Zulu Natal. Therefore, athletes in South Africa may be at a decreased risk of injury due to the fewer number of games played in a season (Pointstreak 2013).

The playing surface and facilities in South Africa could affect injury rates as there is only one ice rink of international size in South Africa (van Doesburgh 2016). There are four other ice rinks in South Africa which are smaller than international standards; three are a similar size to the rinks used in the National Hockey League in North America which is five metres narrower than international size, one is one third of an international size ice rink (van Doesburgh 2016). Therefore, South African players may be at greater risk of injury due to the possible increase in number of collisions on the smaller ice surface.

Collisions with the boards and glass surrounding the ice have been identified as a mechanism of injury (Agel et al. 2007a). Tuominen et al. (2014) showed that flexible boards and glass reduce injury rates as the less rigid structure is able to absorb some

of the impact that would normally be absorbed by the player. Currently, there is only one arena with flexible boards and glass in South Africa (van Doesburgh 2016). This may place players in South Africa at an increased risk of injury as a result of possible collisions with the boards and glass.

Protective equipment in countries such as the United Stated of America, Canada, Sweden and Japan is easily affordable and accessible in many local shops where players are able to fit their equipment accurately. In South Africa, athletes need to import equipment, mostly using online facilities which does not allow for correct fitting (van Doesburgh 2016). The exchange rate, shipping fees and import duties also make it unaffordable resulting in players using out dated, old and inferior products (van Doesburgh 2016).

The intrinsic factors that affect injury rates in ice hockey players in South Africa (age, gender, height, body mass, level of experience and aerobic fitness) have not been investigated in the South African context. The intrinsic factors of international ice hockey players and their corresponding risk factors related to injuries, may not be the same in South Africa. This study will help to establish if these intrinsic factors in South Africa are comparable to countries outside of South Africa.

2.9 Conclusion

This literature review focused on various aspects relating to the current study. Although numerous studies have investigated ice hockey injuries internationally, no such study has investigated ice hockey-related injuries in South Africa. This research therefore aims to determine a profile of ice hockey injuries in South African players.

This study will provide a summary of ice hockey injuries in South Africa and help identify risk factors unique to the South African context which influence the injury rates of ice hockey players.

CHAPTER 3 : MATERIALS AND METHODS

3.1 Introduction

This chapter will describe the research methodology and the process of statistical analysis used in this study.

3.2 Study design

This study was a questionnaire based descriptive study in a quantitative paradigm on the investigation of injuries found in ice hockey players in South Africa.

3.3 Total population

The study was open to all ice hockey players registered with the South African Ice Hockey Association (SAIHA) playing within the three existing provincial associations: Gauteng, KwaZulu-Natal and Western Province.

3.4 Sampling method

A questionnaire was distributed to players that met the study's inclusion and exclusion criteria to obtain the relevant information. Questionnaires have proven to be a good source of information provided that the questionnaire has been determined reliable and valid (Mouton 1996).

3.5 Recruitment

Permission was granted by the SAIHA to conduct the study (Appendix A). There were no advertisements for this study. The participants were informed via email through their respective clubs.

3.6 Sample characteristics

In order for the ice hockey players to participate in this study, they were required to meet the criteria listed below.

3.6.1 Inclusion criteria

- Injured and uninjured ice hockey players who are registered members of the SAIHA.
- Any registered ice hockey player who voluntarily signs the letter of information and informed consent (Appendix N) to participate in the main study.
- Players under 18 years of age to avoid the need for parental consent.

3.6.2 Exclusion criteria

- Ice hockey players that participated in the expert group and pilot study were excluded.

3.7 Study size

At the time of ethics approval from the Durban University of Technology (DUT) Institutional Research Ethics Committee (IREC) for this study, there were 267 ice hockey players registered with the SAIHA. Therefore 267 ice hockey players formed the total population of this study. Of the 267 population, 217 were male and 50 were female.

3.8 Measurement tool

3.8.1 Questionnaire

The questionnaire was developed by adapting questionnaires from similar questionnaire based research studies on sports injury profiles (Archary 2008; Motala 2009; Schick 1999).

3.8.2 Expert group procedure

The questionnaire was submitted to the Durban University of Technology (DUT) Institutional Research Ethics Committee (IREC) for approval and then validated through an expert group. The purpose of the expert group was to critically assess the relevance of questions as well as add, delete or clarify any questions which ultimately strengthened the validity of the questionnaire (Salant and Dillman 1994).

The members of the expert group were invited to participate based on their experience

and expertise in the specific areas highlighted in the questionnaire, in order to address its face validity, content validity and construct validity (Kelley et al. 2003).

The expert group consisted of the following persons:

- Two ice hockey players who met the inclusion criteria for the study.
- One chiropractic master's student who was completing a questionnaire based study at DUT.
- One qualified chiropractor with experience in questionnaire based studies.
- The researcher.
- The research supervisor.

At the expert group meeting, the researcher welcomed all participants and explained the procedure for the meeting. Each member of the expert group was required to sign a letter of information (Appendix C), an informed consent form (Appendix E) as well as a code of conduct and confidentiality statement (Appendix D) before the pre-expert group questionnaire (Appendix B) was handed out. The pre-expert group questionnaire was discussed question by question in sequential order and if any inconsistencies were found or changes proposed, a majority decision was made to amend the questionnaire. An audio recording of the meeting was made and is accessible by the researcher and examiners only, in order to protect the confidentiality of the expert group participants.

The changes made during the expert group are listed in Appendix F, which include a rationale for the changes. The changes led to the development of the post-expert group questionnaire (Appendix G).

3.8.3 Pilot study procedure

The post expert group questionnaire was reviewed in a pilot study. The pilot study group involved two participants who met the study inclusion and exclusion criteria. The pilot study was used to administer the questionnaire exactly as it would be administered to the main study group. The purpose of a pilot study is to represent the intended population by ensuring that the questions are appropriate and clear, to determine the time taken and highlight any problematic areas (Van Teijlingen and Hundley 2002). This helps to add validity to and reduce the ambiguity of the questionnaire.

The changes made during the pilot study are listed in Appendix K. This lead to the development of the post pilot study questionnaire (Appendix L). This became the research questionnaire.

3.9 Response rate

A response rate of 138 males was required for this study to complete data collection (Singh 2016).

The sample size was obtained using Raosoft Statistical Software:

$$n = \left(\frac{z \cdot \sigma}{e} \right)^2 = \left(\frac{1.96 \cdot 1.2}{.2} \right)^2 = 138 \text{ (Males)}$$

Where z is the value corresponding to the 95% confidence interval, standard deviation of 1.2 and an error no bigger than 0.2.

A response rate of 45 females was required for this study to complete data collection (Singh 2016).

The sample size was obtained using Raosoft Statistical Software:

$$n = \left(\frac{z \cdot \sigma}{e} \right)^2 = \left(\frac{1.96 \cdot 0.684}{.2} \right)^2 = 45 \text{ (Females)}$$

Where z is the value corresponding to the 95% confidence interval, standard deviation of 1.2 and an error no bigger than 0.2.

3.10 Procedure

- After approval from the Durban University of Technology (DUT) Institutional Research Ethics Committee (IREC) had been granted (Appendix O), data collection for the study began.
- The presidents of each provincial association (Gauteng, KwaZulu Natal, Western Province) were contacted telephonically to inform them about the research process as well as to schedule a date and time that was suitable for data collection.
- Once a suitable day had been established, information regarding the study was passed on to the club coaches or managers.

- The club coach or manager then sent an invitation via email or telephonically to their players, asking them to remain after their training session or game on the scheduled day, to see if they were willing to participate in this study. Some of the clubs required multiple days to be scheduled for data collection as players attend practices on different days within some of the clubs.
- The researcher arranged data collection days in Cape Town (Grand West Arena), Johannesburg (Festival Mall, Kempton Park), Pretoria (The Grove, Lynwood and Forest Hill, Centurion) and Durban (Galleria) (Table 3.1).

Table 3.1: Regional collection days

Province	City	Ice Rink Arena	Date
Western Province	Cape Town	Grand West	14, 17, 18, 21 January 2016
Gauteng	Johannesburg	Kempton Park	1,2 February 2016
Gauteng	Pretoria	Forrest Hill	25, 26 January 2016
Gauteng	Pretoria	The Grove	28, 29 January, 1 February 2016
KwaZulu-Natal	Durban	Galleria	28 February, 1 March 2016

- At the end of the training session or game, the researcher addressed the ice hockey players to explain the research study and its purpose.
- Once it had been determined that the ice hockey players met the inclusion and exclusion criteria of the study, a letter of information (Appendix M) and informed consent (Appendix N) was distributed to all ice hockey players who were willing to participate in the study.
- Once the players had signed the required documentation (informed consent form), a questionnaire (Appendix L) was handed out to those players.
- The participants were given approximately 20 minutes to complete the questionnaire.
- To ensure anonymity of the participants, it was requested by the researcher that no identifying information be written on the questionnaire.
- To ensure confidentiality, the players placed their completed questionnaires and informed consent forms into two separate sealed boxes which were only opened once the data collection for the study had been completed.
- The researcher opened the sealed boxes after data collection was complete in order to capture the data onto an excel spreadsheet for statistical analysis.

- Only the researcher and supervisor had access to the completed questionnaires.
- Upon completion of the research study, all informed consent forms and questionnaires were safely stored in a locked cabinet at the Durban University of Technology: Department of Chiropractic and Somatology. After a five year period from completion of this research study, the data will be shredded.

3.11 Data and statistical analysis

All questionnaires were coded and the data was placed on a Microsoft Excel spreadsheet. The data was then analysed with the help of a statistician using the statistical software SPSS version 24.

3.11.1 Descriptive analysis

Descriptive statistics describes the organising and summarising of quantitative data using univariate analysis and bivariate analysis. Univariate analysis concerns measures of central tendency and dispersion. The most appropriate measure of central tendency for interval data is mean, and dispersion for interval data is the standard deviation. Bivariate analysis involves the measurement of two variables at the same time (Lind et al. 2004: 6). Descriptive data analysis aims to describe the data by investigating the distribution scores on each variable, and by determining whether the scores on different variables are related to each other. Descriptive statistics involve the use of frequency tables, various types of graphs (pie charts, bar charts) and cross tabulations in the case of categorical variables (Willemse 2009: 29-35).

3.11.2 Inferential statistical analysis

Inferential statistics is focused on the testing of a hypothesis. Primary data was captured and analysed and concluding discussions are based on the results obtained. Inferential statistics allow the researcher to draw conclusions about populations from sample data (Lind et al. 2004: 348-351). Associations between the demographic variables and prevalence of injury was assessed using a chi-square test. A chi-square test evaluated statistical significance between proportions of two or more groups on a data set (Willemse 2009: 209-214). Traditionally, reporting results requires a

statement indicating statistical significance, where a *p* value of < 0.05 is considered to be statistically significant (Lind et al. 2004: 347).

CHAPTER 4 : RESULTS

4.1 Introduction

This chapter presents a descriptive analysis of the results followed by an analytical analysis with proportions and means.

4.2 Data

4.2.1 Primary data

The primary data was obtained from the participants following completion of a questionnaire (Appendix L).

4.2.2 Secondary data

The secondary data was obtained from scientific literature, journal articles, books, internet and personal communications with relevant people in the field of ice hockey which will be compared to the results of the study.

4.3 Response rate

In order to increase the validity of this study, a minimum response rate of 138 males and 45 females was required. This response rate was surpassed with 141 males and 46 females meeting the inclusion and exclusion criteria and completing questionnaires. Therefore, the total response rate for this study was 187 participants with a response rate percentage of 70.04%. The high response rate may be as a result of the researcher's presence after games or practice at players' home ice rink as well as remaining present while all questionnaires were completed. The participants were unable to take the questionnaire home with them and were required to hand them to the researcher immediately after completion.

A total of 187 questionnaires in three different provinces (Gauteng, KwaZulu-Natal and Western Province) in South Africa were completed in this research study. Only three provinces participated in this study because the remaining provinces were not

registered with the South African Ice Hockey Association (SAIHA) at the time of data collection.

4.4 Results

4.4.1 Objective One: Demographics

To establish a demographic profile of ice hockey players in South Africa.

- **Question A1-A3: Age, gender and ethnicity**

Table 4.1: Distribution of age, gender, and ethnicity (N = 187)

		n	%
Age	18-27	116	62
	28-37	36	19,3
	38-47	28	15
	48+	7	3,7
Gender	Male	141	75,4
	Female	46	24,6
Ethnicity	White	159	85
	Coloured	20	10,7
	Black	6	3,2
	Asian	1	0,5
	Indian	1	0,5

The inclusion criteria of this study required that ice hockey players be 18 years and older. The majority of the participants were between the ages of 18 and 27 (62.0%) followed by those between the ages of 28 and 37 (19.3%), 38 and 47 (15.0%) and over 48 years of age (3.7%). The mean and standard deviation for age was determine using grouped data statistics and was found to be 28.1 +- 9.3 years.

Of the 187 participants, 141 (75.4%) were males and 46 (24.6%) were females.

The majority of ice hockey players that participated in this study were White (85.0%, n = 159), followed by Coloured (10.7%, n = 20), Black (3.2%, n = 6), Asian (0.5%, n = 1) and Indian (0.5%, n = 1).

In all instances (χ^2 p-value < 0.001), there was a significant difference in the options for the demographic data.

- **Question A4: How much money do you spend (in Rands) on ice hockey equipment in a season?**

Table 4.2: Money spent on ice hockey equipment in one season

Rands (R)	n	%
<500	9	4,8
500-1000	30	16,0
1000-2000	26	13,9
2000-3000	39	20,9
3000-5000	33	17,6
5000-7000	26	13,9
7000-9000	10	5,3
9000-11000	9	4,8
>11000	5	2,7
Total	187	100,0

The majority of the participants reported spending between R2000 and R3000 (20.9%, n = 39) on equipment in a season. This was followed by the amounts of R3000 to R5000 (17.6%, n = 33), R500 to R1000 (16.0%, n = 30) and R5000 to R7000 (13.9%, n = 26).

The amount spent on equipment varied significantly (χ^2 p-value < 0.001), where more of the participants spent less money on equipment.

➢ Questions A5 and A6: Height and body mass

The results of questions A5 and A6 were used to calculate Body Mass Index (BMI) = kg/m².

Table 4.3: Mean, standard deviation, minimum and maximum of: height (QA5), body mass (QA6) and BMI

	Height	Body Mass	BMI
Mean	1,7	78,2	25,8
Std. Deviation	0,1	14,9	3,9
Minimum	1,5	53,0	16,9
Maximum	2,0	103,0	37,2

The mean value of height in this study was 1.7m with a standard deviation of 0.1m. The minimum height was 1.5m and a maximum of 2.0m. The mean value of body mass was 78.2kg with a standard deviation of 14.9kg. The minimum body mass was 53.0kg and a maximum of 103kg. The mean value of BMI was 25.8kg/m^2

Table 4.4: Body Mass Index

		n	%
Body Mass Index	Underweight <18.5kg/m^2	3	1,6
	Normal 18.5-24.9kg/m^2	90	48,1
	Overweight 25-29.9kg/m^2	69	36,9
	Obese >30kg/m^2	25	13,4
	Total	187	100

Most of the 187 participants have normal BMI (n = 92, 49.2%). The BMI distribution is not uniform (χ^2 p-value < 0.001) as the middle two categories have most of the participants.

When the categories are collapsed into categories for normal and over-weight, it is noted that there were nearly as many participants with a BMI of ≥25kg/m^2 (n = 94, 50.3%) as there were participants with a BMI of <25kg/m^2 (n = 92, 49.2%).

- **Question A7, A13, A8 and A9: Province, ice rink, league and osition played**

Table 4.5: Frequency and percentage distribution of the province, ice rink, league and position played by participants (N = 187)

		n	%
What province do you play in?	Gauteng	117	62,6
	KwaZulu-Natal	16	8,6
	Western Province	54	28,9
At which ice rink do you mostly play?	Festival Mall	41	21,9
	Forrest Hill	35	18,7
	Galleria	16	8,6
	Grand West	54	28,9
	The Grove	41	21,9
What league do you play in?	1st Division	59	31,6
	2nd Division	57	30,5
	Premier	47	25,1
	Ladies	45	24,1
	Intermediate	20	10,7
	u20	10	5,3
What position do you play?	Defence	76	40,6
	Forward	102	54,5
	Goalkeeper	9	4,8

Most of the participants in this study play ice hockey in Gauteng (62.6%, n = 117), followed by Western Province (28.9%, n = 54) and KwaZulu-Natal (8.6%, n = 16).

The ice rink most frequently played at by the participants of the study was Grand West (28.9%, n = 54), Festival Mall (21.9%, n = 41) and The Grove (21.9%, n = 41).

The participants of this study mainly compete in 1st Division (31.6%, n = 59) and 2nd Division (30.5%, n = 57) followed by Premier division (25.1%, n = 47) and Ladies

(24.1%, n = 45). Multiple responses were allowed in this question, therefore the totals exceed the total sample size of 187 participants.

The majority of participants in this study stated that they played the position forward (54.5%, n = 102), followed by defence (40.6%, n = 76) and goalkeeper (4.8%, n = 9).

For all four variables above, the distribution patterns were significantly different (χ^2 p-value < 0.001).

- **Question A10: How many years have you been playing ice hockey?**

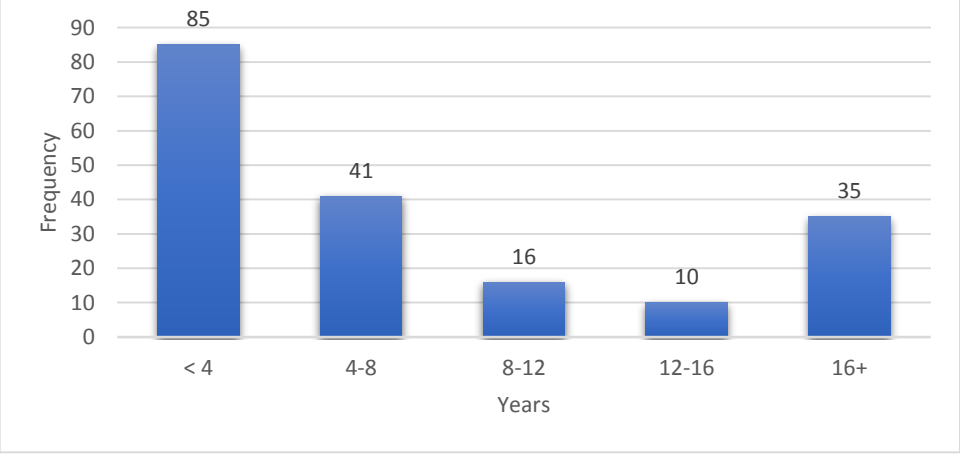


Figure 4.1: Number of years playing ice hockey

Most of the participants reported that they had been playing for less than four years (45.5%, n = 85) followed by those who have played for four to eight years (21.9%, n = 41) and over 16 years (18.7%, n = 35).

- **Question A11: How many hours of training attended per week did you attend in the last season?**

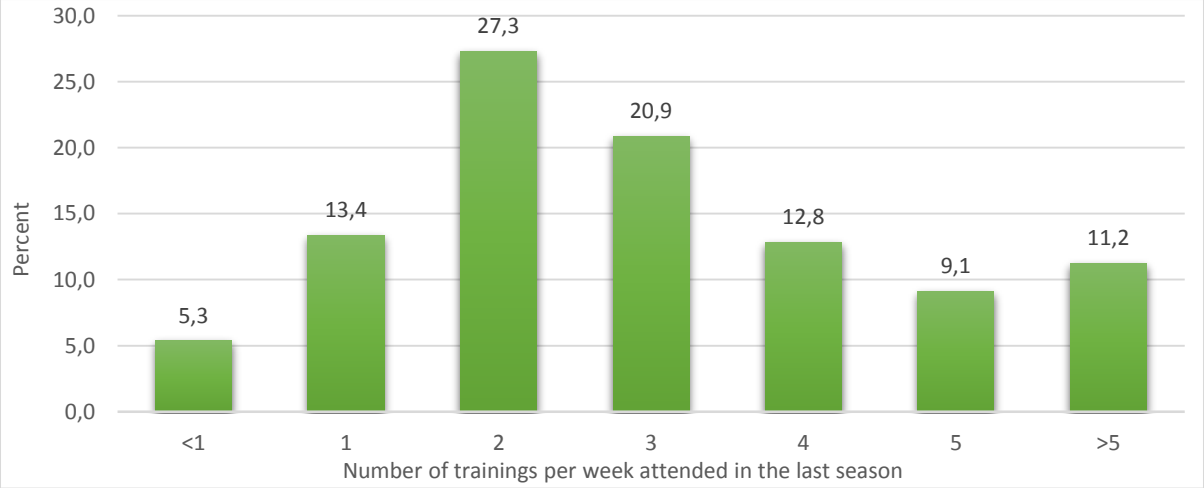


Figure 4.2: Number of training hours per week last season

The majority of number of hours spent in training per week last season was 2 hours (27,3%, n = 51) followed by 3 hours (20.9%, n = 39).

- **Question A12: How many games did you play in the last season?**

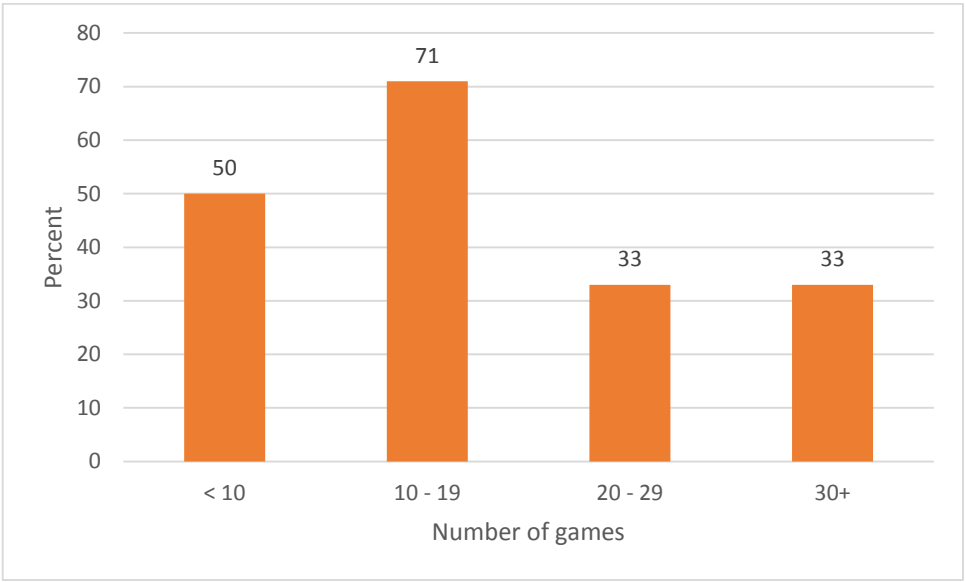


Figure 4.3: Number of games played last season

Of the 187 participants, 71 (38%) played between 10 and 19 games last season, 50 (26.7%) played less than 10 games, and the remainder of participants were evenly split between 20 to 29 and over 30 games (17.6%, n = 33).

- **Question A14: Do you play any other sport?**

Table 4.6: Distribution of other sport played

	Count	Table Total N %
Soccer/Indoor Soccer	32	17,10%
Cycling, Mountain Biking	30	16,00%
Field/Indoor Hockey	20	10,70%
Crossfit, Gym, Strength Training	16	9,00%
Rugby	11	5,90%
Golf	10	5,30%
Swimming, Diving, Waterpolo, Skiing, Wakeboarding	8	4,30%
Squash, Tennis, Badminton	8	4,30%
MMA, Jiu Jitsu, Martial Arts, Karate, Kickboxing	7	3,70%
Cricket	4	2,10%
Motorcross, Motor sport	4	2,10%
Figure Skating, Synchronised Skating	4	2,10%
Surfing, Stand up paddle, Bodyboarding, Kiteboarding	4	2,10%
Running	4	2,10%
Baseball/Softball	3	1,60%
Volleyball/Netball	3	1,60%
Inline/Roller Hockey	2	1,10%
Paintball	1	0,50%
Roller Derby	1	0,50%
Horse Riding	1	0,50%
Rock Climbing	1	0,50%
Total	152	81,30%

Participants reported on any other sport that they played. The most frequent alternate sports were soccer/indoor soccer (17.1%, n = 32), cycling/mountain biking (16.0%, n = 30), field/indoor hockey (10.7%, n = 20), crossfit/gym/strength training (9.0%, n = 16). Participants were allowed to choose more than one answer to this question,

however, not all participants selected an alternative sport. Therefore, the total for this question was 152 answers.

The chi square p-values were all less than 0.05 for each of A10, A11, A12 and A14 above. This implies that the frequency distributions were not similar per option.

Summary of Objective One

The demographic profile of ice hockey players in South Africa showed a majority of players being between the ages of 18 and 27 years (62%, n = 116), male (75.4%, n = 141) and white in ethnicity (85%, n = 159). Of the 187 participants in this study 92 (49.2%) were of normal BMI and 69 (n = 36.9%) showed to be overweight.

Most of the players come from the province of Gauteng (62.6%, n = 117). Many play the position of forward (54.5%, n = 102) and defence (40.6%, n = 76) with only 9 (4.8%) of participants playing goalkeeper. The most common playing time was less than four years (45.5%, n = 85) and the majority of participants had 2 hours of training per week (27.3%, n = 51). Games played in a season were mostly between 10 and 19 games (38%, n = 71).

The most common alternate sports played by participants were soccer or indoor soccer (17.1%, n = 32) and cycling or mountain biking (16%, n = 30).

4.4.2 Objective Two: Profile of injuries

To establish a profile of ice hockey related injuries sustained by players over the previous season.

After Section A, the participants were asked the following question that does not have a question number:

Have you sustained any injuries in the last season?

Table 4.7: Have you had any injuries in the last season?

	n	%
Yes	108	57,8
No	79	42,2
Total	187	100,0

Table 4.7 shows that, of the 187 participants in this study, 108 ice hockey players (57.8%) had at least one injury, while 79 (42.2%) participants reported having no injuries last season. The participants that reported having no injuries last season moved on to Section D.

The difference in the scoring patterns was significant (χ^2 p-value = 0.016).

Characteristics of injury

In Section B, participants were asked to describe up to three of their most severe injuries in the last season, with injury one being the most severe, injury two the second most severe and injury three any additional injuries.

This study is investigating the injuries of ice hockey players in South Africa and therefore the incidence of each injury was calculated using the entire sample population of 187 participants.

- **Question B1: For each injury indicate the body site that was injured**

Table 4.8: Body site of Injury One, Injury Two and Injury Three

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Head	19	10,2	3	1,6	2	1,1
Shoulder	15	8,0	7	3,7	5	2,7
Knee	15	8,0	14	7,5	1	0,5
Back	12	6,4	7	3,7	8	4,3
Ankle	8	4,3	7	3,7	3	1,6
Chest	6	3,2	3	1,6	0	0
Groin	6	3,2	5	2,7	2	1,1
Face	5	2,7	8	4,3	2	1,1
Wrist	5	2,7	2	1,1	4	2,1
Elbow	4	2,1	1	0,5	1	0,5
Thigh	3	1,6	2	1,1	1	0,5
Foot	3	1,6	2	1,1	3	1,6
Neck	2	1,1	0	0	1	0,5
Hip	2	1,1	1	0,5	2	1,1
Upper Arm	1	0,5	0	0	1	0,5
Hand	1	0,5	2	1,1	3	1,6
Abdomen	1	0,5	2	1,1	0	0
Lower Arm	0	0	2	1,1	0	0
Lower Leg	0	0	1	0,5	0	0
Total	108	57,8	69	36,9	39	20,9

For the most severe injury, Injury One, the head was most frequently injured (10.2%, n = 19) followed by the knee (8.0%, n = 15) and shoulder (8.0%, n = 15). The second most severe injury (Injury Two) was reported as the knee (7.5%, n = 14) followed by the face (4.3%, n = 8). Injury Three most commonly affected the back (4.3%, n = 8) and shoulder (2.7%, n = 5). The other sites of each injury were less frequently injured. These are shown in Table 4.7.

The injury distributions were significantly different for Injury One and Injury Two with respect to site ($p < 0.001$), but not significantly different for the injuries listed under Injury Three ($p = 0.135$).

- **Question B2: Have you injured this area before?**

Table 4.9: Previous injury

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Yes	57	30,5	43	23,0	23	12,3
No	51	27,3	26	13,9	16	8,6
Total	108	57,8	69	36,9	39	20,9

Of the 108 injuries in the Injury One category, 57 participants (30.5%) reported that the injury had previously occurred and the remaining 51 participants (27.3%) indicated that the site had not previously been injured. Of the 69 injuries in the Injury Two category, 43 participants (23%) reported that the injury had previously occurred and 26 participants (13.9%) indicated that the site had not previously been injured. Of the 39 injuries in the Injury Three category, 23 participants (12.3%) reported that the injury had previously occurred and the remaining 16 participants (8.6%) indicated that the site had not previously been injured.

Interactions between rows and columns claim that no relationship between the variables exists. Therefore, in this question, the claim is that no relationship exists between previous injury and the injury number. The p-value for Injury One and Three is > 0.05, which means the claim is true and previous injury had no significant effect on current injuries.

However, the p-value for Injury Two is 0.041 therefore a significant relationship between Injury Two and previous injury exists.

- **Question B3: For the injury, indicate the type of injury by ticking the most appropriate box.**

Table 4.10: Type of injury in Injury One, Injury Two and Injury Three

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Concussion	21	11,2	3	1,6	3	1,6
Muscle Injury	21	11,2	24	12,8	17	9,1
Joint/Cartilage Injury	17	9,1	8	4,3	4	2,1
Ligament Injury	14	7,5	12	6,4	6	3,2
Fracture	12	6,4	7	3,7	1	0,5
Severe Bruising	9	4,8	8	4,3	6	3,2
Dislocation	7	3,7	2	1,1	1	0,5
Open wound	6	3,2	5	2,7	0	0
Dental	1	0,5	0	0	1	0,5
Total	108	57,8	69	36,9	39	20,9

The types of injuries sustained by participants for Injury One were concussion (11.2%, n = 21) and muscle injuries (11.2%, n = 21) followed by joint/cartilage injuries (9.1%, n = 17). The types of injuries sustained by participants for Injury Two were muscle injuries (12.8%, n = 24) followed by ligament injuries (6.4%, n = 12). The types of injuries sustained by participants for Injury Three were muscle injuries (9.1%, n = 17), ligament injuries (3.2%, n = 6) and severe bruising (3.2%, n = 6). The less frequent types of injuries are listed in Table 4.9.

The injury distributions were significantly different for all injuries with respect to mechanism of injury ($p < 0.001$).

- **Question B4: How would you describe the injury?**

Table 4.11: Severity of the injury in Injury One, Injury Two and Injury Three

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Mild	20	10,7	13	7,0	18	9,6
Moderate	53	28,3	40	21,4	14	7,5
Severe	35	18,7	16	8,6	7	3,7
Total	108	57,8	69	36,9	39	20,9

The majority of the injuries were reported as moderate in severity (28.3%, n = 53), followed by severe (18.7%, n = 35) and lastly mild (10.7%, n = 20) in Injury One. In Injury Two the majority of the injuries were reported as moderate in severity (21.4%, n = 40), followed by severe (8.6%, n = 16) and mild (7.0%, n = 13). In Injury Three the injuries were mostly mild (9.6%, n = 18) and moderate (7.5%, n = 14), followed by severe (3.7%, n = 7).

A significant relationship exists between the severity of injury and Injury One and Two ($p = 0.001$ and $p < 0.001$ respectively). There was no significant relationship between the severity of injury and Injury Three (χ^2 p-value = 0.092).

- **Question B5: The onset of the injury was:**

Table 4.12: Onset of the injury in Injury One, Injury Two and Injury Three

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Sudden	75	40,1	40	21,4	21	11,2
Continually Ongoing	21	11,2	22	11,8	16	8,6
More than 3 Months	12	6,4	7	3,7	2	1,1
Total	108	57,8	69	36,9	39	20,9

The majority of the participants reported that the injury sustained was sudden for Injury One (40.1%, n = 75), Injury Two (21.4%, n = 40) and Injury Three (11.2%, n = 21).

There was a significant relationship between onset and Injury One (χ^2 p-value < 0.001), Injury Two (χ^2 p-value < 0.001) and Injury Three (χ^2 p-value = 0.001).

- **Question B6: The injury occurred during a:**

Table 4.13: Activity when injury was sustained (Injury One, Injury Two and Injury Three)

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Warm up (office)	3	1,6	3	1,6	1	0,5
Training	32	17,1	21	11,2	17	9,1
Warm up (on ice)	6	3,2	5	2,7	2	1,1
Game	75	40,1	44	23,5	21	11,2
Total	116	62	73	39	41	21,9

Participants ticked more than one answer for this question, therefore the totals exceed the total number of injuries in Injury One, Two and Three. The totals in this question for Injury One is n = 116, injury Two is n = 73 and Injury Three is n = 41.

Injuries reported most frequently occurred during games for Injury One (40.1%, n = 75), Injury Two (23.5%, n = 44) and Injury Three (11.2%, n = 21). This was followed by injuries that occurred during training sessions: Injury One (17.1%, n = 32), Injury Two (11.2% n = 21), and Injury Three (9.1%, n = 17). Injuries during on and off ice warm up occurred less frequently and are listed in Table 4.12.

There was a significant relationship between the activity and Injury One, Two and Three (χ^2 p-value < 0.001).

- **Question B7: What was the mechanism of injury?**

Table 4.14: Mechanism of injury in Injury One, Injury Two and Injury Three

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Player	37	19,8	17	9,1	12	6,4
Boards	24	12,8	10	5,3	3	1,6
Ice	18	9,6	9	4,8	2	1,1
Overuse	16	8,6	13	7,0	8	4,3
Skating	13	7,0	17	9,1	10	5,3
Stick	11	5,9	3	1,6	3	1,6
Puck	8	4,3	11	5,9	7	3,7
Shooting	5	2,7	3	1,6	2	1,1
Goal Net	1	0,5	2	1,1	0	0,0
Total	133	71	85	45	47	25

More than one answer was possible for this question therefore the totals of mechanisms of injury exceed the total number of injuries in Injury One, Two and Three. The totals in this question for Injury One is n = 133, Injury Two is n = 85 and Injury Three is n = 47.

The most frequent mechanism of injury in Injury One was contact with another player (19.8%, n = 37) followed by contact with the boards (12.8%, n = 24) and the ice (9.6%, n = 18). Injury Two most frequently occurred as a result of contact with another player (9.1%, n = 17) and skating (9.1%, n = 17) followed by overuse (7.0%, n = 13). In Injury Three, contact with another player (6.4%, n = 12), skating (5.3%, n = 10) and overuse (5.3%, n = 10) were the most frequent mechanisms of injury.

There was a significant relationship between the mechanism of injury and Injury One, Two and Three (χ^2 p-value < 0.001).

- **Question B8.1: What treatment did you receive for the injury?**

Table 4.15: Treatment received for Injury One, Injury Two and Injury Three

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Physiotherapy	36	19,3	23	12,3	11	5,9
None	27	14,4	22	11,8	17	9,1
GP	20	10,7	5	2,7	2	1,1
First aid	15	8,0	10	5,3	6	3,2
Orthopaedic Surgeon	13	7,0	2	1,1	1	0,5
Chiropractic	11	5,9	8	4,3	3	1,6
Biokineticist	6	3,2	2	1,1	0	0
Acupuncture	1	0,5	1	0,5	0	0,0
Hydrotherapy	1	0,5	0	0	0	0,0
Dentist	0	0,0	0	0	1	0,5
Total	130	70	73	39	41	22

The totals add up to more than the total injuries due to participants being able to choose more than one treatment for each injury sustained. The total in this question for Injury One is n = 130, Injury Two is n = 73 and Injury Three is n = 41.

The most common treatment for Injury One was physiotherapy (19.3%, n = 36), no treatment (14.4%, n = 27) and general practitioner (10.7%, n = 20). The most common treatment for Injury Two was also physiotherapy (12.3%, n =23), followed by no treatment (11.8%, n = 22) and first aid (5.3%, n = 10). No treatment was the most common in Injury Three (9.1%, n = 17) followed by physiotherapy (5.9%, n = 11) and first aid (3.2%, n = 6). The less frequent treatments are listed in Table 4.14.

There was a significant relationship between treatment received and Injury One, Two and Three (χ^2 p-value < 0.001).

- **Question B8.2: Was a diagnosis given by a professional?**

Table 4.16: Was a diagnosis given for the injury in Injury One, Injury Two and Injury Three?

	Yes		No	
	n	%	n	%
Injury One	44	23,5	64	34,2
Injury Two	14	7,5	55	29,4
Injury Three	8	4,3	31	16,6
TOTAL	66	35,3	150	80,2

The majority of the injuries sustained were not given a diagnosis by a professional in Injury One (34.2%, n = 64), Injury Two (29.4%, n = 55) and Injury Three (16.6%, n = 31).

The scoring patterns related to this question were significantly different (χ^2 p-value = 0.0024).

➢ Question B8.3 If yes, what was it?

Table 4.17: Diagnosis given for Injury One, Injury Two and Injury Three

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Concussion	12	6,4	2	1,1	1	0,5
Shoulder Dislocation	5	2,7	1	0,5	0	0,0
Ankle ligament Sprain	3	1,6	0	0,0	1	0,5
AC Joint Dislocation	2	1,1	1	0,5	0	0,0
MCL Damage	1	0,5	2	1,1	0	0,0
Damage to L4-S1	1	0,5	1	0,5	1	0,5
ACL Damage	2	1,1	0	0,0	0	0,0
Fracture of Radius	2	1,1	0	0,0	0	0,0
Fracture of Wrist	2	1,1	0	0,0	0	0,0
Baker's Cyst	1	0,5	0	0,0	0	0,0
Bruised Lung	1	0,5	0	0,0	0	0,0
Cartilage Injury	1	0,5	0	0,0	0	0,0
Dislocation of Jaw	0	0,0	1	0,5	0	0,0
Fracture of the 4th and 5th metatarsal	1	0,5	0	0,0	0	0,0
Fracture of the thumb	0	0,0	0	0,0	1	0,5
Fractured Rib	1	0,5	0	0,0	0	0,0
Grade 1 Adductor muscle tear	0	0,0	1	0,5	0	0,0
Grade 2 Adductor Muscle tear	1	0,5	0	0,0	0	0,0
Grade 3 Tear of Quadratus Lumborum	0	0,0	1	0,5	0	0,0
Greenstick Fracture	0	0,0	0	0,0	1	0,5
Hairline fracture of Patella	0	0,0	1	0,5	0	0,0
Hamstring muscle tear	0	0,0	1	0,5	0	0,0
L4 Interspinous Ligament Sprain	1	0,5	0	0,0	0	0,0
Lateral Meniscus Injury	0	0,0	1	0,5	0	0,0
Myogelosis	1	0,5	0	0,0	0	0,0
Osteophyte Formation	1	0,5	0	0,0	0	0,0
Disc Herniation	0	0,0	0	0,0	1	0,5
Supraspinatus tear	0	0,0	0	0,0	1	0,5
Tennis Elbow	1	0,5	0	0,0	0	0,0
Torn Labrum	1	0,5	0	0,0	0	0,0
Total	44	23,5	14	7,5	8	4

The most common diagnosis given for Injury One and Injury Two was concussion with 6.4% (n = 12), 1.1% (n = 2) respectively. Shoulder dislocation was the second most frequent diagnosis in Injury One (2.7%, n =5). The less frequent diagnoses are listed in Table 4.16. The totals for this question are equal to the number of participants who answered “Yes” to question B8.2.

There was no significant relationship between a diagnosis given and Injury One (χ^2 p-value = 0.277) or Injury Two (χ^2 p-value = 0.102). The variables for Injury Three were constant therefore the Chi-Square test could not be performed.

- **Question B9.1 and B9.2: Did the injury keep you out of playing? If so, how long?**

Table 4.18: Were the participants kept out of playing and for how long?

		Injury One		Injury Two		Injury Three	
		n	%	n	%	n	%
Did the injury keep you out of playing?	Yes	72	38,5	33	17,6	12	6,4
	No	36	19,3	36	19,3	27	14,4
If so, how long?	0 - 7 days	14	7,5	8	4,3	5	2,7
	1 - 3 weeks	25	13,4	13	7,0	4	2,1
	3 - 5 weeks	12	6,4	9	4,8	1	0,5
	5 - 8 weeks	10	5,3	0	0	0	0
	2 - 3 months	4	2,1	2	1,1	2	1,1
	3 - 6 months	5	2,7	2	1,1	1	0,5
	6 - 12 months	3	1,6	1	0,5	0	0

The majority of participants took time out of playing for Injury One (38.5%, n = 72) with the remaining participants returning to play immediately (19.3%, n = 36). Injury Two showed similar results between taking time out from play after injury (17.6%, n = 33) and returning to play immediately (19.3%, n = 36). Twenty seven participants (14.4%) did not take time out of playing following Injury Three with 12 participants (6.4%) not returning to play immediately.

There is a statistically significant relationship between taking time off from playing and Injury One (χ^2 p-value = 0.001) and Injury Three (χ^2 p-value = 0.016).There is no statistically significant relationship between time off playing and Injury Two (χ^2 p-value = 0.7).

Following Injury One, most of the participants were kept out of playing for 1-3 weeks (13.4%, n = 25), followed by 0-7 days (7.5%, n = 14) and 3-5 weeks (6.4%, n = 12). The majority of the participants were kept out of playing for 1-3 weeks (7.0%, n = 13), followed by 3-5 weeks (4.8%, n = 9) and 0-7 days (4.3%, n = 8) following Injury Two. Injury Three results showed that most of the participants were kept out of playing for 0-7 days (2.7%, n = 5) and 1-3 weeks (4%, n = 2.1).

There is a statistically significant relationship between the amount of time taken off playing and Injury One (χ^2 p-value < 0.001) and Injury Two (χ^2 p-value = 0.001). There is no statistically significant relationship between the amount of time taken off playing and Injury Three (χ^2 p-value = 0.279).

- **Question C1: Which ice rink were you playing at when the injury was sustained?**

Table 4.19: Ice Rink where Injury One, Injury Two and Injury Three occurred

	Injury One		Injury Two		Injury Three	
	n	%	n	%	n	%
Forest Hill	27	14,4	9	4,8	7	3,7
Grand West	27	14,4	21	11,2	15	8,0
Festival Mall	25	13,4	18	9,6	5	2,7
The Grove	20	10,7	16	8,6	8	4,3
Galleria	9	4,8	6	3,2	4	2,1
Total	108	57,8	70	37,4	39	20,9

Injuries were more frequently sustained at Grand West (14.4%, n = 27) and Forrest Hill (14.4%, n = 27) followed by Festival Mall (13.4%, n = 25) for Injury One. Injuries reported under Injury Two were more frequently sustained at Grand West (11.2%, n = 21), Festival Mall (9.6%, n = 18), and The Grove (8.6%, n = 16). Most of the injuries in Injury Three were sustained at Grand West (8.0%, n = 15). The facilities that were less frequently related to injury are shown in Table 4.18.

There is a statistically significant relationship between the ice rink where the injury occurred and Injury One (χ^2 p-value = 0.03), Injury Two (χ^2 p-value = 0.024) and Injury Three (χ^2 p-value = 0.048).

- **Question C2 and C2.1: Were there medical professionals available at the time of your injury? If so, who?**

Table 4.20: Medical professionals present at time of injury

		Injury One		Injury Two		Injury Three	
		n	%	n	%	n	%
Were there medical professionals available at the time of your injury?	Yes	67	35,8	38	20,3	20	10,7
	No	40	21,4	31	16,6	19	10,2
If so, who?	First aid	57	30,5	36	19,3	17	9,1
	Physiotherapist	10	5,3	4	2,1	3	1,6
	Chiropractic	2	1,1	1	0,5	2	1,1
	Sports Massage	1	0,5	2	1,1	1	0,5
	Biokineticist	0	0	0	0	0	0
	GP	0	0	0	0	0	0
	Self Treatment	0	0	0	0	0	0
	None	0	0	0	0	0	0

The majority of the participants (35.8%, n = 67) in Injury One stated that there were medical professionals at the ice rink when the injury was sustained. Forty (21.4%) stated that there were no medical professionals present.

Thirty eight (20.3%) of the participants in Injury Two stated that there were medical professionals at the ice rink when the injury was sustained. Thirty one (16.6%) stated that there were no medical professionals present.

Of the participants in Injury Three, 20 (10.7%) stated that there were medical professionals at the ice rink when the injury was sustained. Nineteen (10.2%) stated that there were no medical professionals present.

A statistically significant relationship exists between the presence of a medical professionals and Injury One (χ^2 p-value = 0.009). The relationship between the

presence of a medical professional and Injury Two and Three was statistically insignificant (χ^2 p-value = 0.399 and χ^2 p-value = 0.873 respectively).

The majority of participants reported that First Aid was the medical professional present at the ice rink at the time of Injury One (30.5%, n = 57), Injury Two (36%, n = 19.3) and Injury Three (9.1%, n = 17). The less frequently reported medical professionals present are listed in Table 4.19.

A statistically significant relationship exists between the medical professionals present and all injuries (χ^2 p-value < 0.001).

- **Question C2.2 and 2.3: Did you consult with them at the facility? If yes, who did you choose to see?**

Table 4.21: Did the participant consult with the medical professionals present and if so, who?

		Injury One		Injury Two		Injury Three	
		n	%	n	%	n	%
Did you consult with them at the facility?	Yes	47	25,1	23	12,3	11	5,9
	No	20	10,7	15	8,0	9	4,8
If yes, who did you choose to see?	First aid	37	19,8	21	11,2	7	3,7
	Physiotherapist	8	4,3	2	1,1	2	1,1
	Biokineticist	1	0,5	0	0	1	0,5
	Chiropractic	1	0,5	0	0	1	0,5

For Injury One, 47 participants (25.1%) stated that they consulted with the medical professional, most commonly with First Aid (19.8%, n = 37). Twenty participants (10.7%) chose not to consult with the medical professionals present.

Twenty three participants (12.3%) in Injury Two stated that they consulted with the medical professional, most commonly with First Aid (11.2%, n = 21). Fifteen participants (8.0%) chose not to consult with the medical professionals present.

Eleven participants (5.9%) in Injury Three stated that they consulted with the medical professional, most commonly with First Aid (3.7%, n = 7). Nine participants (4.8%) chose not to consult with the medical professionals present.

There was a statistically significant relationship between participants' consultation with the medical professional and Injury One (χ^2 p-value = 0.001). The relationship between participants' consultation with the medical professional and Injury Two and Three was statistically insignificant (χ^2 p-value = 0.194 and χ^2 p-value = 0.655 respectively). All relationships regarding which medical professional was consulted with and Injury One, Two and Three, were statistically significant (χ^2 p-value < 0.001, χ^2 p-value < 0.001 and χ^2 p-value = 0.029 respectively).

Summary of Objective Two

The majority of the participants in this study reported having at least one injury (58.8%, n = 110). The most severe injury, Injury One, most frequently involved the head (10.2%, n = 19) and the most common type of injuries included concussion (11.2%, n = 21) and muscular injuries (11.2%, n = 21).

Injury Two, the second most severe injury, most commonly affected the thigh (7.5%, n = 14). Of the 60 injuries that occurred under Injury Two, 43 (23%) had been previously injured and 24 (12.8%) were muscle injuries.

Any additional injuries were reported on under Injury Three. The most prevalent site of injury was the back (4.3%, n = 8) and were mostly ligamentous injuries (3.2%, n = 6) or severe bruising (3.2%, n = 6).

For Injury One, Two and Three the injuries were mostly of sudden onset, during games, as a result of player contact. Injuries were commonly treated by physiotherapists, and the majority of participants reported not receiving a diagnosis for the injury.

Most of the injuries were sustained at Grand West ice rink. Participants reported that there were medical professionals present at the time of injury, which was most frequently First Aid. The majority of the participants chose to consult with the First Aid professionals at the facility.

4.4.3 Objective Three: Association between demographic profile and injury

To determine if any associations exist between the demographic profile of the participants and injuries sustained.

Age and the risk of injury

Table 4.22: Age (QA1) versus total number of injuries according to body site (QB1)

	18-27	28-37	38-47	48+
Back	18	5	3	1
Knee	18	7	4	1
Head	17	3	3	1
Shoulder	15	6	3	3
Wrist	10	0	1	0
Ankle	10	6	2	0
Face	9	4	2	0
Groin	6	5	1	1
Chest	3	3	3	0
Hand	3	1	2	0
Hip	3	2	0	0
Thigh	3	3	0	0
Foot	3	2	2	1
Elbow	2	3	0	1
Lower Arm	2	0	0	0
Neck	1	1	1	0
Upper Arm	1	1	0	0
Abdomen	1	0	1	1
Lower Leg	1	0	0	0
Total	126	52	28	10

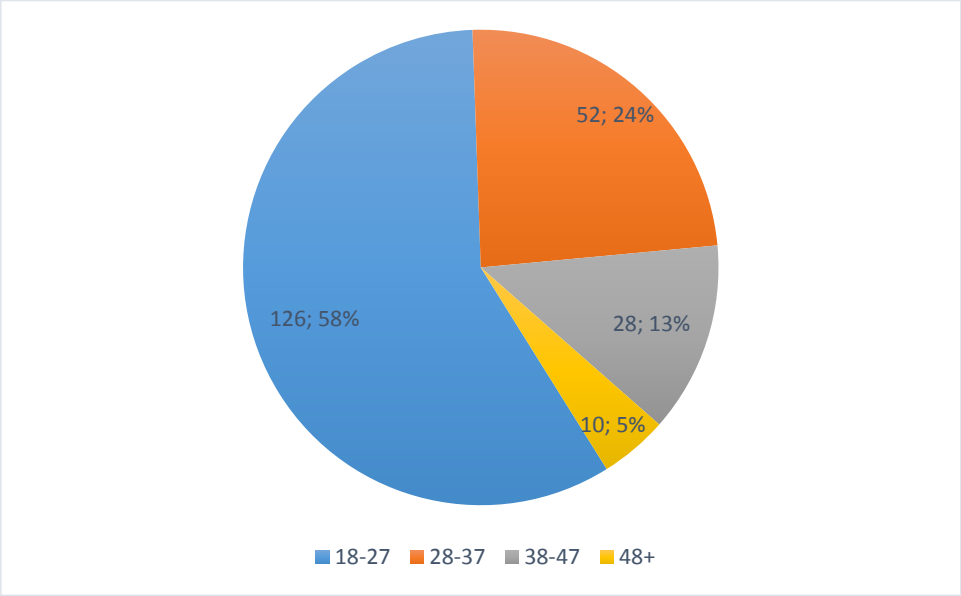


Figure 4.4: Age (QA1) versus total number of injuries

The highest number of injuries sustained to a particular body site was in the youngest age group of 18 to 27 years old who sustained 18 back, 18 knee, 17 head and 15 shoulder injuries. These participants in the younger age group of 18-27 years sustained 58% (n = 126) of the total injuries followed by the second youngest age group of 28-37 years that sustained 24% (n = 52) of the total injuries.

The relationship between age and number of injuries is statistically significant (χ^2 p-value < 0.0001).

Gender and the risk of injury

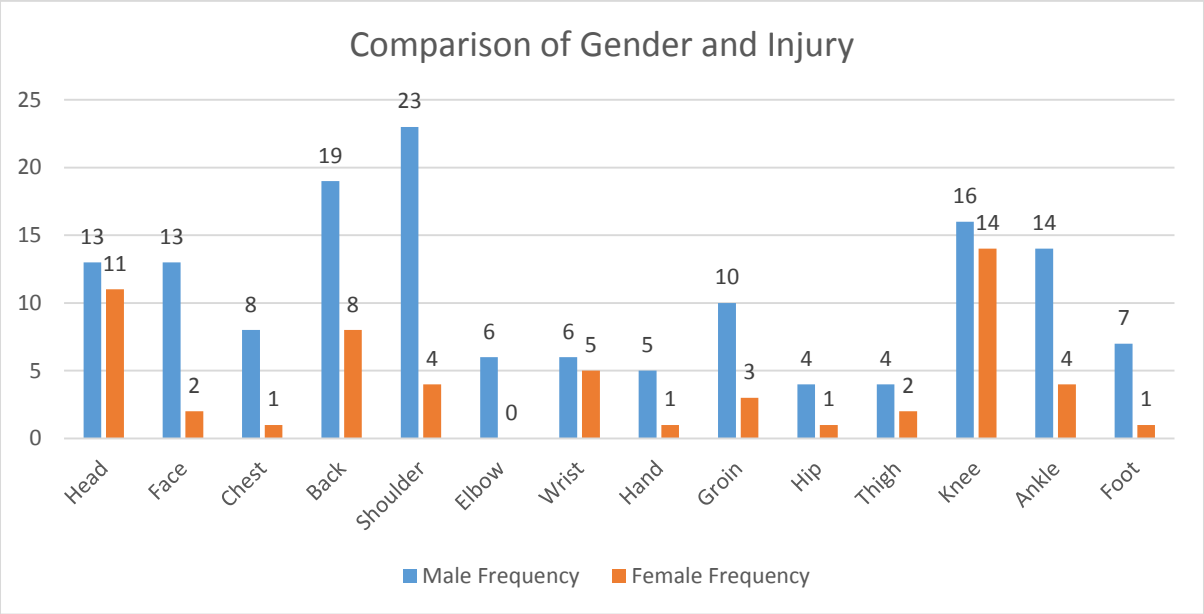


Figure 4.5: Gender (QA2) versus total number of injuries according to body site (QB1)

The most frequently injured anatomical sites injured by males was the shoulder (n = 23), back (n = 19) and knee (16). The most frequently injured anatomical sites for females were the knee (n = 14), head (n = 11) and back (n = 8).

There is no statistically significant relationship between gender and the risk of all injuries as the p-value = 0.7408. However, when analysing injuries of specific body sites there was a statistically significant relationship between gender and head injuries (χ^2 p-value = 0.0196) as well as gender and knee injuries (χ^2 p-value = 0.0046).

Ethnicity and the risk of injury

Table 4.23: Ethnicity (QA3) versus total number of injuries according to body site (QB1)

	Asian	Black	Coloured	Indian	White
Head	0	0	2	0	22
Face	0	0	2	0	13
Neck	0	0	0	0	3
Chest	0	0	1	0	8
Back	1	0	3	0	23
Shoulder	0	0	5	0	22
Upper Arm	0	0	0	0	2
Elbow	0	0	1	0	5
Lower Arm	0	0	0	0	2
Wrist	0	0	0	0	11
Hand	0	0	1	0	5
Abdomen	0	0	0	0	3
Groin	0	0	1	0	12
Hip	0	0	0	0	5
Thigh	0	0	0	0	6
Knee	1	0	4	0	25
Lower Leg	0	0	0	0	1
Ankle	0	0	3	0	15
Foot	0	0	3	0	5
Total	2	0	26	0	188

The majority of injuries were sustained by participants of white ethnicity (n = 188), which most commonly affected the knee (n = 25), back (n = 23), head (n = 22) and shoulder (n = 22). This was followed by participants of coloured ethnicity (n = 26), which mostly affected the shoulder (n = 5) and knee (n = 4).

There was no significant relationship between ethnicity and the risk of injury (χ^2 p-value = 0.9998).

Money spent on equipment and the risk of injury

Table 4.24: Money spent on equipment in a season (QA4) versus total number of injuries according to body site (QB1)

	<500	500-1000	1000-2000	2000-3000	3000-5000	5000-7000	7000-9000	9000-11000	>11000
Head	1	4	2	4	5	5	1	1	1
Face	0	2	1	3	1	2	1	2	3
Neck	0	0	1	0	1	1	0	0	0
Chest	0	2	1	1	0	2	3	0	0
Back	1	4	5	3	5	5	3	0	1
Shoulder	0	5	3	3	6	4	2	3	1
Upper Arm	0	1	0	0	0	0	0	1	0
Elbow	0	0	4	1	1	0	0	0	0
Lower Arm	0	0	1	0	1	0	0	0	0
Wrist	0	2	2	3	2	0	1	1	0
Hand	0	0	1	1	2	1	1	0	0
Abdomen	0	0	0	2	0	1	0	0	0
Groin	1	1	3	1	4	3	0	0	0
Hip	0	0	1	1	1	1	0	0	1
Thigh	0	1	1	1	3	0	0	0	0
Knee	1	3	6	5	6	7	1	0	1
Lower Leg	0	0	1	0	0	0	0	0	0
Ankle	1	2	2	3	3	4	0	2	1
Foot	0	0	1	1	3	1	1	1	0
Total	5	27	36	33	44	37	14	11	9

The majority of injuries occurred in those participants that spend between R3000 and R5000 on equipment in a season (n = 44). The most frequently injured body site in this group was the shoulder (n = 6), knee (n = 6), back (n = 5) and head (n = 5). Those participants that spend between R5000 and R7000 on equipment in a season sustained the second highest number of injuries (n = 37), most frequently affecting the knee (n = 7). This was followed by the participants who spend R1000 to R2000 on equipment in a season (n = 36), which were to the knee (n = 6).

There was no significant relationship between amount of money spent on equipment in a season and the risk injury (χ^2 p-value = 0.9911).

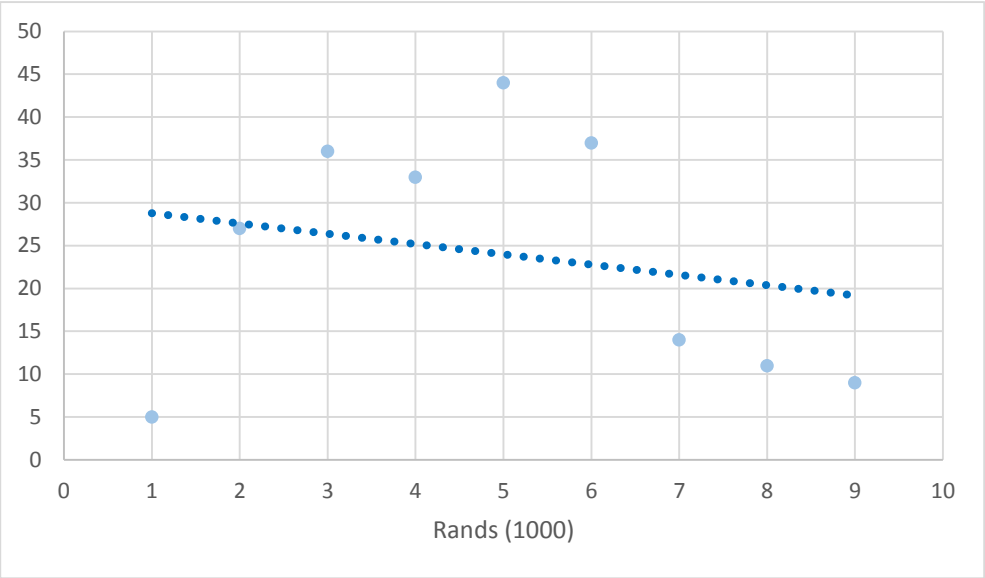


Figure 4.6: Money spent on equipment in a season (QA4) versus total number of injuries

BMI and the risk of injury

Table 4.25: BMI (QA5&6) versus total number of injuries according to body site (QB1)

	<25kg/m²	≥25kg/m²
	Count	Count
Head	17	7
Face	7	8
Neck	2	1
Chest	4	5
Back	11	16
Shoulder	14	13
Upper Arm	1	1
Elbow	2	4
Lower Arm	2	0
Wrist	5	6
Hand	4	2
Abdomen	1	2
Groin	6	7
Hip	2	3
Thigh	5	1
Knee	13	17
Lower Leg	0	1
Ankle	5	13
Foot	4	4
Total	105	111

The most commonly injured body site in those participants with a BMI of < 25kg/m² was the head (n = 17), shoulder (n = 14) and knee (n = 13). The most frequently injured body site in those participants with a BMI > 25kg/m² was the knee (n = 17), back (n = 16), shoulder (n = 13) and ankle (n = 13).

There was no significant relationship between BMI and the risk injury (χ^2 p-value = 0.9689).

Province played in and the risk of injury

Table 4.26: Province played in (QA7) versus total number of injuries according to body site (QB1)

	Gauteng	KwaZulu-Natal	Western Province
Head	15	1	8
Face	7	1	7
Neck	2	0	1
Chest	7	1	1
Back	14	6	7
Shoulder	15	2	10
Upper Arm	1	0	1
Elbow	3	1	2
Lower Arm	1	0	1
Wrist	5	2	4
Hand	3	1	2
Abdomen	3	0	0
Groin	7	2	4
Hip	4	0	1
Thigh	4	0	2
Knee	21	2	7
Lower Leg	1	0	0
Ankle	11	2	5
Foot	4	0	4
Total	128	21	67

The majority of injuries occurred in players from the province of Gauteng (n = 128). The most frequently injured anatomical site in these participants was the knee (n = 21), shoulder (n = 15) and head (n = 15). The second highest number of injured players according to province were those participants from Western Province (n = 67). These participants more commonly sustained injuries to the shoulder (n = 10), head (n = 8), back (n = 7) and knee (n = 7). Fewest number of injuries occurred in participants from KwaZulu-Natal (n = 21), which mostly affected the back (n = 6).

There was no significant relationship between the province played in and the risk injury (χ^2 p-value = 0.9999). Players' risk of injury was therefore not dependent on the province they played in.

League played in and the risk of injury

Table 4.27: League played in (QA8) versus total number of injuries according to body site (QB1)

	1st Division	2nd Division	Ladies	Intermediate	Premier	u20
	Count	Count	Count	Count	Count	Count
Head	9	7	11	3	5	2
Face	4	3	2	1	9	0
Neck	1	1	1	1	0	0
Chest	1	6	1	0	2	0
Back	6	8	7	3	10	1
Shoulder	7	8	4	3	10	3
Upper Arm	1	0	1	1	0	0
Elbow	0	2	0	0	4	0
Lower Arm	1	0	2	1	0	0
Wrist	2	1	5	0	6	0
Hand	2	2	1	1	1	1
Abdomen	1	2	1	0	0	0
Groin	4	4	3	1	3	0
Hip	3	1	1	0	1	0
Thigh	2	2	2	1	1	0
Knee	11	9	13	2	6	2
Lower Leg	0	1	0	0	0	0
Ankle	8	3	4	0	7	1
Foot	1	3	1	3	3	2
Total	64	63	60	21	68	12

Injuries most frequently occurred in the premier league (n = 68), 1st division (n = 64), 2nd division (n = 63) and ladies league (n = 60).

There was no significant relationship between the league played in and the risk of injury (χ^2 p-value = 1.0000). This indicates that the league in which players compete is not a risk factor for injury.

Position played and the risk of injury

Table 4.28: Position played (QA9) versus total number of injuries according to body site (QB1)

	Defence	Forward	Goalkeeper
Shoulder	14	13	0
Back	12	14	1
Knee	11	16	3
Head	11	12	1
Ankle	10	6	2
Groin	8	4	1
Face	7	7	1
Foot	7	1	0
Chest	6	3	0
Wrist	4	7	0
Elbow	3	3	0
Hand	3	3	0
Thigh	2	4	0
Hip	2	3	0
Abdomen	2	1	0
Lower Arm	2	0	0
Neck	1	2	0
Upper Arm	1	1	0
Lower Leg	0	1	0
Total	106	101	9

The most frequently injured body site in defence players was the shoulder (n = 14), back (n = 12), knee (n = 11), head (n = 11) and ankle (n = 11). Knee injuries were most common in forwards (n = 16) followed by back (n = 14), shoulder (n = 13), and head (n = 12) injuries. The most common injury in goalkeepers involved the knee (n = 3) and ankle (n = 2).

There was no significant relationship between position played and the risk of injury (χ^2 p-value = 0.9996), which suggests that all players' risk of injury is not dependant on the position played.

Playing experience and the risk of injury

Table 4.29: Playing experience in years (QA10) versus total number of injuries according to body site (QB1)

	< 4	4-8	8-12	12-16	16+
	Count	Count	Count	Count	Count
Head	14	6	2	0	2
Shoulder	14	6	1	1	5
Back	11	6	3	3	4
Knee	11	11	2	2	4
Chest	7	1	0	0	1
Foot	6	1	0	0	1
Thigh	4	1	1	0	0
Ankle	4	7	2	1	4
Neck	3	0	0	0	0
Elbow	3	1	0	0	2
Wrist	3	4	2	0	2
Hand	3	1	1	0	1
Groin	3	4	0	2	4
Face	1	4	1	1	8
Upper Arm	1	0	0	0	1
Lower Arm	1	1	0	0	0
Abdomen	1	0	0	0	2
Hip	1	1	1	0	2
Lower Leg	1	0	0	0	0
Total	92	55	16	10	43

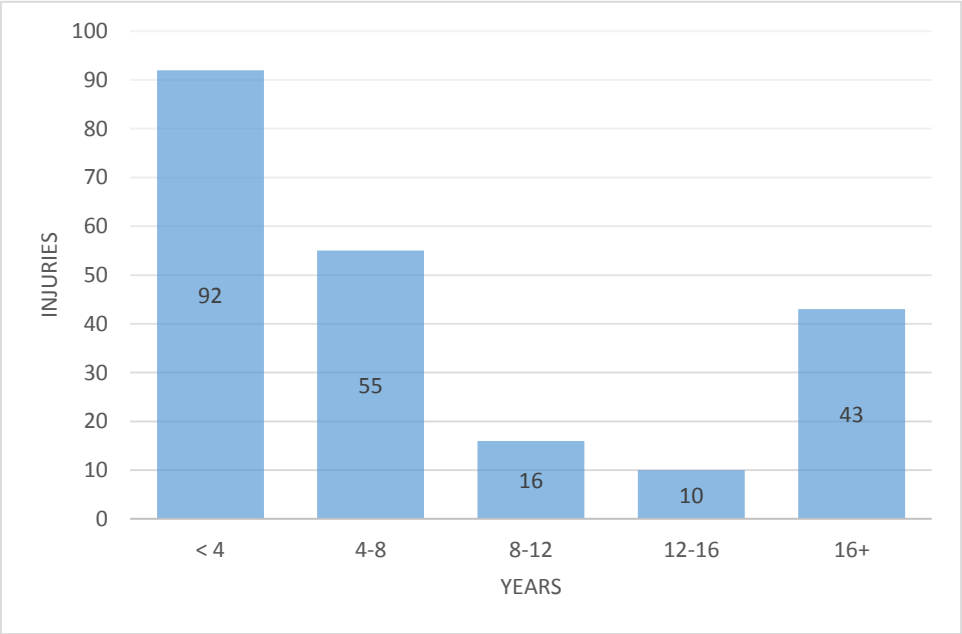


Figure 4.7: Number of years playing ice hockey (QA10) versus total number of injuries

Those participants who have played for the least amount of time, less than four years, sustained the most injuries (n = 92) which mostly affected the head (n = 14) and shoulder (n = 14). This was followed by those who have played for four to eight years (n = 55) who most frequently sustained injuries to the knee (n = 11) and ankle (n = 7). Those who have played for the longest amount of time, over 16 years (n = 43) sustained most of their injuries to the face (n = 8) and shoulder (n = 5).

There was no significant relationship between the number of years playing ice hockey and the risk of injury (χ^2 p-value = 1.0000), therefore the implication is that players of all levels of experience may sustain an injury at any time.

Number of hours spent training per week and the risk of injury

Table 4.30: Number of hours of training per week (QA11) versus total number of injuries according to body site (QB1)

	<1	1	2	3	4	5	>5
	Count	Count	Count	Count	Count	Count	Count
Head	1	2	5	8	3	1	4
Knee	1	4	5	7	4	5	4
Shoulder	1	4	3	6	5	2	6
Chest	0	2	2	4	0	0	1
Back	0	8	6	4	3	2	4
Groin	0	3	1	3	2	2	2
Face	0	1	3	2	6	1	2
Neck	0	0	1	2	0	0	0
Elbow	0	2	0	2	0	1	1
Wrist	0	2	2	2	3	1	1
Hip	0	0	0	2	0	1	2
Thigh	0	1	0	2	1	2	0
Ankle	0	3	2	2	4	2	5
Upper Arm	0	0	0	1	1	0	0
Lower Arm	0	0	0	1	1	0	0
Hand	0	1	1	1	2	1	0
Abdomen	0	0	2	1	0	0	0
Foot	0	1	1	1	0	2	3
Lower Leg	0	0	1	0	0	0	0
Total	3	34	35	51	35	23	35

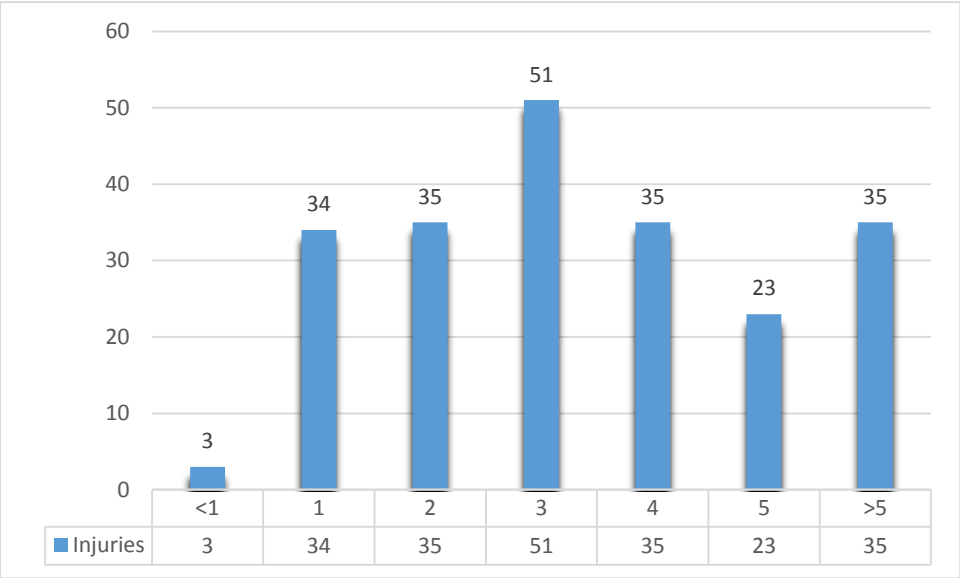


Figure 4.8: Number of hours of training per week (QA11) versus total number of injuries

Those participants that attended three hours of training per week had the highest incidence of injury (n = 51). The majority of these injuries involved the head (n = 8), knee (n = 7) and shoulder (n = 6). This was followed by those who attended two, four and over five hours of training per week (n = 25). Those who attended two hours per week sustained more back injuries (n = 6), head injuries (n = 5) and knee injuries (n = 5). Participants who attended 4 hours of training per week sustained majority of injuries to the face (n = 6) and shoulder (n = 5). Those who attended over 5 hours of training in a week sustained most of the injuries to the shoulder (n = 6) and ankle (n = 5).

There was no significant relationship between the number of hours of training per week and the risk injury (χ^2 p-value = 1.0000), therefore the amount of hours spent training in a week is not a risk factor for injury.

Number of games played in the last season and the risk of injury

Table 4.31: Number of games played in the last season (QA12) versus total number of injuries according to body site (QB1)

	< 10	10 - 19	20 - 29	30+
	Count	Count	Count	Count
Knee	8	11	6	5
Back	5	10	7	5
Shoulder	10	9	3	5
Ankle	4	9	2	3
Head	7	7	4	6
Chest	1	7	1	0
Groin	2	6	3	2
Face	1	5	6	3
Wrist	0	5	3	3
Foot	0	5	1	2
Elbow	0	4	2	0
Hand	1	3	0	2
Abdomen	0	3	0	0
Neck	1	1	1	0
Upper Arm	1	1	0	0
Lower Arm	1	0	0	1
Hip	1	0	4	0
Thigh	3	0	3	0
Lower Leg	0	0	1	0
Total	46	86	47	37

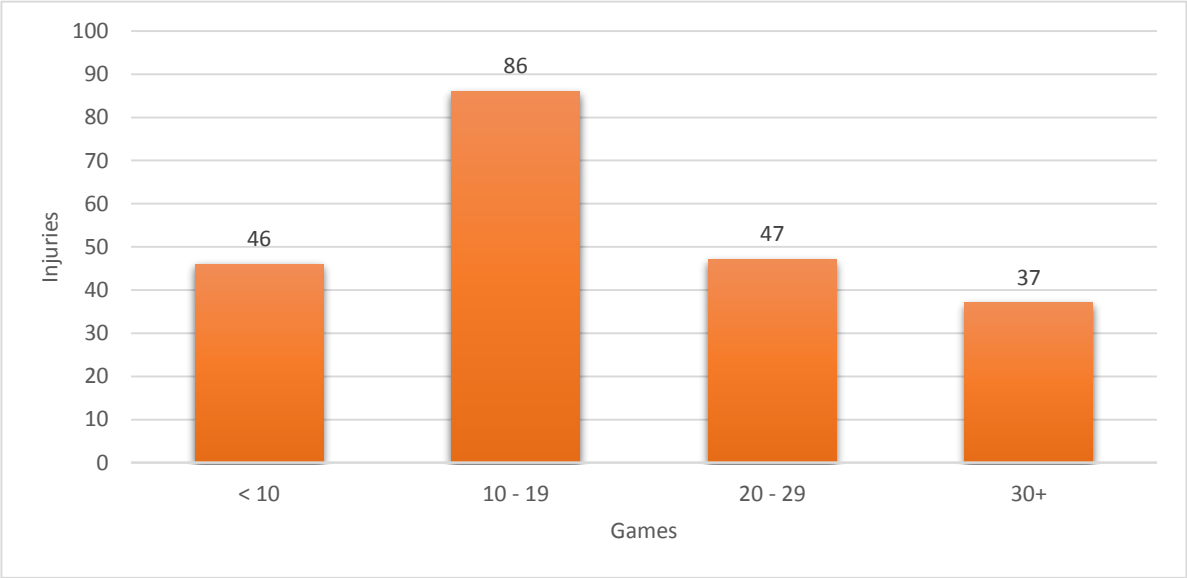


Figure 4.10: Number of games played (QA12) versus total number of injuries

The majority of injuries occurred in participants who played between 10 and 19 games last season (n = 86). These injuries mostly involved the knee (n = 11), back (n = 10), shoulder (n = 9) and ankle (n = 9). This was followed by those who participated in 20 to 29 games (n = 47), who mostly injured the back (n = 7), knee (n = 6) and face (n = 6). Those participants who played less than 10 games last season (n = 46) sustained most injuries to the shoulder (n = 10), knee (n = 8) and head (n = 7). The least number of injuries occurred in participants who exceed 35 games last season (n = 37). The most commonly injured body site was the head (n = 6).

There was no significant relationship between the number of games played last season and the risk of injury (χ^2 p-value = 1.0000). This implies that players are at similar risk of injury regardless of the number of games played in a season.

Facilities and the risk of injury

Table 4.32: Ice rink mostly played at (QA13) versus total number of injuries according to body site (QB1)

	Festival Mall	Forrest Hill	Galleria	Grand West	The Grove
Head	6	3	1	8	6
Face	1	1	1	7	5
Neck	2	0	0	1	0
Chest	1	5	1	1	1
Back	6	5	6	7	3
Shoulder	2	7	2	10	6
Upper Arm	1	0	0	1	0
Elbow	0	1	1	2	2
Lower Arm	1	0	0	1	0
Wrist	2	1	2	4	2
Hand	1	1	1	2	1
Abdomen	0	2	0	0	1
Groin	2	3	2	4	2
Hip	1	2	0	1	1
Thigh	0	1	0	2	3
Knee	7	7	2	7	7
Lower Leg	1	0	0	0	0
Ankle	3	2	2	5	6
Foot	1	2	0	4	1
Total	38	43	21	67	47

The majority of injuries were sustained by participants who most frequently play at Grand West ice rink (n = 67). The most common injury body sites sustained by these participants was shoulder (n = 10), head (n = 8), face (n = 7) and knee (n = 7).

Participants who mostly played at The Grove ice rink sustained the second highest total number of injuries (n = 47). The most frequently injured site in these participants was the knee (n = 7), head (n = 6), shoulder (n = 6) and ankle (n = 6).

Those participants who mostly play at the Forrest Hill ice rink sustained the third highest number of injuries (n = 43) which most frequently affected the shoulder (n = 7) and knee (n = 7).

Injuries sustained by participants who play mostly at Festival Mall (n = 38), most frequently affected the knee (n = 7), head (n = 6), and back (n = 6).

The fewest number of injuries were sustained by participants who mostly play at the Galleria ice rink (n = 21). The most frequently injured body site was the back (n = 6).

There was no significant relationship between the ice rink most frequently played at and the risk injury (χ^2 p-value = 1.0000), therefore players are at similar risk of injury no matter which ice rink they frequently play at.

Table 4.33: Ice rink where injury occurred (QC1) versus total number of injuries according to body site (QB1)

	Festival Mall	Forest Hill	Galleria	Grand West	The Grove
	Count	Count	Count	Count	Count
Head	5	5	0	7	7
Face	4	0	1	7	3
Neck	1	1	0	1	0
Chest	4	2	1	1	1
Back	10	3	6	7	1
Shoulder	3	8	2	9	5
Upper Arm	2	0	0	0	0
Elbow	1	2	0	3	0
Lower Arm	0	0	0	1	1
Wrist	2	1	1	5	2
Hand	0	1	1	2	2
Abdomen	1	0	0	0	2
Groin	4	4	2	1	2
Hip	0	2	0	1	2
Thigh	1	1	0	3	1
Knee	7	9	2	6	6
Lower Leg	0	0	0	0	1
Ankle	3	2	2	5	6
Foot	0	2	0	4	2
Total	48	43	18	63	44

The ice rink where the majority of injuries occurred was Grand West (n = 63). At this ice rink, the most frequently injured body sites where shoulder (n = 9), head (n = 7), face (n = 7) and back (n = 7).

Festival Mall was the ice rink where the second highest number of injuries occurred (n = 48). The most common site of injury sustained was the back (n = 10) and knee (n = 7).

This was followed by The Grove ice rink (n = 44) where injuries mostly affected the head (n = 7) and knee (n = 6) and Forrest Hill (n = 43) where injuries involved the knee (n = 9) and shoulder (n = 8).

The Galleria ice rink is where the fewest number of injuries occurred (n = 18) which mostly affected the back (n = 6).

There was no significant relationship between the ice rink where the injury occurred and the risk injury (χ^2 p-value = 1.0000) which indicates that the risk of injury is not dependant on the ice rink where the injury occurred.

Other sport played and the risk of injury

Table 4.34: Other sport played (QA14) versus total number of injuries according to body site (QB1)

	Head	Face	Neck	Chest	Back	Shoulder	Upper Arm	Elbow	Lower Arm	Wrist	Hand	Abdomen	Groin	Hip	Thigh	Knee	Lower Leg	Ankle	Foot
Soccer/Indoor Soccer	3	5	1	0	6	5	0	0	0	5	0	0	4	1	0	4	0	5	4
Cycling/Mountain Biking	5	1	1	1	3	6	0	2	1	1	0	1	1	0	2	4	0	4	2
Field/Indoor Hockey	7	4	1	0	4	0	0	0	1	1	1	0	3	0	1	0	0	0	0
Crossfit, Gym, Strength	2	2	0	0	2	2	0	2	0	1	0	0	1	2	1	4	0	2	1
MMA/Jiu Jitsu/Martial Arts/ Karate/Kickboxing	1	0	0	0	2	1	0	0	0	0	0	0	1	1	2	4	0	2	2
Golf	0	0	0	2	2	4	0	1	0	0	0	0	1	0	0	2	0	1	0
Rugby	1	4	0	0	2	2	0	1	0	0	0	0	0	1	0	0	0	1	0
Running	1	0	1	1	1	1	0	0	0	1	0	0	1	0	1	1	0	2	0
Swimming/Diving/Waterpolo/ Skiing/ Wakeboarding	0	0	1	0	3	1	0	1	0	0	0	0	1	0	0	1	1	1	0
Figure Skating/Synchronised	2	1	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	1	0
Cricket	0	1	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0
Volleyball/Netball	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Squash/Tennis/Badminton	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0
Inline/roller Hockey	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Surfing/Stand up paddle/ Bodyboarding/Kiteboarding	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0
Motorcross/Motor sport	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Paintball	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
Rock Climbing	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baseball/Softball	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0

The majority of injuries of those who partake in other sports were amongst those who participate in soccer/indoor soccer (n = 43). These participants most commonly sustained injuries to the back (n = 6), face (n = 5), shoulder (n = 5) and ankle (n = 5).

The second highest number of injuries according to sport were those participants who also participate in cycling/mountain biking (n = 35). Majority of these injuries affected the shoulder (n = 6) and head (n = 5).

Those participants who also play field/indoor hockey sustained 23 injuries, which mostly affected the head (n = 7).

Participants who also partake in crossfit/gym/strength training (n = 22), sustained most of their injuries to the knee (n = 4).

There was no significant relationship between other sport played and the risk injury (χ^2 p-value = 1.0000).

Summary of Objective Three

Objective Three was to determine if any associations exist between the demographic profile of the participants and injuries sustained. A statistically significant relationship exists between age and the risk of injury where participants in the age group of 18 to 27 years had a higher incidence of all injuries according to body site.

Overall injuries according to gender showed no statistically significant relationship with the risk of injuries, however, a statistically significant relationship does exist between gender and specific body sites, namely, the head and knee. Females are shown to be at increased risk of head and knee injuries when compared to males.

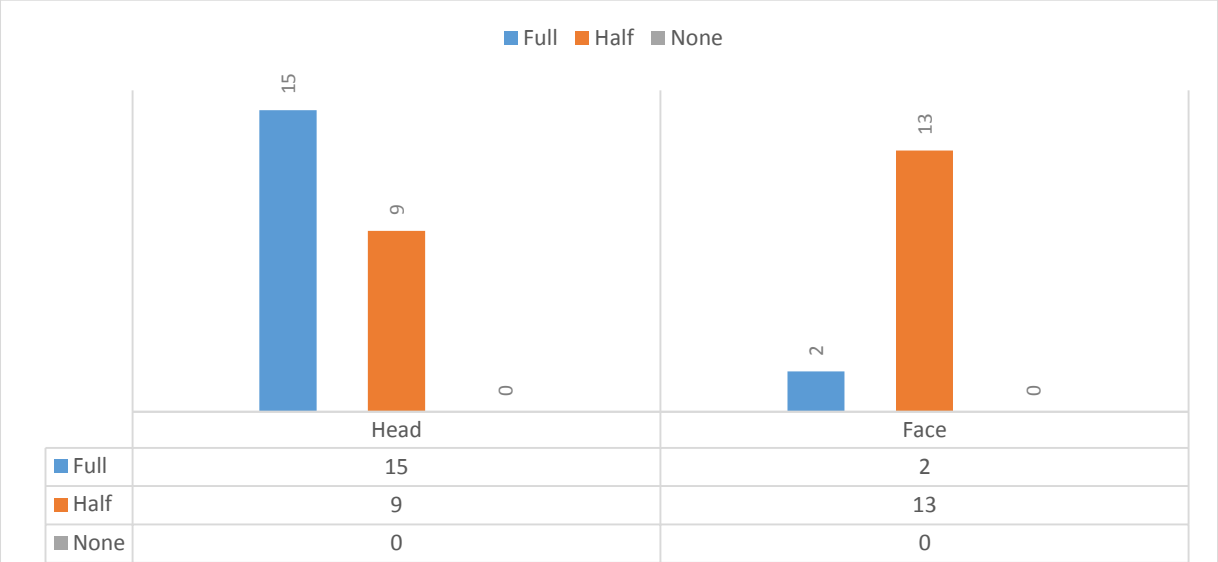
The remaining demographics, namely: ethnicity, BMI, money spent on equipment, province and league played in, position played, playing experience, hours of training per week, number of games played and ice rink most frequently played at, other sports played showed no statistically significant relationship with the risk of injury.

4.4.4 Objective Four: Protective equipment

To establish if an association between injuries sustained and use of protective equipment exists.

Section D of the questionnaire did not provide question numbers, therefore the results will be presented under the headings as they appear in the rows of the table on page four.

Visor worn on helmet and the risk of injury



	Head	Face
Full	15	2
Half	9	13
None	0	0

Figure 4.9: Visor worn on helmet versus total number of injuries according to body site (QB1)

Fifteen 15 head injuries occurred in participants who wear full facial protection and nine head injuries occurred in participants who wear half facial protection. There was no statistically significant relationship between facial protection and the risk of head injuries (χ^2 p-value = 0.221).

Two facial injuries occurred in participants wearing full facial protection and 13 facial injuries were sustained by those participants wearing half facial protection. There was a statistically significant relationship between the type of facial protection and the risk of facial injuries (χ^2 p-value = 0.005).

Mouthguard type and the risk of injury

Table 4.35: Type of mouthguard used versus total number of injuries according to body site (QB1)

Mouth Guard					
	Custom-made	Shop Bought	I don't wear one	p-value	Statistically significant
Head	3	9	12	0,072	No
Face	2	6	7	0,247	

The majority of the participants that sustained head injuries reported that they do not wear a mouth guard (n = 12) followed by those who have a shop bought mouthguard (n = 9) and custom-made mouthguard (n = 3). The majority of the participants that sustained facial injuries also reported that they do not wear a mouthguard (n = 7), followed by shop bought (n = 6) and custom-made (n = 2). No statistically significant relationship exists between the type of mouthguard worn and the risk of injury to the head or face.

Table 4.36: Manufacturing year of equipment versus total number of injuries according to body site (QB1)

	<2005	2006 - 2008	2009 - 2011	2012 - 2014	2015	P-value	Statistically significant
Helmet							
Head	1	0	5	12	6	0.016	Yes
Face	3	1	0	8	3	0.197	No
Neck	0	0	1	2	0		
Mouthguard							
Head	0	1	2	10	1	0.264	No
Face	0	0	1	5	3	0.247	
Shoulder Pads							
Chest	0	0	2	2	5	<0.001	Yes
Back	2	2	7	11	5	0.015	
Shoulder	3	1	5	14	4	0.001	
Upper Arm	0	0	0	2	0	0.847	No
Elbow Pads							
Upper Arm	0	0	1	1	0	0.102	No
Elbow	0	0	2	3	1	0.607	
Lower Arm	0	0	1	1	0	0.102	
Pants							
Back	2	3	4	12	6	0.020	Yes
Abdomen	0	0	1	1	1	0.001	
Groin	3	0	2	5	3	0.057	No
Hip	0	0	1	4	0	0.121	
Thigh	0	0	1	3	2	0.125	
Pelvic Protector							
Groin	3	1	1	4	0	0.717	No
Skates							
Lower Leg	0	0	0	1	0	0.637	No
Ankle	2	1	0	8	7	0.042	Yes
Foot	1	0	0	3	4		
Shin Pads / Leg Pads							
Knee	1	0	7	18	4	<0.001	Yes
Lower Leg	0	0	1	0	0	0.003	
Ankle	2	1	3	7	5	<0.001	
Gloves / Mitt & Blocker							
Wrist	0	0	4	5	2	0.529	No
Hand	0	1	2	2	1	0.414	

The majority of all protective equipment used by participants in this study was manufactured between 2012 and 2014.

Helmets that were manufactured between 2012 and 2014 were involved in the most head (n = 12), facial (n = 8) and neck (n = 2) injuries and showed a significant relationship with the risk of injury to the head (χ^2 p-value = 0.016).

Mouthguards that were manufactured between 2012 and 2014 were involved in the most head (n = 10) and facial (n = 5) injuries, however the trend was not statistically significant.

Shoulder pads that were manufactured between 2012 and 2014 were involved in the most back (n = 11), shoulder (n = 14) and upper arm (n = 2) injuries. Shoulder pads manufactured in 2015 were involved in the highest number of injuries to the chest (n = 5). A statistically significant relationship exists between the manufacturing year of shoulder pads and chest, back and shoulder injuries (χ^2 p-value <0.001, χ^2 p-value = 0.015 and χ^2 p-value = 0.001 respectively).

Elbow pads that were manufactured between 2012 and 2014 were involved in the majority of the elbow injuries (n = 3). Elbow pads manufactured in 2009-2011 and 2012-2014 were equally involved in upper arm (n = 1) and lower arm injuries (n = 1). This was not a significant relationship.

Ice hockey pants manufactured between 2012 and 2014 were involved in the majority of back (n = 12), groin (n = 5), hip (n = 4) and thigh (n = 3) injuries. A significant relationship was shown to exist between the year of manufacturing of ice hockey pants and the risk of injury to the back and abdomen (χ^2 p-value = 0.020 and χ^2 p-value = 0.001 respectively).

Pelvic protectors that were manufactured between 2012 and 2014 were involved in majority of groin injuries (n = 4), however this was not statistically significant.

Skates that were manufactured between 2012 and 2014 were involved in the majority of lower leg (n = 1) and ankle (n = 8) injuries. Skates manufactured in 2015 were worn during the majority of foot injuries (n = 4) and the second highest number of ankle injuries (n = 7). There is a statistically significant relationship between year of manufacturing of skates and the risk of injury to the ankle and foot (χ^2 p-value = 0.042).

Shin pads or leg pads that were manufactured between 2012 and 2014 were involved in the majority of knee (n = 18) and ankle (n = 7) injuries. Shin pads or leg pads that were manufactured between 2009 and 2011 were involved in lower leg injuries (n = 1). This shows a significant relationship between the year of manufacturing of shin pads or leg pads and the risk of injury to the knee, lower leg and ankle (χ^2 p-value <0.001, χ^2 p-value = 0.003 and χ^2 p-value <0.001 respectively).

Gloves or mitt and blocker that were manufactured between 2012 and 2014 were involved in the majority of wrist injuries (n = 5). The majority of hand injuries were sustained in participants wearing gloves or a mitt and blocker that was manufactured between 2009 and 2011 (n = 2) and 2012 and 2014 (n = 2). There was no statistically significant relationship between year of manufacturing of gloves or mitt and blocker with the risk of injury to the wrist and hand.

Table 4.37: Quality of equipment versus total number of injuries according to body site (QB1)

	Entry Level	Intermediate	Top of the Range	P-value	Statistically significant
Helmet					
Head	3	14	7	0.021	Yes
Face	1	6	8		
Neck	1	2	0		
Mouthguard					
Head	0	10	4	0.109	No
Face	1	4	4	0.020	Yes
Shoulder Pads					
Chest	0	8	1	0.003	Yes
Back	2	20	5		
Shoulder	3	17	7		
Upper Arm	0	1	1	<0.001	
Elbow Pads					
Upper Arm	0	1	1	*	*
Elbow	0	5	1	0.102	No
Lower Arm	0	1	1	*	*
Pants					
Back	5	16	6	0.016	Yes
Abdomen	1	1	1	*	*
Groin	4	4	5	0.004	Yes
Hip	2	1	2	0.336	No
Thigh	2	3	1	0.016	Yes
Pelvic Protector					
Groin	2	2	5	0.739	No
Skates					
Lower Leg	0	1	0	0.637	No
Ankle	0	8	10		
Foot	0	5	3		
Shin Pads / Leg Pads					
Knee	6	16	8	0.061	No
Lower Leg	0	1	0	0.712	
Ankle	1	11	6	0.059	
Gloves / Mitt & Blocker					
Wrist	1	5	5	0.007	Yes
Hand	2	3	1	0.234	No

* These values could not be found as the data was constant.

The quality of the helmet was mostly intermediate (n = 14) in head injuries, top of the range (n = 8) in facial injuries and intermediate (n = 2) in neck injuries. These results were statistically significant for head, face and neck injuries (χ^2 p-value = 0.021).

The quality of the mouthguard was mostly intermediate (n = 10) in head injuries, and intermediate (n = 4) and top of the range (n = 4) in facial injuries, which presented a significant relationship between the quality of mouthguard used and the risk of facial injuries (χ^2 p-value = 0.020).

The quality of the shoulder pads worn was mostly intermediate in chest (n = 8), back (n = 20) and shoulder (n = 17) injuries. The relationship between the quality of shoulder pads and the risk of injury to the chest, back and shoulder was statistically significant (χ^2 p-value = 0.003).

The quality of the elbow pads worn during elbow injuries was mostly intermediate (n = 5). Elbow pads worn in upper and lower arm injuries was equally distributed between intermediate (n = 1) and top of the range (n = 1).

The quality of the pants worn was mostly intermediate for back (n = 16) and thigh (n = 3) injuries and top of the range for groin injuries (n = 5). Pants worn during injuries to the abdomen were equal between entry level, intermediate and top of the range. This shows that a statistically significant relationship between quality of ice hockey pants and the risk of injury to the back, abdomen, groin and thigh exists.

The majority of participants that sustained groin injuries use a top of the range pelvic protector (n = 5), however the quality of the pelvic protector was not a risk factor for injury in this study.

The quality of the skates worn during the lower leg injury was intermediate (n = 1). The majority of the skates worn during ankle injuries were top of the range quality (n = 10) and intermediate quality for foot injuries (n = 5). No relationship exists between the quality of skates work by participants that sustained injuries and the risk of injury to the lower leg, ankle and foot.

The quality of the shin pads or leg pads worn was mostly intermediate for injuries to the knee (n = 16), lower leg (n = 1) and ankle (n = 11), however this trend was not statistically significant.

The quality of the gloves or mitt and blocker worn was mostly intermediate and top of the range for injuries to the wrist (n = 5) and intermediate quality for hand injuries (n = 3). A relationship that is statistically significant exist between the quality of equipment used and the risk of injury to the wrist (χ^2 p-value = 0.007).

Table 4.38: How often this equipment is worn during a training session versus total number of injuries according to body site (QB1)

	Always (100%)	Very Often (75%)	Some-times (50%)	Not Often (25%)	Never (0%)	p-value	Statistically Significant
Helmet							
Head	22	2	0	0	0	<0.001	Yes
Face	11	3	1	0	0		
Neck	3	0	0	0	0		
Mouthguard							
Head	2	2	1	1	18	<0.001	Yes
Face	3	0	2	2	8	0.247	No
Shoulder Pads							
Chest	8	1	0	0	0	<0.001	Yes
Back	23	3	1	0	0		
Shoulder	23	3	0	1	0		
Upper Arm	2	0	0	0	0		
Elbow Pads							
Upper Arm	2	0	0	0	0	These values could not be found as the data was constant.	
Elbow	6	0	0	0	0		
Lower Arm	2	0	0	0	0		
Pants							
Back	24	3	0	0	0	<0.001	Yes
Abdomen	3	0	0	0	0		
Groin	13	0	0	0	0		
Hip	5	0	0	0	0		
Thigh	6	0	0	0	0		
Pelvic Protector							
Groin	9	0	0	0	4	0.166	No
Skates							
Lower Leg	1	0	0	0	0	These values could not be found as the data was constant.	
Ankle	18	0	0	0	0	These values could not be found as the data was constant.	
Foot	8	0	0	0	0		
Shin Pads / Leg Pads							
Knee	29	0	0	0	1	<0.001	Yes
Lower Leg	1	0	0	0	0		
Ankle	16	1	1	0	0		
Gloves / Mitt & Blocker							
Wrist	11	0	0	0	0	These values could not be found as the data was constant.	
Hand	6	0	0	0	0		

Table 4.39: How often this equipment is worn during a game versus total number of injuries according to body site (QB1)

	Always (100%)	Very Often (75%)	Some-times (50%)	Not Often (25%)	Never (0%)	p-value	Statistically Significant
Helmet							
Head	24	0	0	0	0	These values could not be found as the data was constant.	
Face	15	0	0	0	0		
Neck	3	0	0	0	0		
Mouthguard							
Head	3	0	2	3	16	0.002	Yes
Face	6	0	0	2	7	0.247	No
Shoulder Pads							
Chest	9	0	0	0	0	These values could not be found as the data was constant.	
Back	27	0	0	0	0		
Shoulder	27	0	0	0	0		
Upper Arm	2	0	0	0	0		
Elbow Pads							
Upper Arm	2	0	0	0	0	These values could not be found as the data was constant.	
Elbow	6	0	0	0	0		
Lower Arm	2	0	0	0	0		
Pants							
Back	27	0	0	0	0	These values could not be found as the data was constant.	
Abdomen	3	0	0	0	0		
Groin	13	0	0	0	0		
Hip	5	0	0	0	0		
Thigh	6	0	0	0	0		
Pelvic Protector							
Groin	9	0	0	0	4	0.166	No
Skates							
Lower Leg	1	0	0	0	0	These values could not be found as the data was constant.	
Ankle	18	0	0	0	0		
Foot	8	0	0	0	0		
Shin Pads / Leg Pads							
Knee	29	0	0	0	1	<0.001	Yes
Lower Leg	1	0	0	0	0	These values could not be found as the data was constant.	
Ankle	18	0	0	0	0		
Gloves / Mitt & Blocker							
Wrist	11	0	0	0	0	These values could not be found as the data was constant.	
Hand	6	0	0	0	0		

The majority of participants who sustained injures reported that they wear their helmet, shoulder pads, elbow pads, pants, skates, shin pads/leg pads and gloves/mitt and blocker “Always (100%)” during a training session and a game. This shows a statically significant relationship exists with the use of these protective equipment pieces at a training session or game and the risk of injury (χ^2 p-value <0.05).

The majority of participants who sustained head and facial injuries reported that they never wear their mouthguard during a training session or a game. A statistically significant relationship exists between risk of head injury and the use of mouthguards during training sessions (χ^2 p-value <0.001) and a game (χ^2 p-value = 0.002).

The majority of the participants who sustained groin injuries always wear their pelvic protector during a training session or game (n = 9) and the remainder of participants that sustained a groin injury never wear their pelvic protector during a training session or game (n = 4). The use of a pelvic protector during a training session or a game is not a risk factor for groin injuries in this study.

Table 4.40: Were you wearing this equipment at the time of the injury? versus total number of injuries according to body site (QB1)

	Yes	No	p-value	Statistically Significant
Helmet				
Head	24	0	0.0187	Yes
Face	11	4		
Neck	3	0		
Mouthguard				
Head	4	19	0.002	Yes
Face	5	10	0.197	No
Shoulder Pads				
Chest	8	1	<0.001	Yes
Back	26	1		
Shoulder	27	0		
Upper Arm	2	0		
Elbow Pads				
Upper Arm	2	0	These values could not be found as the data was constant.	
Elbow	6	0		
Lower Arm	2	0		
Pants				
Back	26	1	<0.001	Yes
Abdomen	3	0		
Groin	13	0		
Hip	4	1		
Thigh	5	1		
Pelvic Protector				
Groin	9	3	0.083	No
Skates				
Lower Leg	1	0	These values could not be found as the data was constant.	
Ankle	18	0		
Foot	7	1	0.034	Yes
Shin Pads / Leg Pads				
Knee	29	1	<0.001	Yes
Lower Leg	1	0	These values could not be found as the data was constant.	
Ankle	18	0		
Gloves / Mitt & Blocker				
Wrist	11	0	These values could not be found as the data was constant.	
Hand	6	0		

Participants reported that they were wearing their helmet, shoulder pads, elbow pads, pants, skates, shin pads/leg pads and gloves/mitt and blocker when the majority of all

injuries were sustained, therefore there is a statistically significant relationship between the use of this equipment and the risk of injury.

The majority of the participants who sustained groin injuries (n = 9) were wearing a pelvic protector at the time of the injury. The remainder of participants that sustained a groin injury never wear their pelvic protector during a training session or game (n = 4) and were not wearing this equipment at the time of injury.

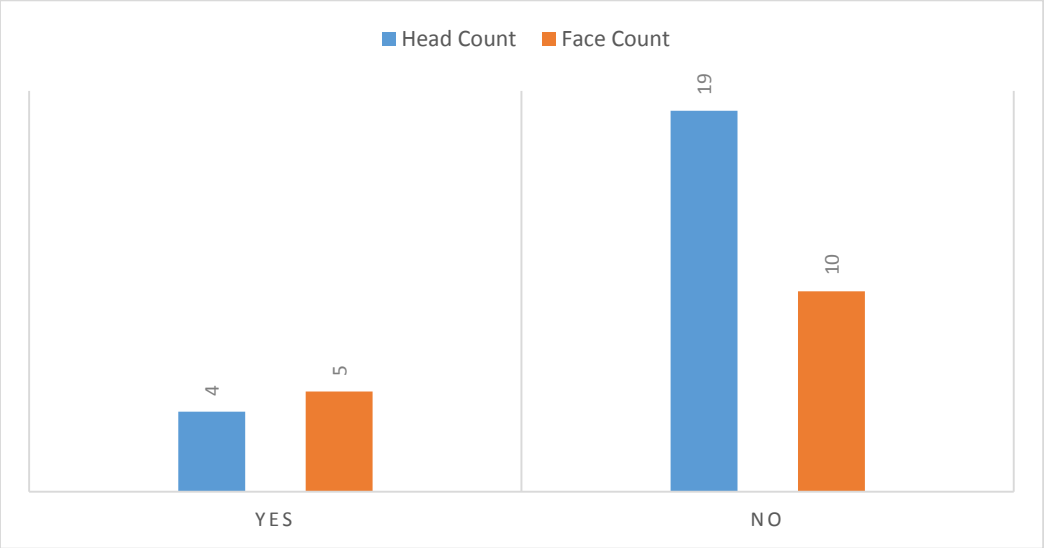


Figure 4.10: Were you wearing this equipment during the injury? versus total number of injuries according to body site (QB1)

The majority of those participants who sustained head and facial injuries reported that they were not using a mouth guard when the injury occurred. Of the 24 head injuries, 19 participants were not using a mouth guard and 10 participants of the 15 facial injuries were also not wearing a mouth guard. A significant relationship exists between the use of a mouthguard and the risk of head injury (p = 0.002).

Summary of Objective Four

Objective four was to establish if an association between injuries sustained and use of protective equipment exists. In terms of the visor used on the helmet, facial injuries were significantly higher in those participants using half facial protection (χ^2 p-value = 0.005). The use of facial protection did not significantly affect head injuries. The type of mouthguard used was not a risk factor for head or facial injuries.

The majority of all equipment was manufactured between 2012 and 2014 and was of intermediate quality. Some injuries showed statistically significant relationships between the manufacturing year and quality of that equipment with the risk of injury to a particular body site. Helmet, shoulder pads, elbow pads, pants, skates, shin pads/leg pads and gloves/mitt and blocker were reported to be worn during the majority of training sessions and games as well as when the injuries were sustained.

Most of the participants of this study reported that for the majority of the time they do not make use of a mouthguard during a training session, game or when the injury occurred. This presented a statistically significant relationship between the use of a mouthguard and the risk of head injury ($p = 0.002$).

Pelvic protectors were worn during a training session or game by the majority of the participants that sustained groin injuries, however this trend was not significantly associated to the risk of groin injury.

CHAPTER 5 : DISCUSSION

5.1 Introduction

This chapter will discuss the results of the study as they are outlined in each objective and within the context of the literature discussed in Chapter 2.

5.2 Discussion of results

5.2.1 Response rate

The minimum response rate required for males was 138 participants out of a total sample of 217 and 45 females out of a total sample of 50. The response rate of the participants was 141 males and 46 females which met the minimum response rate discussed in Chapter 3. The response rate percentage for this study was 70.04%. A possible reason for the high response rate was that the participants had to complete the questionnaire immediately after their practice or game and were not allowed to take the questionnaire home with them. The researcher remained present while the questionnaires were being completed and were collected immediately thereafter. This helped to aid in a high completion rate of the questionnaire.

5.2.2 Objective One

The first objective was to establish a demographic profile of ice hockey players in South Africa. This included age, gender, ethnicity, BMI, province, ice rink, league and position played, level of experience, training hours and games played in the last season.

- **Question A1-3: Age, Gender and Ethnicity**

The majority (62%) of the participants in this study were between 18 and 27 years of age. As ice hockey is a physically demanding sport, it is expected that as players age they may retire to a less physically demanding activity. Kutáč and Sigmund (2015) found that players participating in the Russian and Czech Republic elite ice hockey leagues had a mean age of 27.1 ± 5.1 years. Kuzuhara et al. (2009) found that the

mean age was 26.7 ± 4.4 years in the Japanese elite league and in the National hockey League of North America the mean age was 24 ± 4 years. In recreational leagues in the U.S.A. Woods et al. (2007) found that the mean age for players was 34 ± 8.7 years and in a recreational league in Canada, Voaklander et al. (1996) found the mean age of players to be 28.9 ± 5.5 years. Therefore, these findings indicate that the South African age profile is consistent with international recreational leagues. The age profile is slightly higher than the age profile of international elite leagues. This may be due to this study including all players in South Africa over the age of 18 years irrespective of the league they compete in.

Throughout the world ice hockey is a male dominant sport (Schik 1999), and the results of this study were no different. Male players in this study comprised 75.4% of the total participants. The lower number of female players in ice hockey in South Africa and other countries may be attributed to the physical nature of the sport that puts off females from participating.

In terms of ethnicity, the majority of participants in this study were white (85%, n = 159) followed by coloured (10.7%, n = 20). According to Statistics South Africa (2015), the ethnic distribution of the entire population in South Africa is 80.5% black, 8.8% coloured, 8.3% white and 2.5% Indian/Asian. Therefore, this indicates that the ethnic profile of ice hockey players in South Africa is not a representation of the population of South Africa and that ice hockey is mostly played by those players of white ethnicity.

During the years of apartheid the white minority dominated the sporting infrastructure in South Africa and the rest of the population had no access to adequate sporting facilities which therefore prevented the development of sport in the black population (U.S. Sports Academy 2005). The post-apartheid transformation of sport in South Africa has been slow and inequalities, with respect to ethnicity, still exist (U.S. Sports Academy 2005). There have been significant efforts made to make sport equally available to the majority of the population, however, this transformation may be many years away from accurately representing the population in South Africa.

There is limited literature regarding the ethnic profile of international ice hockey players. One study showed that the majority of players in the United States of America are of white ethnicity (Hostetler et al. 2004). Therefore, it cannot be determined whether the ethnic profile of ice hockey players in South Africa is similar to other

countries and whether the ethnic profile could affect the injury profile of ice hockey players.

- **Question A4: How much money do you spend (in Rands) on ice hockey equipment in a season?**

The amount of money spent on equipment varied greatly with the majority of the participants spending less money on equipment in a season (χ^2 p-value < 0.001). Most participants spent R2000-R3000 (n = 39) and R3000-R5000 (n = 33). According to Stamper (2014), the average amount spent annually in Canada is $1200. At the time of the study the exchange rate from Canadian Dollars to South African Rand was $1 is equivalent to R10.56, therefore the average amount spent annually in Canada is the equivalent to R12 683.94 (XE 2016). Therefore, South African ice hockey players spend significantly less money on equipment every year. This could be due to the fact that equipment is passed down and players use outdated, second hand equipment due to the availability and high import costs of sourcing new equipment. This may place South African ice hockey players at a higher risk of injury as a result of outdated equipment.

- **Questions A5 and A6: Height and body mass**

The BMI of participants in this study ranged from 16.9kg/m² to 37.2kg/m, with a mean BMI of 25.8kg/m². The mean BMI for this sample is considered overweight (Pollack et al. 2008). Grant et al. (2014) found that the mean BMI of players competing in the Division 1 ice hockey league of the National Collegiate Athletic Association in the U.S.A. was 25.7 ± 1.6kg/m², and Kutáč and Sigmund (2015) found that the mean BMI for the playing in the elite Russian and Czech Republic leagues were 26.69 ± 1.88kg/m² and 26.99 ± 1.92kg/m² respectively. The BMI profile of ice hockey players in South Africa is similar to international findings. Therefore, South African, and international player BMI profiles are considered overweight. Kutáč and Sigmund (2015) suggest that although these values indicate that the majority of players are overweight, the increased value may be a result of increased mass caused by a higher distribution of fat-free muscle mass. The Fat Free Muscle Index is required to accurately state whether the overweight BMI of the South African population is relevant. Grant et al. (2015) found that ice hockey players were 2.1 times more likely to sustain an injury if their BMI was ≥25kg/m². The mean BMI of the participants in this

study was ≥25kg/m², therefore South African ice hockey players may be at a higher risk of injury.

- **Question A7, A13, A8 and A9: Province, ice rink, league and position played**

Most of the participants in this study play in Gauteng (62.6%, n = 117). The Gauteng province consists of two cities where ice hockey is played, namely, Johannesburg and Pretoria. In KwaZulu Natal, ice hockey is played in one city, Durban and in the Western Province ice hockey is played in one city, Cape Town. The population of these cities differ significantly. According to Statistics South Africa (2011) the population size of Johannesburg (n = 4,4 million) and Pretoria (n = 2,9 million) combine to a total population of 7,3 million. Durban has a population of 3,4 million and Cape Town, 3,7 million (Statistics South Africa 2011). Therefore it is an expected finding that there are more participants from the Gauteng province as there a greater number of people have exposure to the sport.

The Gauteng players were relatively evenly distributed between the three ice rinks that exist in Gauteng: Festival Mall (21.9%, n = 41), The Grove (21.9%, n = 41) and Forrest Hill (18.7%, n = 35). As there is only the Galleria ice rink in KwaZulu Natal and the Grand West ice rink in the Western Province, all participants from these provinces play at the respective provincial ice rink (8.6%, n = 16 and 28.9%, n = 54 respectively). The greater number of participants from Gauteng may be explained by the three rinks in Gauteng which provides more exposure and demand for the sport as well as being able to accommodate more players. The highest number of participants reported that they most frequently play at the Grand West ice rink in Cape Town, Western Province. This was an expected finding as the Grand West ice rink is of international size (van Doesburgh 2016) and can therefore accommodate more players than any of the other ice rinks in South Africa (28.9%, n = 54). The Galleria ice rink in Durban, KwaZulu Natal, is half the size of a standard ice rink and can therefore accommodate a fewer number of players (8.6%, n = 16).

The majority of the participants compete in First division (31.6%, n = 59) and Second division (30.5%, n = 57) followed by Premier division (25.1%, n = 47) and Ladies division (24.1%, n = 45). The Premier division is the elite division in South Africa, followed by First division then Second division and the female players who compete in the Ladies division can also compete in the First and Second division (van

Doesburgh 2016). It is expected that the Premier division will have fewer numbers of participants than in the leagues below as this is the elite level in South Africa. The First and Second division, which have similar number of participants, is where the bulk of the population compete. The Ladies division is exclusive to female players therefore the majority of female players (n = 45) participate in the Ladies division.

The most common position played in reported by players in this study was forward (54.5%, n = 102) followed by defence (40.6%, n = 76) and goalkeeper (4.8%, n = 9). Caputo and Mattson found that in the recreational ice hockey league in the U.S.A. the player distribution was similar to the results in this study for forwards (n = 123), defence (n = 64) and goalkeepers (n = 19). Tegner and Lorentzon (1996) found that in the Swedish elite ice hockey league over four consecutive seasons the player position distribution was the highest for forwards (n = 63) followed by defence (24) and finally goalkeepers (n = 7).

The findings of this study is therefore similar to international studies. This can be attributed to the rules of ice hockey which state that there are three forwards, two defence and one goalkeeper on the ice at one time and teams then have an additional two or three line changes on the bench that also consist of three forwards and two defence (International Ice Hockey Federation 2015). The goalkeeper remains on the ice for the duration of the game (International Ice Hockey Federation 2015). Thus, a typical team consists of 9-12 forwards, 6-8 defence and 2 goalkeepers. The profile of player position in South Africa is similar to international findings, therefore player position should not have an effect on the risk of injury.

- **Question A10: How many years have you been playing ice hockey?**

Most of the participants in this study had been playing for less than four years (45.5%, n = 85) followed by those who have played for four to eight years (21.9%, n = 41) and over sixteen years (18.7%, n = 35). An explanation for this result may be that the data collection was conducted in the off season period when the more experienced players do not always attend practices or games, however the less experienced players tend to be more committed to their skill progression in the off season. Those players who have been playing for longer than 16 years are often involved in coaching the younger players before the adult practices and therefore there are more of them at training sessions or games.

In Canada, the majority of players start ice hockey at a very young age and can begin playing in organised leagues by the age of 8 years old (Boucher and Mutimer 1994), therefore by the time they reach 18 years of age they would have been playing for at least 10 years. Ice hockey is available in South Africa to anyone from the age of 6 years old (Western Province Ice Hockey Association 2016), however there is limited participation by younger players in South Africa which may be a result of ice hockey not being offered as a school sport as well as the lack of exposure to ice hockey through the media (van Doesburgh 2016). The results of this study show that most players have been playing for less than 4 years therefore in the South African ice hockey context, players have less years of playing experience than ice hockey players internationally. The lack of experience in South African ice hockey players may place them at greater risk of injury than the more experienced international ice hockey players.

- **Question A11: How many hours of training attended per week did you attend in the last season?**

Most of the total number of hours per week spent in training sessions in the previous season was two hours (27.3%, n = 51) followed by three hours (20.9%, n = 39). The cost to hire out the ice rink arena for a training session or game is costly in South Africa and players must cover these expenses in their personal capacity, therefore most clubs offer one to three hours of total training per week (van Doesburgh 2016). At certain ice rinks in South Africa, there is limited availability to hire the arena for a training session and therefore these training sessions occur late at night (Western Province Ice Hockey Association 2016). This may deter ice hockey players in South Africa from attending all training sessions in a week. The total number of hours that international ice hockey players spend training per week is over four hours (Agel et al. 2007a; Kuzuhara et al. 2009). Therefore, the exposure to activity is less in South African ice hockey players which may affect the risk of injury.

- **Question A12: How many games did you play in the last season?**

Of the 187 participants, 71 (38%) played between ten and nineteen games last season and 50 (26.7%) played less than ten games. The results to this question are expected as most of the leagues that operate within South Africa play an average of 15 games

in a calendar season (Pointstreak 2013). It is possible that players compete in more than one league and will therefore play more games in a season.

Players that compete in the National Hockey League of North America play a minimum of 80 games in a regular season (McKay et al. 2014). Players that compete in the National Collegiate Athletic Association of the Unites States of America average over 30 games in a season (Agel et al. 2007a). This finding is similar to the Japanese Ice Hockey League where players average over 35 games a season, therefore players in South Africa have a significantly reduced exposure to games compared to ice hockey players in other countries. This reduced exposure to the number of games played in a season may affect the injury profile of ice hockey players in South Africa.

- **Question A14: Do you play any other sport?**

The most popular alternate sport played by ice hockey players in this study was soccer/indoor soccer (17.1%, n = 32) and cycling/mountain biking (16.0%, n = 30). Archery (2008) found that all soccer and indoor soccer players competing in leagues in Durban, South Africa, sustained at least one injury playing soccer or indoor soccer over one season. Mills (2006) investigated the injury profile of South African cyclists and mountain bikers and found that cyclists and mountain bikers are at a higher risk of lower back, knee and neck injuries. These findings indicate that the alternate sport that the majority of South Africans ice hockey players participate in are high risk activities which may affect their risk of ice hockey-related injuries.

5.2.3 Objective Two

The second objective was to establish a profile of ice hockey related injuries sustained by players over the previous season.

The majority of the participants in this study had sustained at least one injury over the last season as a result of playing ice hockey (58.8%, n = 110). This was a significant finding (χ^2 p-value = 0.016). Across the world the incidence of injury in ice hockey players is high, however, studies differ in their definition of injury (Flik 2005; Kuzuhara 2009; Molsa et al. 1997). Caputo and Mattson (2005) found that 17.3% of all players in a recreational league in the U.S.A. sustained at least one injury, where an injury was defined as an event which prevents the player from completing a game, causes

a player to miss a game or forces the player to seek medical attention after the game. Emery et al. (2010) found that in two Canadian Junior ice hockey leagues 22.4% of players in Alberta sustained at least one injury and 8.4% of players in Quebec sustained at least one injury where an injury was defined as an event which prevents the player from participating for at least a week. Therefore, there is a higher percentage of South African players that sustain at least one injury in a season. However, this may be explained by the inconsistency in the definition of the word 'injury' as this study included any injurious event regardless of the time taken off or treatment received.

- **Question B1: For each injury indicate the body site that was injured.**

For the most severe injury, Injury One, most commonly involved the head (10.2%, n = 19) followed by the knee (8.0%, n = 15) and shoulder (8.0%, n = 15). The second most severe injury (Injury Two) commonly involved the thigh (7.5%, n = 14) and face (4.3%, n = 8). The additional injuries of Injury Three most commonly affected the back (4.3%, n = 8). These findings are congruent with the studies by McKay et al. (2014) and Tegner and Lorentzon (1991). McKay et al. (2014) found that the most commonly injured body site over six seasons of the National Hockey League in U.S.A. and Canada was the head (16.8%). Tegner and Lorentzon (1991) reported that 39% of all injuries in the Swedish elite league were to the head. Therefore, this finding is similar to the most severe injury (Injury One) in South African ice hockey players.

When combining all injuries according to body site, the knee was more frequently injured (16.0%, n = 30) in this study. Pelletier et al. (1993) found that in the Canadian Intercollegiate ice hockey leagues, the knee was most frequently injured (18.6%). Molsa et al. (1997) showed similar results in the Finish National League where knee injuries were the highest at 24.7% of all injuries. Although there are different studies that present the head or knee as the most commonly injured anatomical site of injury, South African ice hockey players have shown similar results, in that the most severe injury more commonly affected the head, and overall, the knee was the most frequently injured site.

- **Question B2: Have you injured this area before?**

The majority of the participants stated that the reported injury had occurred previously. These findings are consistent with those studies of Arnason et al. (2004), Bennell et al. (1996) and Maffey and Emery (2007) who found previous injury to be the most common contributing factor to injury across various sports. Certain injuries have an increased risk of re-injury regardless of sufficient rest and rehabilitation however many reoccurring injuries are due to inadequate management of the injury by the player (Hagglund et al., 2006).

In this study, however, a statically significant relationship between previous injury and risk of injury only exists for Injury Two (χ^2 p-value = 0.041). This may be explained by the large number of muscular injuries sustained in Injury Two which have shown to increase the risk of future injury due to scar tissue formation and reduced flexibility of the muscle (Hagglund et al. 2006; Croisier 2004; Gabbe et al. 2006).

- **Question B3: For the injury, indicate the type of injury by ticking the most appropriate box.**

The most frequent type of injury in Injury One was concussion (11.2%, n = 21) and muscle injuries (11.2%, n = 21). Muscle injuries were also the most common types of injuries for Injury Two (12.8%, n = 24) and Injury Three (9.1%, n = 17).

Abbott (2014) stated that concussion is consistently the most frequently reported type of injury in collegiate teams in the U.S.A. In the National Hockey League of Canada and the U.S.A. McKay et al. (2014) found that concussion rates were the highest injury overall (17%). These findings contradict the result of studies conducted in Europe and Asia. Kuzuhara et al. (2009) found the concussion rate in Japanese elite teams was 1.6%, Molsa et al. (1997) found the concussion rate in the Finnish National league was 4.2% and Pettersson and Lorentzon (1993) found that the concussion rate in a Swedish Elite team was 3.8%. The difference between the high rate of concussions in the North American teams in comparison to Europe and Asia may be a result of the more physical style of play in North America and the smaller ice surfaces used on this continent, which increase the rate and speed of collisions therefore placing players at a higher risk of injury (Flik et al. 2005). Therefore, the rate of concussions in South Africa is similar to findings in North America, but significantly higher than the

concussion rates in Europe and Asia. The reason for this may be that four out of the five ice rinks in South Africa have smaller ice surfaces (van Doesburgh 2016). This will place players at a higher risk of concussions as a result of the greater number of collisions that can occur on a small ice rink.

Muscular injuries was the highest type of injury in Injury Two, Injury Three and overall. This finding is not similar to international literature. Kuzuhara et al. (2009) found that contusions were the most common type of injury in the elite Japanese teams and McKnight et al. (1992) also found that contusion was the most common type of injury in the National Collegiate Athletic Association in the U.S.A. A number of studies show muscular strains combined with sprains and although in these studies the combination of strains and sprains is the most common type of injury (Dryden et al. 2000; Moslener and Wadsworth 2010; Tegner and Lorentzon 1991), in the present study, injuries to the muscle, joint or ligament remain separate. In the studies of Kuzuhara et al. (2009) and McKnight et al. (1992), athletic trainers or medical professionals were onsite when the injuries occurred therefore, according to Caputo and Mattson (2005), there may be an underreporting of chronic overuse injuries as there is a bias toward acute injuries with a sudden onset. This may explain why there is a higher number of muscular injuries in South African ice hockey players. Internationally, team staff such as coaches, managers and athletic trainers are paid for the services they provide to that team or club, however, in South Africa, team or club staff is minimally remunerated for their services (Giot 2016). The position is mostly on a volunteer basis which may result in coaches and trainers being less qualified or experienced (Giot 2016). Therefore, the coaching and training offered to South African ice hockey players may result in lower fitness and conditioning which increases the risk of muscular injuries.

- **Question B4: How would you describe the injury?**

The majority of participants reported that the severity of the injury was moderate. There was a significant relationship between the severity of the injury and Injury One and Two ($p = 0.001$ and $p < 0.001$ respectively).

Caputo and Mattson (2005) and Pettersson and Lorentzon (1993) found that most injuries were mild (59% and 61-73% respectively). Pettersson and Lorentzon (1993) defined injury severity as nuisance injuries (without any time loss), minor injuries (less than 1 week time off), moderate (8-30 days time loss) and severe (over 30 days time

loss). Caputo and Mattson (2005) classified injuries as mild (less than 8 days time loss), moderate (8-28 days time loss) and severe (over 28 days time loss). Question B4 provided no definition of severity of injury and did not ask for the time taken off playing. Instead Question B4 allowed participants to use their own subjective definition which may vary depending on the individual.

If the classification used by Caputo and Mattson (2005) and Pettersson and Lorentzon (1993) was applied to the results of this study the combination of players that took no time off play for Injury One, Two and Three (n = 36, n = 36, n = 27 respectively) and players that took 0-7 days off playing for Injury One, Two and Three (n = 14, n = 8, n = 5 respectively), would be greater than those that were kept out of playing for over one week. Therefore, if Question B4 on severity of injury in this study was classified according to the results of Question B9.1 and 9.2, the majority of participants would have reported their injuries as mild and as a result, South Africa would be similar to other countries in terms of severity of injuries sustained.

- **Question B5: The onset of the injury was:**

The injuries reported by the participants of this study were more frequently sudden in onset. In the International World Championships and Olympic Games between 2006 and 2013 that took place in various countries across the world, Tuominen et al. (2014) found that the majority of injuries were acute (92.8%). Hawn et al. (2002) describes ice hockey as the fastest and most violent team sport in the world were injuries frequently occur due to collisions with surrounding obstacles, therefore a high percentage of acute, sudden injuries is expected in ice hockey. The majority of injuries in South African ice hockey players were sudden in onset which is similar to international findings.

- **Question B6: The injury occurred during a:**

In this study, the majority of the injuries in Injury One, Two and Three occurred during games (χ^2 p-value < 0.001). Similar results were found in studies conducted internationally by Bancroft (1993), Pelletier et al. (1993), Pettersson and Lorentzon (1993) and McKnight et al. (1992) which showed the majority of injuries occurred during games. This result shows that South African ice hockey players, like international ice hockey players, are at a higher risk of injury during games.

- **Question B7: What was the mechanism of Injury?**

The majority of injuries in Injury One, Two and Three sustained by the participants in this study were as a result of contact with another player. A significant relationship exists between the mechanism of injury and all injuries (χ^2 p-value < 0.001).

These findings are consistent with the literature of Tuominen at al. (2014) who found that over a seven year period of International World Championships, including the Olympic Games, the most common mechanism of injury was as a result of contact with another player. A number of other international authors have shown the most frequent mechanism of injury to be player contact such as Molsa et al. (1997) in the Finnish National League, Dryden et al. (2000) in a Canadian recreational ice hockey league, Agel et al. (2007a) in the National Collegiate Athletic Association ice hockey leagues in the U.S.A and McKay et al. (2014) in the National Hockey League of North America. Contact with another player has shown to be the most common mechanism of injury internationally and in South Africa.

- **Question B8.1: What treatment did you receive for the injury?**

The most frequently sought after treatment for Injury One and Injury Two was physiotherapy (19.3% and 12.3% respectively). The majority of injuries in Injury Three did not receive any treatment (9.1%). Dryden et al. (2002) found that 36.0% of injured players in the study on recreational ice hockey players in Canada did not receive treatment for their injuries, this was followed by treatment of a general practitioner (32.0%). The high percentage of players not seeking medical attention in other countries may be explained by the findings on injury severity where majority of injuries have shown to be mild (Caputo & Mattson 2005; Pettersson and Lorentzon 1993) which may result in players seeking less assistance for their injuries. In this study, there were a higher number of injuries which were reported as moderate in severity and therefore players were more likely to seek medical attention.

Injury One showed a high incidence of concussions (11.2%, n = 21), therefore it is unexpected that majority of the participants in Injury One would choose treatment by a physiotherapist. Guskiewicz et al. (2000) stated that the diagnosis and management of concussions is challenging due to the complexity of the brain and therefore it is

recommended that should an ice hockey player suspect a concussion, diagnosis should be made by a physician or general practitioner.

- **Question B8.2 & B8.3: Was a diagnosis given by a professional? If yes, what was it?**

The majority of participants were not given a diagnosis for Injury One, Two or Three. This may be explained by a large number of the participants not seeking any medical attention for their injury as well as many players not being given a diagnosis by the medical professional or the participant not being able to remember the diagnosis that was given for their injury.

The most frequently given diagnosis in this study was concussion. International studies consistently show concussion as the most common type of injury in ice hockey across the world (Abbott 2014; Flik 2005; Moslener and Wadsworth 2010). Therefore, South African ice hockey players are at a similar level of risk of concussion to international ice hockey players.

- **Question B9.1 and B9.2: Did the injury keep you out of playing? If so, how long?**

Injury One, the most severe injury, showed the majority of participants took time out of playing (38.5%, n = 72), most commonly for one to three weeks (13.4%, n = 25). Injury Two showed similar results between taking time out of playing and returning to play immediately and those that did take time off from playing were mostly one to three weeks (7.0%, n = 13). The majority of players who sustained a third injury did not take any time out of playing (14.4%, n = 27). The findings can be explained by considering Injury One as the most severe injury and therefore requires a definite rest period in certain cases. Injury Two, the second most severe injury, may or may not need rest time. Injury Three as any additional injury which is the least severe injury and therefore may not require time out of playing.

Injury One showed a high number of concussions (11.2%, n = 21) and the majority of participants that sustained an injury in Injury One took time off from playing (38.5%, n = 72). According to Abbott (2014), any ice hockey player that is suspected of sustaining a concussion should be removed from all activity until the symptoms are no longer present, as continuation of play may place the ice hockey player at risk of further

injury which includes severe neurological injury with an extended recovery period. Therefore, it was appropriate that the majority of participants took time off from playing following Injury One.

The findings of Dryden et al. (2000), Caputo and Mattson (2005), McKnight et al. (1992) and Petterrsson and Lorentzon (1993) suggest that the majority of injuries in other countries, keep players from activity for 0-7 days. The injuries reported in Injury One required more rest time than international studies may be because in this study, Injury One was considered the most severe injury sustained by participants and therefore these injuries may require more time off from playing. However, overall, time taken off from playing following an injury in international ice hockey players was similar to South African ice hockey players.

- **Question C1: Which ice rink were you playing at when the injury was sustained?**

Injuries were more frequently sustained at Grand West (14.4%, n = 27) and Forrest Hill (14.4%, n = 27) followed by Festival Mall (13.4%, n = 25) for Injury One. Injuries reported under Injury Two were more frequently sustained at Grand West (11.2%, n = 21), Festival Mall (9.6%, n = 18). Most of the injuries in Injury Three were sustained at Grand West (8.0%, n = 15). Overall, the majority of injuries occurred at the Grand West ice rink (33.7%, n = 67).

A number of authors have documented the increased number of injuries as result of a higher collision rates on a smaller ice surface (Benson and Meeuwisse 2005; Flik et al. 2005; Wennberg 2004). Wennberg (2005) and Watson et al. (1997) suggested that using larger international size ice rinks could reduce injury rates by decreasing the rate of injury-related collisions in ice hockey. The Grand West ice rink is the only international sized ice rink in South Africa (van Doesburgh 2016), but the larger ice surface has not reduced the rate of injury in South African ice hockey players.

Tuominen et al. (2014) found that the use of flexible boards and glass reduced the number of all injuries as they assist in absorbing the impact of a collision and therefore decrease the forces generated into the body part. As there was no statistically significant relationship between the ice rink where the injury occurred and the total number of injuries (χ^2 p-value = 1.0000), the flexible boards and glass found at one

ice rink in South Africa (Grand West) did not assist in reducing the risk of injury. Therefore, flexible boards and glass do not reduce the risk of injury in South Africa as they have been shown to do internationally.

- **Question C2 and C2.1: Were there medical professionals available at the time of your injury? If so, who?**

The majority of participants for all injuries sustained (Injury One, Two and Three) reported that at the time of the injury there were medical professionals present which the majority chose to consult with. First Aid were the professionals most frequently present and consulted for injury One, Two and Three.

In previous studies in other countries around the world, teams have their own physician, physiotherapist or chiropractor as part of the team staff therefore players will consult with those medical professionals when the injury occurs (Agel et al. 2007a; Benson et al. 1999; Listola et al. 2013; Tuominen et al. 2014). In South Africa, teams do not have medical professionals at most training sessions, recreational games or as part of their team staff due to the financial implications, however the provincial associations arrange for First Aid to be present at the more competitive games and tournaments (Giot 2016). As a result, for 90 of the 215 injuries there were no medical professionals present. Thus, the South African ice hockey environment places less emphasis on medical support at trainings and recreational games.

5.2.4 Objective Three

The third objective was to determine if associations with the demographic profile and injuries sustained by ice hockey players exists.

Age versus total number of injuries according to body site

This study showed that a statically significant relationship exists between age and the risk of injury (χ^2 p-value <0.0001), where those players in the younger age groups of 18 to 27 years old are at greater risk of injury. According to a number of international studies, ice hockey injuries peak at adolescence and taper off into the older age groups, with the least number of injuries sustained by players in the older age groups (Hostetler et al. 2004, Josse 2008, Tator et al. 1998). Hostetler et al. (2004) suggested that the decrease in the risk of injury as players get older is a result of less aggressive

play, less illegal activity, equipment which is better quality and correctly fitted and a realistic view of the protective ability of equipment in older players. Hostetler et al. (2004) also suggests that younger players are not as proficient in skating and therefore may fall more which may lead to a higher injury rate. In this study, the majority of players are in the youngest age bracket (18 to 27 years) and have been playing ice hockey for the shortest period of time (less than four years), therefore the high injury rate may be a result of less proficient skating ability. When compared to international countries, South African ice hockey players are at the same risk of injury with respect to age.

Gender versus total number of injuries according to body site

A review of the international literature by MacCormick et al. (2014) showed that in all studies, males had significantly higher rates of injury than females. MacCormick et al. (2014) suggested that the lower rate of injury in female ice hockey players is a result of differences in rules of the game where body checking is prohibited. Therefore injuries are high in male leagues where body checking is allowed (Abbott 2014; Agel et al. 2010). However, in this study, the relationship between gender and the risk of total injuries was significantly insignificant (χ^2 p-value = 0.7408). This may be explained by the inclusion of participants in this study who compete in the Second division (30.5%, n = 57) and the Intermediate division (10.7%, n = 20) where body checking is prohibited (van Doesburgh 2016). This may result in a lower than expected injury rate in male ice hockey players in South Africa and therefore no difference is shown between male and female ice hockey players.

When analysing gender and specific body sites, a significant relationship exists between gender and head injuries (χ^2 p-value = 0.0196). This shows that females are at a higher risk of head injuries than males in South Africa. Abbott (2014) found that during intercollegiate ice hockey games in the U.S.A, during one season female ice hockey players had a concussion rate of 14.9/1000 hours of athlete exposure compared to 7.5/1000 hours of athlete exposure in males. Agel et al. (2010) found that the rate of head injuries in males was 0.72/1000 hours athlete exposure and 0.82/1000 hours athlete exposure in females. Abbott (2014) suggested that societal or cultural differences between male and female ice hockey players may result in a higher reporting of injurious events by females due to the overprotection of female ice hockey

players by coaches. Another suggestion for the higher rate of head injuries and concussions in female ice hockey players is that due to the prohibition of body checking in female ice hockey, female players are not trained to anticipate collisions of body contact and are therefore greater forces are transmitted to the head which may result in injury. Therefore, the higher incidence of head injuries in female ice hockey players in South Africa is similar to international findings.

Knee injuries were the most common finding in female participants (n = 14) and show a statistically significant relationship between gender and knee injuries with a p value = 0.0046. The increased risk of knee injuries in female ice hockey players is an uncommon finding internationally. Agel et al. (2010) stated that female ice hockey players in the National Collegiate Athletic Association's ice hockey leagues sustain fewer number of knee injuries than males as knee injuries are usually as a result of high-speed contact situations that predominantly occur in male ice hockey. Schick and Meeuwisse (2003) found that male ice hockey players sustain more knee injuries than females in the Canadian intercollegiate leagues. Female ice hockey players in South Africa are allowed to play with other male players at training sessions and in the First division league where body checking is permissible therefore this may place females at a higher risk of high-speed collisions which increase the risk of knee injuries.

No statistically significant relationships exited between the remaining demographics (ethnicity, money spent on equipment, height, body mass, province, ice rink played at, league, position, playing experience, hours training, games, and other sport) and the risk of injury (χ^2 p-value > 0.05

5.2.5 Objective Four

The fourth objective was to establish if an association between injuries sustained and the use of protective equipment exists.

Section D of the questionnaire did not provide question numbers, therefore the discussion will be presented under the headings as they appear in the rows of the table on page four of the questionnaire.

5.2.5.1 Visor worn on helmet versus total number of injuries according to body site (QB1)

Of the total number of facial injuries (n = 15), 13 were sustained by participants wearing half facial protection and two occurred in those wearing full facial protection. Those participants that do not wear facial protection sustained no facial injuries. The statically significant relationship between facial protection and facial injuries (χ^2 p-value = 0.005) is congruent with the literature of Benson et al. (1999) and Stuart et al. (2002). These studies suggest the use of mandatory full facial protection to avoid the risk of facial injury. This study shows that half facial protection is a risk factor for facial injuries in South African ice hockey players which is similar to international findings. Therefore, South African players may reduce injury rates to the face with the mandatory use of full facial protection.

5.2.5.2 Manufacturing year of equipment versus total number of injuries according to body site (QB1)

A significant relationship between the year that equipment was manufactured and the risk of injury, which indicated that newer equipment or equipment manufactured in the groups of 2012-2014 and 2015 resulted in more injuries. In this study, there was a higher number of injuries sustained by players who had been playing for less than four years, therefore these players would have purchased equipment between the years of 2012 and 2015 when they started playing ice hockey. Therefore the correlation between newer equipment and the risk of injury may be a result of the experience level of the players wearing that equipment.

The use of newly manufactured skates (2012-2014 and 2015) was a risk factor for ankle and foot injuries. This finding is congruent with Agel at. (2010) who suggested that newer models of skates have significantly less material covering the ankle and foot in order to produce a lighter design therefore this may increase the risk of ankle and foot injuries. In this study, the newer models of skates are a risk factor for ankle and foot injuries.

5.2.5.3 Quality of equipment versus total number of injuries according to body site (QB1)

The quality of the helmet used by participants in this study was a risk factor for head, facial and neck injuries. The results of this study show that intermediate quality helmets have a higher risk of head injury than that of entry level or top of the range helmets. A recent study by Rowson et al. (2015) showed that the protective function of ice hockey helmets is not dependant on the price of the helmet and some intermediate quality helmets will outperform top of the range helmets of another brand. For this reason, the make and model number of each helmet is required to accurately investigate the relationship between the quality of the helmet used and the risk of head injuries.

Shoulder pads of intermediate quality was a risk factor for chest, back and shoulder injuries and ice hockey pants of intermediate quality were a risk factor for back and thigh injuries. In an attempt to make middle of the range equipment more affordable, manufacturers produce equipment which may offer less protective function than top of the range equipment and may not be as well-fitted in comparison, leaving certain areas exposed to the possibility of injury (van Doesburgh 2016).

The majority of the participants in this study use intermediate quality protective equipment, possibly due to the affordability of intermediate quality protective equipment compared to the higher priced top of the range protective equipment (van Doesburgh 2016), therefore it is an expected finding that the majority of the injuries sustained are with intermediate quality equipment.

5.2.5.4 Use of equipment during a training, a game or at the time of the injury versus total number of injuries according to body site (QB1)

There was a statistically significant relationship between the use of a helmet, shoulder pads, elbow pads, pants, skates, shin pads/leg pads and gloves/mitt and blocker and the risk of all injuries, however the majority of participants wear the equipment during all trainings, games, and at the time of the injury. Josse (2008) stated that although wearing protective equipment is beneficial, ice hockey players are still susceptible to injury, therefore equipment must be fitted correctly and regularly maintained to provide the greatest amount of protective function possible. Tator et al. (1998) stated that ice

hockey players feel that they are exempt from injury due to the protective equipment worn and play with more aggression and recklessness which increases the risk of injury. The relationship between the use of protective equipment during training sessions, games and when the injury occurred and the risk of injury indicates that although this protective equipment is worn, injuries still occur.

There was a statically significant relationship between the use of a mouthguard during trainings, games and when the injury occurred, and head injuries which indicates that those players that do not wear mouthguards are at a higher risk of sustaining a head injury. This finding supports the international literature of Biasca et al. (2002), Hawn et al. (2002) and Tran et al. (2001) who stated that mouthguards absorb the forces to the mouth, jaw, teeth and reduce the forces transmitted from the mandible to the occiput in contact situations therefore reducing the risk of concussion. Therefore, South African ice hockey players, like international ice hockey players, may reduce the rate of head injuries with the use of mouthguards.

CHAPTER 6 : CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter comprise a summary and conclusion of the results of the study. The recommendations for this study and future studies are provided as well as a listing of the limitations of this study.

6.2 Conclusions

Objective One:

To establish a demographic profile of ice hockey players in South Africa.

This study found that the majority of ice hockey players in South Africa are between the ages of 18 and 27 years, male, white in ethnicity with a mean value of BMI as 25.8kg/m^2. This demographic profile of South African ice hockey players is similar to the demographic profile of ice hockey players internationally. Most of the ice hockey players in this study have been playing ice hockey for less than four years. This is significantly less experience than ice hockey players internationally. The majority of players in South African did not start playing in their childhood years. The majority of ice hockey players trained for 2 hours per week and played between 10 and 19 games in the last season. The exposure to activity in the South African ice hockey context is less than that of international findings.

Objective Two:

To establish a profile of ice hockey related injuries sustained by players over the previous season.

The most severe injury (Injury One) more frequently affected the head and the overall combination of injuries most commonly affected the knee. The most common types of injuries were concussions for the most severe injury and muscular injuries overall. South African ice hockey players reported that the majority of all injuries were sudden, occurred during a game, and were as a result of contact with another player. Most of the players sought treatment from a physiotherapist, followed by the choice not to have any treatment. The injury profile of South African ice hockey players is similar to the

injury profile found in international literature. Previous injury showed no association to the risk of injury in this study. Larger ice surfaces and ice rink arenas with flexible boards and glass have been shown to reduce injury rates internationally. However, the ice rink arenas included in this study showed no correlation to an increase in injury rate despite the variances in materials enclosing the arena and the various ice surface sizes.

Objective Three:

To determine if associations with the demographic profile and injuries sustained by ice hockey players exists.

There was a significant relationship between those participants between the ages of 18 and 27 years and the risk of injury. Females were at a higher risk of head injuries than males. These findings are similar to that of international ice hockey. Females were also at a higher risk of knee injuries than males. Factors such as ethnicity, BMI, playing experience, playing position, level of competition, hours of training and total number of games last season did not have a statistically significant relationship with the risk of injury in this study.

Objective Four:

To establish if an association between injuries sustained and the use of protective equipment exists.

The results of this study showed that the use of protective equipment does not prevent injuries from occurring, however, players should make informed decisions about the protective equipment that they choose to wear. The use of half facial protection was shown to be a risk factor for facial injuries and players that chose not to wear a mouthguard sustained a higher rate of head injuries. The association between the use of protective equipment and the risk of injury is similar between South African and international ice hockey players.

Aim:

The aim of this study was to determine a profile of ice hockey injuries in South African players.

The profile of ice hockey injuries in South African players has been determined in this study. The results show that the demographic profile of ice hockey players in South Africa is similar to international profiles in terms of age, gender, BMI and player postion. The injury profile of South African ice hockey players was shown to be congruent with the injury profiles in international literature with regard to site, type, severity, onset and mechanism of injury. South African ice hockey players sustained the majority of injuries during a game, which is a similar finding in the international literature. International studies have shown that the younger age groups are at a higher risk of injury and in the results of this study showed similar findings in the South African context. Females were at a higher risk of head injuries in South African ice hockey players, which corresponds with international literature. A significant relationship between the use of a half visor and the risk of facial injuries exists which is parallel to international data. This study, like international studies, showed that the use of a mouthguard may reduce the rate of head injuries in South African ice hockey players. Injuries still occur in South African and international ice hockey players that use protective equipment.

The demographic profile of this study showed that South African ice hockey players spend less money on equipment in a season than international players, which may increase the risk of injury. South African ice hockey players have a different demographic profile due to the lesser number of years of experience, weekly total hours of training and number of games played in a season, compared to international ice hockey players. The injury profile of South African ice hockey players showed a higher number of muscular injuries than international injury profiles. International ice hockey players have shown a reduced rate of injury in ice rink arenas which are a larger ice surface area and are enclosed with flexible boards and glass, however, the ice rink where the injury occurred was not a risk factor for injury in this study.

6.3 Recommendations

- Future research should include following players during the course of a season and monitoring all injuries.
- Future research should plan to physically examine injuries in order to obtain accurate diagnoses of injuries in ice hockey players.
- Future studies should investigate various brand and model numbers of equipment and the risk of injury.

6.4 Limitations

- Injuries in this study were self-reported therefore may have resulted in inaccurate data from recall biasness.
- Although the minimum sample size was met, a larger sample size may have produced more significant results. The data collection for this study occurred during the preseason period therefore the study may have had a larger sample size had data collection occurred in the middle of the ice hockey season.

REFERENCES

Abbott, K. 2014. Injuries in women's ice hockey: special considerations. *Current sports medicine reports*, 13(6): 377-382.

Agel, J. and Harvey, E. J. 2010. A 7-year review of men's and women's ice hockey injuries in the NCAA. *Canadian journal of surgery*, 53(5): 319.

Agel, J., Dick, R., Nelson, B., Marshall, S.W. and Dompier, T.P. 2007a. Descriptive epidemiology of collegiate women's ice hockey injuries: National Collegiate Athletic Association Injury Surveillance System, 2000-2001 through 2003-2004. *Journal of athletic training*, 42(2): 249.

Agel, J., Dompier, T. P., Dick, R. & Marshall, S. W. 2007b Descriptive epidemiology of collegiate men´s ice hockey injuries: National Collegiate Athletic Association Injury Surveillance System. 1988-1989 Through 2003-2004. *Journal of athletic training* 42(2): 241-248.

Archary, N. 2008. Profiling of soccer injuries prevalent in amateur indoor and outdoor soccer players in the Greater Durban and surrounding areas. M.Tech. dissertation. Durban University of Technology.

Arnason, A., Sigurdsson, S. B., Gudmundsson, A., Holme, I., Engebretsen, L. and Bahr, R. 2004. Risk factors for injuries in football. *The American journal of sports medicine*, 32(1 suppl): 5S-16S.

Asplund, C., Bettcher, S. and Borchers, J. 2009. Facial protection and head injuries in ice hockey: a systematic review. *British journal of sports medicine*, 43(13): 993-999.

Bahr, R. and Holme, I. 2003. Risk factors for sports injuries – a methodological approach. *British journal of sports medicine*, 37: 384-392.

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

Bennell, K. L., Malcolm, S. A., Thomas, S. A., Reid, S. J., Brukner, P. D., Ebeling, P. R. and Wark, J. D. 1996. Risk factors for stress fractures in track and field athletes: a twelve-month prospective study. *The American journal of sports medicine*, 24(6): 810-818.

Benson, B. and Meeuwisse, W. 2005. Ice hockey injuries. *Epidemiology of pediatric sports injuries,* 49: 86-119.

Benson, B. W., Mohtadi, N. G., Rose, M. S. and Meeuwisse, W. H. 1999. Head and neck injuries among ice hockey players wearing full face shields vs half face shields. *Jama*, 282(24): 2328-2332.

Biasca, N., Wirth, S., and Tegner, Y. 2002. The avoidability of head and neck injuries in ice hockey: an historical review. *British journal of sports medicine*, 36(6): 410-427.

Boucher, J. L. and Mutimer, B. T. 1994. The relative age phenomenon in sport: a replication and extension with ice-hockey players. *Research quarterly for exercise and sport*, 65(4): 377-381.

Bracko, M. R., Fellingham, G. W., Hall, L. T., Fisher, A. G. and Cryer, W. 1998. Performance skating characteristics of professional ice hockey forwards. *Research in sports medicine: an international journal*, 8(3): 251-263.

Brust, J. D., Leonard, B. J., Pheley, A., and Roberts, W. O. 1992. Children's ice hockey injuries. *American journal of diseases of children*, 146(6): 741-747.

Caine, D., Maffulli, N. and Caine, C. 2008. Epidemiology of injury in child and adolescent sports: injury rates, risk factors, and prevention. *Clinical sports medicine,* 27: 19-50.

Caputo, P. and Mattson, D.J., 2005. Recreational ice hockey injuries in adult nonchecking leagues: a United States perspective. *Journal of sports science and medicine*, 4(1): 58-65.

Chamard, E., Théoret, H., Skopelja, E.N., Forwell, L.A., Johnson, A.M. and Echlin, P.S. 2012. A prospective study of physician-observed concussion during a varsity university hockey season: metabolic changes in ice hockey players. Part 4 of 4. *Neurosurgical focus*, 33(6): E4.

College Sports Scholarships. n.d. Ice hockey history. Historical facts about hockey (online). Available: http://www.collegesportsscholarships.com/history-hockey.htm (Accessed: 17 May 2016).

Cook, S. G. 2015. *Shin guard / shin pad guide for hockey players* (online). Available: http://newtohockey.com/shin-guard-shin-pad-guide-hockey-players/ (Accessed: 15 May 2016).

Cox, M. H., Miles, D. S., Verde, T. J. and Rhodes, E. C. 1995. Applied physiology of ice hockey. *Sports medicine*, 19(3): 184-201.

Croisier, J.L., 2004. Factors associated with recurrent hamstring injuries. *Sports medicine*, 34(10): 681-695.

Cummings, P. D. (2016). *Proper safety equipment for ice hockey* (online). Available: http://www.hughston.com/hha/a.hocksafe.htm (Accessed: 21 February 2016).

Cusimano, M. D., Taback, N. A., McFaull, S. R., Hodgins, R., Bekele, T. M., and Elfeki, N. 2011. Effect of bodychecking on rate of injuries among minor hockey players. *Open medicine*, 5(1): e57.

Daly, P. J., Sim, F. H. and Simoner, W. T. 1990. Ice hockey injuries: a review. *Sports medicine* 10930: 122-131.

Deemer, A. 2010. *What gear do hockey players wear?* (online). Available: http://www.livestrong.com/article/261152-what-gear-do-hockey-players-wear/ (Accessed 15 February 2016).

Deits, J., Yard, E. E., Collins, C. L., Fields, S. K. and Comstock, R. D. 2010. Patients with ice hockey injuries presenting to US emergency departments, 1990-2006. *Journal of athletic training*, 45(5): 467.

DeYoung, A. K., Robinson, E. and Godwin, W. C. 1994. Comparing comfort and wearability: custom-made vs. self-adapted mouthguards. *The journal of the American dental association*, 125(8): 1112-1117.

Dirckx, J.H. ed. 1997. *Stedman's concise medical & allied health dictionary.* Philadelphia, PA: Williams & Wilkins.

Dryden, D. M., Francescutti, L. H., Rowe, B. H., Spence, J. C. and Voaklander, D. C. 2000. Epidemiology of women's recreational ice hockey injuries. *Medicine and science in sports and exercise*, 32(8): 1378-1383.

Emery, C. A., Hagel, B., Decloe, M. and Carly, M. 2010. Risk factors for injury and severe injury in youth ice hockey: a systematic review of the literature. *Injury prevention*, 16(2): 113-118.

Engebretsen, L., Steffen K., Alonso, J. M., Aubury, M., Dvorak, J., Junge, A., Meeuwisse, W. H., Mountijoy, M., Renstrom, P. and Wilkinson, M. 2010. Sports injuries and illnesses during the winter Olympic Games 2010. *British journal of sports medicine*, 44: 772–780.

Fitzgerald, M. D., Tanaka, H., Tran, Z. V. and Seals, D. R. 1997. Age-related declines in maximal aerobic capacity in regularly exercising vs. sedentary women: a meta-analysis. *Journal of applied physiology*, 83(1): 160-165.

Flik, K., Lyman, S. and Marx, R. G. 2005. American collegiate men's ice hockey an analysis of injuries. *The American journal of sports medicine*, 33(2): 183-187.

Francis, K. T. and Brasher, J. 1991. Physiological effects of wearing mouthguards. *British journal of sports medicine*, 25(4): 227-231.

Fukuchi, R. K., Stefanyshyn, D. J., Stirling, L., Duarte, M. and Ferber, R. 2014. Flexibility, muscle strength and running biomechanical adaptations in older runners. *Clinical Biomechanics*, 29(3): 304-310.

Gabbe, B. J., Bennell, K. L., Finch, C. F., Wajswelner, H. and Orchard, J. W. 2006. Predictors of hamstring injury at the elite level of Australian football. *Scandinavian journal of medicine and science in sports*, 16(1): 7-13.

Gabbett, T. J., Ullah, S. and Finch, C. F. 2012. Identifying risk factors for contact injury in professional rugby league players–Application of a frailty model for recurrent injury. *Journal of science and medicine in sport*, 15(6): 496-504.

Giot, M. 2016. Personal communications with D. van Doesburgh. Durban University of Technology.

Grant, J. A., Bedi, A., Kurz, J., Bancroft, R., Gagnier, J. J. and Miller, B. S. 2015. Ability of preseason body composition and physical fitness to predict the risk of injury in male collegiate hockey players. *Sports health: a multidisciplinary approach*,7(1): 45-51.

Guskiewicz, K. M., Weaver, N. L., Padua, D. A. and Garrett, W. E. 2000. Epidemiology of concussion in collegiate and high school football players. *The American journal of sports medicine*, 28(5): 643-650.

Hägglund, M., Waldén, M. and Ekstrand, J. 2006. Previous injury as a risk factor for injury in elite football: a prospective study over two consecutive seasons. *British journal of sports medicine*, 40(9): 767-772.

Hawn, K. L., Visser, M. F. and Sexton, P. J. 2002. Enforcement of mouthguard use and athlete compliance in National Collegiate Athletic Association men's collegiate ice hockey competition. *Journal of athletic training*, 37(2): 204.

Hootman, J. M., Dick, R. and Agel, J. 2007. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *Journal of athletic training,* 42(2): 311–319

Hostetler, S. G., Xiang, H. and Smith, G. A. 2004. Characteristics of ice hockey–related injuries treated in US emergency departments, 2001–2002. *Pediatrics*, 114(6): e661-e666.

International Ice Hockey Federation. 2015. *IIHF OFFICIAL RULE BOOK 2014-2018* (online). Available at: http://www.iihf.com/fileadmin/user_upload/PDF/Sport/IIHF_Official_Rule_Book_2014-18_Web_V6.pdf (Accessed: 7 July 2016).

Josse, J. M. 2008. The economic cost of hockey injury in Ontario. M.Sci: Thesis. York University, Canada.

Junge, A., Rösch, D., Peterson, L., Graf-Baumann, T. and Dvorak, J. 2002. Prevention of soccer injuries: a prospective intervention study in youth amateur players. *The American journal of sports medicine*, 30(5): 652-659.

Kelley, K., Clark, B., Brown, V. and Sitzia, J. 2003. Good practice in the conduct and reporting of survey research. *International journal for quality in health care*, 15(3): 261-266.

Kutáč, P. and Sigmund, M. 2015. A comparison of somatic variables of elite ice hockey players from the Czech ELH and Russian KHL. *Journal of human kinetics* 45(1): 187-195.

Kuzuhara, K., Shimamoto, H. and Mase, Y. 2009 Ice hockey injuries in a Japanese elite team: a 3-year prospective study. *Journal of athletic training*, 44(2): 208.

LaPrade, R.F., Burnett, Q.M., Zarzour, R. and Moss, R., 1995. The Effect of the mandatory use of face masks on facial lacerations and head and neck injuries in ice hockey a prospective study. *The American journal of sports medicine*, *23*(6): 773-775.

LaPrade, R. F., Surowiec, R. K., Sochanska, A. N., Hentkowski, B. S., Martin, B. M., Engebretsen, L. and Wijdicks, C. A. 2013. Epidemiology, identification, treatment and return to play of musculoskeletal-based ice hockey injuries. *British journal of sports medicine*, 48(1): 4-10.

LaPrade, R. F., Wijdicks, C. A. and Griffith, C. J. 2009. Division I intercollegiate ice hockey team coverage. *British journal of sports medicine*, 43(13): 1000-1005.

Lind, D. A., Marchal, W. G. and Mason, R. D. 2004. *Statistical techniques in business & economics*. 11th ed. Boston, MA: McGraw Hill Higher Education.

Lindenfeld T. N., Schmitt D. J., Hendy M. P., Mangine, R. E., Noyes, F. R. 1994. Incidence of injury in indoor soccer. *The American journal of sports medicine*, (22): 364-371.

Lippert, L. 2006. *Clinical kinesiology and anatomy*. 4th ed. Philadelphia: Davis Company.

MacCormick, L., Best, T. M. and Flanigan, D. C. 2014. Are there differences in ice hockey injuries between sexes? A systematic review. *Orthopaedic journal of sports medicine*, 2(1).

Maffey, L. and Emery, C. 2007. What are the risk factors for groin strain injury in sport? A systematic review of the literature. *Sports med*icine (37): 881-894.

Marchie, A. and Cusimano, M. D. 2003. Bodychecking and concussions in ice hockey: Should our youth pay the price?. *Canadian medical association journal*, 169(2): 124-128.

McKay, C.D., Tufts, R.J., Shaffer, B. and Meeuwisse, W.H. 2014. The epidemiology of professional ice hockey injuries: a prospective report of six NHL seasons. *British journal of sports medicine*, 48(1): 57-62.

McKnight, C. M., Ferrara, M.S. and Czerwinska, J. M. 1992. Intercollegiate ice hockey injuries: a three-year analysis. *Journal of athletic training,* 27(4): 338-343.

Meeuwisse, W. H. 1994. Assessing causation in sport injury: a multifactorial model. *Clinical journal of sport medicine*, 4(3): 166-170.

Mills, B.J. 2006. An investigation to establish an injury profile in South African cyclists and its association to bicycle set-up. M.Tech.dissertation. Durban University of Technology.

Molsa, J., Airaksinen, O., Nasman, O. and Torstila I. 1997. Ice hockey injuries in Finland: a prospective epidemiologic study. *The American journal of sports medicine,* 25(4): 495–499.

Moslener, M. D. and Wadsworth, L. T. 2010. Ice hockey: a team physician's perspective. *Current sports medicine reports*, 9(3): 134-138.

Motala, F. 2009. The prevalence and risk factors of injuries in amateur outdoor and indoor volleyball players in a KwaZulu-Natal North Coast Region. M.Tech.dissertation. Durban University of Technology.

Mouton J. 1996. *Understanding social research*. Pretoria: Van Schaik.

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

Newsome, P. R. H., Tran, D. C. and Cooke, M. S. 2001. The role of the mouthguard in the prevention of sports-related dental injuries: a review. *International journal of paediatric dentistry*, 11(6): 396-404.

Nicholas, S. J. and Tyler, T. F. 2002. Adductor muscle strains in sport. *Sports medicine*, 32(5): 339-344.

Östenberg, A. and Roos, H. 2000. Injury risk factors in female European football. A prospective study of 123 players during one season. *Scandinavian journal of medicine and science in sports*, 10(5): 279-285.

Pelletier, R. L., Montelpare, W. J. and Stark, R. M. 1993. Intercollegiate ice hockey injuries: a case for uniform definitions and reports. *The American journal of sports medicine,* 21(1): 78-81.

Peterson, L., Junge, A., Chomiak, J., Graf-Baumann T. and Dvorak, J. 2000. Incidence of football injuries and complaints in different age groups and skill levels. *The American journal of sports medicine.* 28(5): S51-S57.

Pettersson M.and Lorentzon R. 1993. Ice hockey injuries: a 4-year prospective study of a Swedish elite ice hockey team. *British journal of sports medicine*, 27(4): 251-254.

Pinto, M., Kuhn, J. E., Greenfield, M. L. V. and Hawkins, R. J. 1999. Prospective analysis of ice hockey injuries at the Junior A level over the course of one season. *Clinical journal of sport medicine*, 9(2): 70-74.

Pointstreak. 2013. *SAIHA GPL standings.* (online) Available: http://www.pointstreak.com/prostats/scoreboard.html?leagueid=1388&seasonid=11020. (Accessed 20 May 2015).

Pollack, K. M., Sorock, G. S., Slade, M. D., Cantley, L., Sircar, K., Taiwo, O. and Cullen, M. R. 2008. Association between body mass index and acute traumatic workplace injury in hourly manufacturing employees. *American journal of epidemiology*, 166(2): 204-211.

Posthumus, M. and Viljoen, W. 2008. BokSmart: safe and effective techniques in rugby union. *South African journal of sports medicine*, 20(3): 64.

Poutiainen, P. 2012. Comparison of impact characteristics of different ice hockey arena dasher boards. MBpa: Thesis, University of Jyväskylä, Finland.

Proactive Health Group. (online). 2015. Available: http://www.proactivehealthgroup.ca/resources_articles/Helmets.pdf (Accessed 13 June 2016).

Quinn, E. 2016. *Essential ice hockey safety equipment and gear* (online). Available at: https://www.verywell.com/essential-ice-hockey-safety-equipment-and-gear-3120419 (Accessed 30 April 2016).

Rishiraj, N., Lloyd-Smith, R., Lorenz, T., Niven, B. and Michel, M. 2009. University men's ice hockey: rates and risk of injuries over 6-years. *Journal of sports medicine and physical fitness*, 49(2): 159.

Rowson, B., Rowson, S. and Duma, S.M., 2015. Hockey STAR: a methodology for assessing the biomechanical performance of hockey helmets. *Annals of biomedical engineering*, 43(10): 2429-2443.

Salant, P. and Dillman, D. 1994. *How to conduct your own survey.* New York, NY: John Wiley & Sons Inc.

Schick, D. M. 1999. Injury rates and profiles in female ice hockey. MSci: Thesis, University of Calgary, Canada.

Schick, D. M. and Meeuwisse, W. H. 2003. Injury rates and profiles in female ice hockey players. *The American journal of sports medicine*, 31(1): 47-52.

Singh, D. 2016. Personal communications with D. van Doesburgh. Durban University of Technology.

SmartPlay. 2015. *Protect against injury: wear the right gear*. (online). Available: http://www.smartplay.com.au/Content/Pub/ContentDetail.asp?lngContentID=119 (Accessed 13 June 2016).

Sports Definitions. 2016. *Ice hockey* (online). Available at: http://www.sportsdefinitions.com/ice-hockey/terms (Accessed: 7 July 2016).

Stamper, G. 2014. *Spoke* (online). Available: http://spokeonline.com/2014/03/cost-of-minor-sports-varies-greatly. (Accessed 1 July 2016).

Statistics South Africa. 2011. *Metropolitan municipality: population size* (online). Available at: http://www.statssa.gov.za/?page_id=1021&id=ekurhuleni-municipality (Accessed: 7 July 2016).

Statistics South Africa. 2015. *Mid-year population estimates, 2015* (online). Available at: https://www.statssa.gov.za/publications/P0302/P03022015.pdf (Accessed: 7 July 2016).

Stevens, S. T., Lassonde, M., de Beaumont, L. and Keenan, J. P. 2006. The effect of visors on head and facial injury in National Hockey League players. *Journal of science and medicine in sport*, 9(3): 238-242.

Stevenson, M. R., Hamer, P., Finch, C. F., Elliot, B., and Kresnow, M. J. 2000. Sport, age, and sex specific incidence of sports injuries in Western Australia. *British journal of sports medicine*, 34(3): 188-194.

Stuart, M. J., Smith, A. M., Malo-Ortiguera, S. A., Fischer, T. L.and Larson, D. R. 2002. A comparison of facial protection and the incidence of head, neck, and facial injuries in Junior A hockey players: a function of individual playing time. *The American journal of sports medicine*, 30(1): 39-44.

Survey of players (online) 2015. Available at: http://www.iihf.com/iihf-home/the-iihf/survey-of-players/ (Accessed: 17 May 2016).

Taimela, S., Kujala, U.M., Osterman, K. 1990. Intrinsic risk factors and athletic injuries. *Sports medicine,* 9(4): 205-215.

Tator, C. H., Carson, J. D. and Edmonds, V. E. 1998. Spinal injuries in ice hockey. *Clinics in sports medicine*, 17(1): 183-194.

Tegner, Y. and Lorentzon, R. 1991. Ice hockey injuries: incidence, nature, and causes. *British journal of sports medicine*, 25(2): 87–89.

Tegner, Y. and Lorentzon, R. 1996. Concussion among Swedish elite ice hockey players. *British journal of sports medicine*, 30(3): 251-255.

Tran, D., Cooke, M. S. and Newsome, P. R. 2001. Laboratory evaluation of mouthguard material. *Dental traumatology*, 17(6): 260-265.

Tuominen, M., Stuart, M. J., Aubry, M., Kannus, P. and Parkkari J. 2014. Injuries in men's international ice hockey: a 7-year study of the International Ice Hockey Federation Adult World Championship Tournaments and Olympic Winter Games. *British journal of sports medicine,* 49(1): 30-36.

U.S. Sports Academy. 2005. *Race, gender and sport in post-apartheid South Africa.* (online). Available at: http://thesportjournal.org/article/race-gender-and-sport-in-post-apartheid-south-africa/ (Accessed: 9 July 2016).

Van Doesburgh, J. 2016. *Ice hockey in SA* (online). Available at: http://michjoubert3.wix.com/vandhockey (Accessed 8 May 2016).

Van Teijlingen, E. and Hundley, V. 2002. The importance of pilot studies. *Nursing standard*, 16(40): 33-36.

Voaklander, D. C., Saunders, L. D., Quinney, H. A. and Macnab, R. B. 1996. Epidemiology of recreational and old-timer ice hockey injuries. *Clinical journal of sport medicine*, 6(1): 15-21.

Wennberg, R. 2004. Collision frequency in elite hockey on North American versus international size rinks. *The Canadian journal of neurological sciences*, 31(3): 373-377.

Wennberg, R. A. and Tator, C. H. 2003. National Hockey League reported concussions, 1986-87 to 2001-02. *Canadian journal of neurological sciences/journal Canadien des sciences neurologiques*, 30(3): 206-209.

Western Province Ice Hockey Association. 2016. *Learn to play* (online). Available at: http://www.wpicehockey.co.za/ltp.htm (Accessed 10 July 2016).

Willemse, I. 2009. *Statistical methods and calculation skills.* 3rd ed. Cape Town: Juta & Co.

Woods, S. E., Zabat, E., Daggy, M., Diehl, J., Engel, A. and Okragly, R. 2007. Face protection in recreational hockey players. *Family medicine-Kansas City,* 39(7): 473.

World Health Organization. 2016. *Health topics: risk factors* (online). Available at: http://www.who.int/topics/risk_factors/en/ (Accessed: 7 July 2016).

Wozniak, E. 2015. *Pricing out protection: the best hockey equipment on a budget* (online). Available at: http://www.beerleagueblog.ca/pricing-out-protection-the-best-hockey-equipment-on-a-budget/ (Accessed: 25 April 2016).

XE. 2016. *XE Currency Convertor: CAD to ZAR.* (online). Available: http://www.xe.com/currencyconverter/convert/?Amount=1200&From=CAD&To=ZAR (Accessed 22 November 2016).

APPENDIXES

Appendix A: Letter of permission: SAIHA

SA Ice Hockey Association
Po Box 34474
Erasmia, 0023
Centurion, Gauteng,
South Africa

Contact details:
Office No: +27 (0) 12 522 2494
Fax. No. +27 (0) 86 501 1780

President: +27 (0) 83 640 6222
Vice-President +27 (0)82 491 4544

E-mail address :
elsabe.stockhoff@bmw.co.za
(General Secretary)

Website:
www.saicehockey.org.za

Affiliated to:

IIHF (International Ice Hockey Federation);
SASCOC (South African Sports Confederation& Olympic Committee)

22 June 2015

Donne Oxenham

c/o Durban University of Technology

Re: LETTER OF PERMISSION

Dear Donne

We hereby grant you permission to carry out your research on the injury profile of ice hockey players in South Africa.

Please liaise directly with the Presidents from our Provincial Ice Hockey Association's regarding the questionnaire.

Gauteng:	Marinus Willemstijn - president@giha.co.za
Kwa-Zulu Natal:	Nola Faber - nolag@telkomsa.net
Western Province:	Jason Cerff - jason@blaauwberggroup.co.za

We wish you all the best with your project.

Yours in Sport

[redacted]

E Stockhoff
General Secretary

Appendix B: Pre-expert group questionnaire

QUESTIONNAIRE FOR ICE HOCKEY PLAYERS

Thank you for your participation in this study. Please do not write your name, contact details or any other identifying data on this questionnaire.

All questions are strictly confidential. Please be as truthful as possible and tick one box per question, unless otherwise stated.

Section A: Patient Information

1. Age (Years):					**2. Gender:**		MALE		FEMALE	
3. Ethnicity	ASIAN	BLACK	COLOURED	INDIAN	WHITE					
4. What is your height in metres?										
<1.55m	1.55-1.59	1.6-1.64	1.65-1.69	1.7-1.74	1.75-1.79	1.8-1.84	1.85-1.89	1.9-1.94	1.95-1.99	>2m
5. What is your weight in kg?										
<55	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100	>100
6. Do you have any pre-existing medical conditions?					Anemia	Arthritis	Asthma	Diabetes	High Blood Pressure	
					High Cholesterol	Musculoskeletal Problems	Osteoporosis			
					Other:					
7. What province do you play in?			Gauteng			KwaZulu-Natal		Western Province		
8. Which league do you play in?			1st Division	2nd Division	Ladies	Intermediate	Premier	u20		
9. What position do you play?			Defense			Forward		Goalkeeper		
10. How many years have you been playing ice hockey?										
<1	1	2	3	4	5	6	7	8	9	10	>10
11. How many hours of training per week did you attend in the last season?										
<1	1	2	3	4	5	>5				
12. How many games did you play in the last season?	0-4	5-9	10-14	15-19	20-24	25-29	30+			

Section B: History if Injury

In the answers below, consider only the information over the last season.
Please base all answers on the three most severe injuries you sustained last season.

1. For each injury indicate the body site that was injured by ticking the appropriate box.					
INJURY ONE		**INJURY TWO**		**INJURY THREE**	
Abdomen	Ankle	Abdomen	Ankle	Abdomen	Ankle
Back	Chest	Back	Chest	Back	Chest
Elbow	Facial	Elbow	Facial	Elbow	Facial
Foot	Genital	Foot	Genital	Foot	Genital
Hand	Head	Hand	Head	Hand	Head
Hip	Knee	Hip	Knee	Hip	Knee
Neck	Shoulder	Neck	Shoulder	Neck	Shoulder
Wrist		Wrist		Wrist	

2. For each injury indicate the type of injury by ticking the appropriate box.

INJURY ONE		INJURY TWO		INJURY THREE	
Bruise	Concussion	Bruise	Concussion	Bruise	Concussion
Dislocation	Fracture	Dislocation	Fracture	Dislocation	Fracture
Laceration	Sprain	Laceration	Sprain	Laceration	Sprain
Strain	Tendonitis	Strain	Tendonitis	Strain	Tendonitis
Other		Other		Other	

3. How would you describe the injury?

INJURY ONE			INJURY TWO			INJURY THREE		
Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe

4. Was the injury:

INJURY ONE		INJURY TWO		INJURY THREE	
Acute (sudden onset)	Chronic (>3 months)	Acute (sudden onset)	Chronic (>3 months)	Acute (sudden onset)	Chronic (>3 months)
Traumatic	Repetitive Strain	Traumatic	Repetitive Strain	Traumatic	Repetitive Strain

5. Did the injury occur in training or game?

INJURY ONE		INJURY TWO		INJURY THREE	
Training	Game	Training	Game	Training	Game

6. Which were the mechanisms of each injury?

INJURY ONE		INJURY TWO		INJURY THREE	
Boards	Goal Net	Boards	Goal Net	Boards	Goal Net
Ice	Overuse	Ice	Overuse	Ice	Overuse
Player	Puck	Player	Puck	Player	Puck
Shooting	Skating	Shooting	Skating	Shooting	Skating
Stick	Other	Stick	Other	Stick	Other

7. What treatment did you receive for the following injuries? (More than one answer is possible)

INJURY ONE		INJURY TWO		INJURY THREE	
Biokineticist	Chiropractic	Biokineticist	Chiropractic	Biokineticist	Chiropractic
First aid	GP	First aid	GP	First aid	GP
Orthopedic Surgeon	Physiotherapy	Orthopedic Surgeon	Physiotherapy	Orthopedic Surgeon	Physiotherapy
None	Other	None	Other	None	Other

8. How many WEEKS were you unavailable for training sessions or competitive games because of the injury?

INJURY ONE				INJURY TWO				INJURY THREE			
0-2	2-4	4-6	> 6	0-2	2-4	4-6	> 6	0-2	2-4	4-6	> 6

Section C:

1. Which ice rink were you playing at when the injury was sustained?				
Festival Mall	Forrest Hill	Galleria	Grand West	The Grove

2. What medical facilities are available at your games?					
Biokineticist	Chiropractic	First aid	GP		
Physiotherapy	Self Treatment	Sports Massage	None	Other.....	

Equipment

Please tick the relevant boxes regarding the details of your current protective equipment

	HELMET	SHOULDER PADS	ELBOW PADS	PANTS	SHIN PADS	SKATES	GLOVES
Visor:	Full / Half / None						
Year:	<2005	<2005	<2005	<2005	<2005	<2005	<2005
	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008
	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011
	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014
	2015	2015	2015	2015	2015	2015	2015
How often do you wear this equipment during a training session?	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)
	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)
	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)
	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)
	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)
How often do you wear this equipment during a game?	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)
	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)
	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)
	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)
	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)

MOUTH GUARD

Do you wear a mouth guard?	YES	NO	
Custom-made		**Shop Bought**	
How long have you used it for?			

How often do you wear this equipment during a training session or game?				
Always (100%)	Very Often (75%)	Sometimes (50%)	Not Often (25%)	Never (0%)

How often do you wear this equipment during a game?				
Always (100%)	Very Often (75%)	Sometimes (50%)	Not Often (25%)	Never (0%)

Appendix C: Letter of Information – expert group

LETTER OF INFORMATION – EXPERT GROUP

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 ice hockey players in South Africa.

Name of Supervisor: Dr. G. Matkovich (031 201 8204)
M.Tech.: Chiropractic

Name of Research Student: Donne Oxenham (031 5634064)
B. Tech.: Chiropractic

Background to the study:

Internationally there have been a number of studies conducted on various ice hockey teams which have shown that ice hockey players are at a high risk of injury due to the aggressive, fast-pace nature of the game and frequent collisions with the boards, nets, sticks, pucks and other players. In South Africa we have a unique ice hockey environment in comparison to the rest of the world, which may place the players at a greater risk of injury. Therefore this study aims to determine a profile of ice hockey injuries in South African players.

Objective of the study:

The data obtained by means of this questionnaire will allow for the establishment of an injury profile of ice hockey players and provide valuable information to assist healthcare professionals.

Outline of the procedures:

- Please read and sign the informed consent letter and the confidentiality statement prior to commencement of the expert group meeting.
- All expert group participants will be handed a copy of the questionnaire and are invited to review the questionnaire. Each question will be discussed in sequential order.
- As a member of the expert group, please feel free to make your opinions or suggestions known to the researcher as all comments can contribute to the questionnaire validity.
- This expert group is voluntary; the participant may at any time withdraw from the study.
- The questionnaire will take approximately 20 minutes to complete.
- The researcher will review the data and make the necessary changes to the questionnaire.

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 either me or my supervisor, Dr Grant Matkovich (031 201 8204)

Kind regards,

Donne Oxenham
Researcher
B.Tech: Chiropractic

Appendix D: Confidentiality statement and code of conduct – expert group

CONFIDENTIALITY STATEMENT AND CODE OF CONDUCT:
EXPERT GROUP

- All information contained in the research documents and any information discussed during the expert group meeting must be kept private and confidential. This is especially binding to any information that may identify any of the participants in the expert group.
- 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.
- The information from this focus group will be made public in terms of a dissertation/thesis and/or journal publication, which will in no way identify any of the participants involved in this focus group.
- The returned questionnaires will be coded and kept anonymous in the research process.
- The focus group may be either voice or video recorded, as a transcript of the proceedings will need to be made. The data will stored securely under password protection.
- All data generated from this focus group (including the recording) will be kept for 15 years in a secure location at Durban University of Technology and thereafter will be destroyed.

Once this form has been read and agreed to, please fill in the appropriate information below and sign to acknowledge agreement.

Please print in block letters:

Focus Group Member: _____Signature:_____

Witness Name: _____Signature:_____

Researcher's Name: _____Signature:_____

Supervisor's Name: _____Signature:_____

Appendix E: Informed consent form – expert group

INFORMED CONSENT FORM – EXPERT GROUP

TITLE OF RESEARCH PROJECT:
An injury profile of ice hockey players in South Africa.

NAME OF SUPERVISOR: Dr. G. Matkovich (031 201 8204)
NAME OF RESEARCHER: Donne Oxenham (031 563 4064)

Please circle the appropriate answer:

1. Have you read the research information sheet?	Yes No
2. Have you had an opportunity to ask questions regarding this 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. Do you understand the implications of your involvement in this study?	Yes No
7. Do you understand that you are free to	
a) withdraw from this study at any time?	Yes No
b) withdraw from this study at any time, without reasons given?	Yes No
c) withdraw from this study at any time without affecting your future health care or relationship with the Chiropractic day clinic at the Durban University of Technology?	Yes No
8. Do you agree to voluntarily participate in this study?	Yes No
9. Who have you spoken to regarding this study? _____	

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.

Please print in block letters:

Focus Group Member: _____ Signature: _____

Witness Name: _____ Signature: _____

Researcher's Name: _____ Signature: _____

Supervisor's Name: _____ Signature: _____

Appendix F: Corrections to pre-expert group questionnaire

Questionnaire changes following the expert group.

The number of the questions refer to the numbers on the **pre-expert** questionnaire.

The wording, 'Please be as truthful as possible and tick one box per question, unless otherwise stated.' was changed to 'Please be as honest as possible and tick one box per question, unless otherwise stated.'

Section A: Patient Information

- Blocks were added for the answers to Question 1 in increments of 5 years.
- The questions 'What do you spend on ice hockey in a season? (in Rands)' and 'What do you spend in ice hockey equipment in a season? (in Rands)' were added.
- Question 6 was removed.
- The answers in Question 10 were changed to increments of 2 years.
- The question 'Do you play any other sport?' was added.

The question 'Have you had any injuries in the last season?' and statement 'If so, move on to Section B' was added between Section A and B.

Section B: History of Injury for the past season

- Section B title changed to 'History of Injury for the past season'.
- The wording, 'In the answers below, consider only the information over the last season.' was changed to 'Amongst the answers below, consider only the information over the last season.'.
- The sentence, 'If you have had one injury, fill in one block. If you have had two injuries, fill in two blocks. If you have had three injuries, fill in three blocks.' was included.
- The headings of the columns for Question 1 changed to 'Injury One (Most Severe)', 'Injury Two (Second Most)' and 'Injury Three (Additional)'.
- The answer blocks 'Upper arm', 'Lower arm', 'Thigh' and 'Lower leg' were add to Question 1.
- The question, 'Have you injured this area before?' was added.
- In Question 2, answer blocks were changed to include, 'Severe Bruising', 'Dental', 'Joint/Cartilage Injury', 'Ligament Injury', 'Muscle Injury' and 'Open Wound'.
- Question 4 changed from 'Was the injury?' to 'The onset of the injury was:' and the answers blocks changed to 'Sudden', 'Continually ongoing' and 'More than 3 months'.
- Question 5 changed to 'The injury occurred during a:' as well as blocks added to include the answers 'Warm up (off ice)' and 'Warm up (on ice)'.
- The words '(More than one answer is possible)' was added to Question 6.

- The word 'following' was removed from Question 7. A second and third part was added to include the questions 'Was a diagnosis given by a professional?' and 'If yes, what was it?'.
- Question 8 was changed to 'Did the injury keep you out of playing?' and 'If so, how long?'.

Section C: Facilities

- The word 'Facilities' was added to the heading.
- The answers to Question 1 changed to include 'Injury One', 'Injury Two' and 'Injury Three' columns.
- Question 2 'What medical facilities are available at your games?' changed to a four part question: 'Were there medical professionals available at the time of your injuries?', 'If so, who?', 'Did you consult with them?' and 'If yes, who did you choose to see?'.

Equipment was changed to 'Section D: Protective Equipment'.

- The heading of column 'SHIN PADS' was changed to 'SHIN PADS/LEG PADS'.
- The heading of column 'GLOVES' was changed to 'GLOVES/MITT & BLOCKER'.
- An extra column was added for 'PELVIC PROTECTOR'.
- The question 'How would you rate it?' was added as well as answer blocks 'Entry Level', 'Intermediate' and 'Top of the Range'.
- The question 'Where you wearing this equipment during the injury?' was added as well as rows for 'Injury One', 'Injury Two' and 'Injury Three' and answer blocks for 'Yes' and 'No'.
- The question on 'MOUTH GUARD' was included in the protective equipment table.

Page Numbers were added.

The words 'Thank you for your time in completing this questionnaire.' were added.

[redacted]

Dr Grant Matkovich
Research Supervisor

[redacted]

Donne Oxenham
Researcher

Appendix G: Post-expert group questionnaire

QUESTIONNAIRE FOR ICE HOCKEY PLAYERS

Thank you for your participation in this study. Please do not write your name, contact details or any other identifying marks on this questionnaire. All answers are strictly confidential. Please be as honest as possible and tick one box per question, unless otherwise stated

Section A: Patient Information

1. Age (Years):	18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	>57
2. Gender:	MALE	FEMALE	**3. Ethnicity**	ASIAN	BLACK	COLOURED	INDIAN	WHITE	
4. How much money do you spend (in Rands) on ice hockey equipment in a season?									
<500	500-1000	1000-2000	2000-3000	3000-5000	5000-7000	7000-9000	9000-11000	>11000	
5. What is your height in metres?									
<1.55m	1.55-1.59	1.6-1.64	1.65-1.69	1.7-1.74	1.75-1.79	1.8-1.84	1.85-1.89	1.9-1.94	1.95-1.99	>2m
6. What is your weight in kg?									
<55	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100	>100
7. What province do you play in?	Gauteng	KwaZulu-Natal	Western Province						
8. Which league do you play in?	1st Division	2nd Division	Ladies	Intermediate	Premier	u20			
9. What position do you play?	Defense	Forward	Goalkeeper						
10. How many years have you been playing ice hockey?									
<2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	>20
11. How many hours of training per week did you attend in the last season?									
<1	1	2	3	4	5	>5			
12. How many games did you play in the last season?	0-4	5-9	10-14	15-19	20-24	25-29	30+		
13. At which ice rink do you mostly play?									
Festival Mall	Forrest Hill	Galleria	Grand West	The Grove					
14. Do you play any other sport? (you may tick more than one answer)	Field Hockey	Indoor Hockey	Rugby	Crossfit					
Soccer	Indoor Soccer	Cycling/Mountain Biking	Other						

Have you had any injuries in the last season? YES ☐ NO ☐ **If NO, move on to Section D.**

Section B: History of Injury in the last season

For the questions below, please answer with the information from the last season.
Please base all answers on the three most severe injuries you sustained last season. If you have had one injury, fill in one block. If you have had two injuries, fill in two blocks. If you have had three injuries, fill in three blocks.

1. For each injury indicate the body site that was injured by ticking the appropriate box.					
INJURY ONE (Most Severe)		**INJURY ONE (Second Most)**		**INJURY ONE (Additional)**	
Head	Hand	Head	Hand	Head	Hand
Face	Abdomen	Face	Abdomen	Face	Abdomen
Neck	Groin	Neck	Groin	Neck	Groin
Chest	Hip	Chest	Hip	Chest	Hip
Back	Thigh	Back	Thigh	Back	Thigh
Shoulder	Knee	Shoulder	Knee	Shoulder	Knee
Upper arm	Lower leg	Upper arm	Lower leg	Upper arm	Lower leg
Elbow	Ankle	Elbow	Ankle	Elbow	Ankle
Lower arm	Foot	Lower arm	Foot	Lower arm	Foot
Wrist		Wrist		Wrist	

1

2. Have you injured this area before?

INJURY ONE		INJURY TWO		INJURY THREE	
YES	NO	YES	NO	YES	NO

3. For the injury, indicate the type of injury by ticking the appropriate box.

INJURY ONE		INJURY TWO		INJURY THREE	
Concussion	Dental	Concussion	Dental	Concussion	Dental
Dislocation	Fracture	Dislocation	Fracture	Dislocation	Fracture
Joint/Cartilage Injury	Ligament Injury	Joint/Cartilage Injury	Ligament Injury	Joint/Cartilage Injury	Ligament Injury
Muscle Injury	Open Wound	Muscle Injury	Open Wound	Muscle Injury	Open Wound
Severe Bruising	Other.....	Severe Bruising	Other.....	Severe Bruising	Other.....

4. How would you describe the injury?

INJURY ONE			INJURY TWO			INJURY THREE		
Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe

5. The onset of the injury was:

INJURY ONE		INJURY TWO		INJURY THREE	
Sudden	More than 3 months	Sudden	More than 3 months	Sudden	More than 3 months
Continually ongoing		Continually ongoing		Continually ongoing	

6. The injury occurred during a:

INJURY ONE		INJURY TWO		INJURY THREE	
Warm up (off ice)	Warm up (on ice)	Warm up (off ice)	Warm up (on ice)	Warm up (off ice)	Warm up (on ice)
Training	Game	Training	Game	Training	Game

7. What was the mechanism of injury? (More than one answer is possible)

INJURY ONE		INJURY TWO		INJURY THREE	
Boards	Goal Net	Boards	Goal Net	Boards	Goal Net
Ice	Overuse	Ice	Overuse	Ice	Overuse
Player	Puck	Player	Puck	Player	Puck
Shooting	Skating	Shooting	Skating	Shooting	Skating
Stick		Stick		Stick	
Other.....		Other.....		Other.....	

8.1. What treatment did you receive for the injury? (More than one answer is possible)

INJURY ONE		INJURY TWO		INJURY THREE	
Biokineticist	Chiropractic	Biokineticist	Chiropractic	Biokineticist	Chiropractic
First aid	GP	First aid	GP	First aid	GP
Orthopedic Surgeon	Physiotherapy	Orthopedic Surgeon	Physiotherapy	Orthopedic Surgeon	Physiotherapy
None		None	Other	None	
Other.....		Other.....		Other.....	

8.2. Was a diagnosis given by a professional?

INJURY ONE		INJURY TWO		INJURY THREE	
YES	NO	YES	NO	YES	NO

8.3. If yes, what was it?		
INJURY ONE	**INJURY TWO**	**INJURY THREE**
.....	.....	.....

9.1. Did the injury keep you out of playing?					
INJURY ONE		**INJURY TWO**		**INJURY THREE**	
YES	NO	YES	NO	YES	NO

9.2. If so, how long?								
INJURY ONE	0-7 Days	1-3 Weeks	3-5 Weeks	5-8 Weeks	2-3 Months	3-6 Months	6-12 Months	>1 Year
INJURY TWO	0-7 Days	1-3 Weeks	3-5 Weeks	5-8 Weeks	2-3 Months	3-6 Months	6-12 Months	>1 Year
INJURY THREE	0-7 Days	1-3 Weeks	3-5 Weeks	5-8 Weeks	2-3 Months	3-6 Months	6-12 Months	>1 Year

Section C: Facilities

1. Which ice rink were you playing at when the injury was sustained?					
INJURY ONE		**INJURY TWO**		**INJURY THREE**	
Festival Mall	Forrest Hill	Festival Mall	Forrest Hill	Festival Mall	Forrest Hill
Galleria	Grand West	Galleria	Grand West	Galleria	Grand West
The Grove		The Grove		The Grove	

2. Were there medical professionals available at the time of your injuries?					
INJURY ONE		**INJURY TWO**		**INJURY THREE**	
YES	NO	YES	NO	YES	NO

2.1. If so, who?					
INJURY ONE		**INJURY TWO**		**INJURY THREE**	
Biokineticist	GP	Biokineticist	GP	Biokineticist	GP
Chiropractic	Physiotherapist	Chiropractic	Physiotherapist	Chiropractic	Physiotherapist
First Aid	Self Treatment	First Aid	Self Treatment	First Aid	Self Treatment
Sports Massage	None	Sports Massage	None	Sports Massage	None
Other.....		Other.....		Other.....	

2.2 Did you consult with them?					
INJURY ONE		**INJURY TWO**		**INJURY THREE**	
YES	NO	YES	NO	YES	NO

2.3 If yes, who did you choose to see?					
INJURY ONE		**INJURY TWO**		**INJURY THREE**	
Biokineticist	GP	Biokineticist	GP	Biokineticist	GP
Chiropractic	Physiotherapist	Chiropractic	Physiotherapist	Chiropractic	Physiotherapist
First Aid	Self Treatment	First Aid	Self Treatment	First Aid	Self Treatment
Sports Massage	None	Sports Massage	None	Sports Massage	None
Other.....		Other.....		Other.....	

Section D: Protective Equipment

Please tick the relevant boxes regarding the details of your current protective equipment.

	HELMET		MOUTH GUARD		SHOULDER PADS		ELBOW PADS		PANTS		PELVIC PROTECTOR		SKATES		SHIN PADS / LEG PADS		GLOVES / MITT & BLOCKER	
	Visor:		Custom-made															
	Full	Half / None	Shop Bought															
			I don't wear one															
Year:	<2005		<2005		<2005		<2005		<2005		<2005		<2005		<2005		<2005	
	2006 - 2008		2006 - 2008		2006 - 2008		2006 - 2008		2006 - 2008		2006 - 2008		2006 - 2008		2006 - 2008		2006 - 2008	
	2009 - 2011		2009 - 2011		2009 - 2011		2009 - 2011		2009 - 2011		2009 - 2011		2009 - 2011		2009 - 2011		2009 - 2011	
	2012 - 2014		2012 - 2014		2012 - 2014		2012 - 2014		2012 - 2014		2012 - 2014		2012 - 2014		2012 - 2014		2012 - 2014	
	2015		2015		2015		2015		2015		2015		2015		2015		2015	
How would you rate it?	Entry Level		Entry Level		Entry Level		Entry Level		Entry Level		Entry Level		Entry Level		Entry Level		Entry Level	
	Intermediate		Intermediate		Intermediate		Intermediate		Intermediate		Intermediate		Intermediate		Intermediate		Intermediate	
	Top of the Range		Top of the Range		Top of the Range		Top of the Range		Top of the Range		Top of the Range		Top of the Range		Top of the Range		Top of the Range	
How often do you wear this equipment during a training session?	Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)	
	Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)	
	Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)	
	Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)	
	Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)	
How often do you wear this equipment during a game?	Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)		Always (100%)	
	Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)		Very Often (75%)	
	Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)		Sometimes (50%)	
	Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)		Not Often (25%)	
	Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)		Never (0%)	
Where you wearing this equipment during the injury?																		
INJURY ONE	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
INJURY TWO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
INJURY THREE	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO

Thank you for your time in completing this questionnaire.

Appendix H: Letter of information – pilot study

LETTER OF INFORMATION

Dear Participant

Thank you for your time and consideration to participate in this study. Please read this information carefully.

Title of the Research Study: An injury profile of ice hockey players in South Africa.

Name of Supervisor: Dr. G. Matkovich (031 201 8204)
M.Tech.: Chiropractic

Name of Research Student: Donne Oxenham (031 5634064)
B. Tech.: Chiropractic

Name of Institution: Durban University of Technology

Purpose of the Study:

Internationally there have been a number of studies conducted on various ice hockey teams which have shown that ice hockey players are at a high risk of injury due to the aggressive, fast-pace nature of the game and frequent collisions with the boards, nets, sticks, pucks and other players. In South Africa we have a unique ice hockey environment in comparison to the rest of the world, which may place the players at a greater risk of injury. Therefore this study aims to determine a profile of ice hockey injuries in South African players.

Outline of the procedures:

This study will involve you filling out a questionnaire, which will take approximately 20 minutes to complete. Please do not make any markings on the questionnaire which will identify who you are. Participation in this study is entirely voluntary and there will be no remuneration for completion of the questionnaire.

Risks or Discomforts to the Participant:

Participation in this study will pose no risk to any of the participants. All information gathered will be kept confidential; no individual will be identified in the data. The results will be combined and analysed as a group therefore no individuals will be singled out.

Benefits:

The results of this study may be made available to the public in the form of a published article in a journal and a dissertation that will be available in the Durban University of Technology library. Should any of the participants be interested in the results the researcher can be contacted and the results obtained.

Reason/s why the Participant May Be Withdrawn from the Study:

You are free to withdraw from the study at any time. There will be no adverse consequences for the participant should you choose to withdraw.

Remuneration:

No participants will receive any form of remuneration.

Costs of the study:

There will be no cost for participating in this research.

Confidentiality:

Any of the information that is gained will be kept confidential at all times. All completed questionnaires will be placed in sealed box that only the researcher and supervisor will have access to. The box will only be opened once data collection has been completed and only done so by the researcher. All data will be coded: each questionnaire will be numbered with no personal information of the participant appearing on the questionnaire. All data will be kept in storage for a period of fifteen years. Thereafter, it will be shredded.

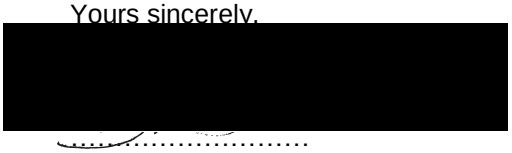
Risks/Discomforts/Research-related injury and costs:

There are no risks/discomforts/research-related injuries or cost involved from participation in this study.

Persons to Contact in the Event of Any Problems or Queries:

If you require any further information or there are any queries in this regard, please contact the researcher, Donne (Tel no. 072 604 4134), my supervisor, Dr Grant Matkovich (Tel no. 031 201 8204), or the Institutional Research Ethics administrator on 031 373 2900.

Yours sincerely,



……

Donne Oxenham
Researcher
B.Tech: Chiropractic

Appendix I: Consent form – pilot study

CONSENT

Statement of Agreement to Participate in the Research Study:

I hereby confirm that I have been informed by the researcher, Miss Donne Oxenham, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: 132/15.

I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.

I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.

In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.

I may, at any stage, without prejudice, withdraw my consent and participation in the study.

I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

I, Donne Oxenham, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**
_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**

Appendix J: Pilot study evaluation form

Pilot Study Questionnaire Evaluation Sheet

(Please tick one box only)

1. What is your opinion on the subject raised in this questionnaire?

- ☐ Very Interesting
- ☐ Interesting
- ☐ Average
- ☐ Boring
- ☐ Very Boring

2. Was the topic adequately covered in the questionnaire?

- ☐ Yes
- ☐ No

3. What is your opinion of the Letter of Information?

- ☐ Very clear
- ☐ Sufficiently clear
- ☐ Adequate
- ☐ Unclear
- ☐ Need revising

4. What is your opinion of the instructions on the Letter of Information?

- ☐ Very clear
- ☐ Sufficiently clear
- ☐ Adequate
- ☐ Unclear
- ☐ Need revising

5. In your opinion, is the questionnaire too long?

- Yes
- No

6. What is your opinion of the wording of the questionnaire?

- All questions are absolutely clear
- Questions are mostly clear
- Too many confusing Chiropractic/Medical terms
- The questionnaire will be difficult for the lay person to understand
- The questionnaire is completely confusing and needs to be revised

If you found any question/s difficult to answer, please write the number/s of the questions in the space provided with your comments on how the question/s can be improved.

_____

_____

_____

_____

_____

_____

_____

Please print in block letters:

Participant: _____ Signature: _____

Witness Name: _____ Signature: _____

Researcher's Name: _____ Signature: _____

Supervisor's Name: _____Signature: _____

Appendix K: Corrections to post-expert/pre-pilot questionnaire

Questionnaire changes following the pilot study.

The number of the questions refer to the numbers on the **pre-pilot study** questionnaire.

Section B: History of Injury for the past season

- The headings of the columns for Question 1 corrected to 'Injury One (Most Severe)', 'Injury Two (Second Most)' and 'Injury Three (Additional)'.
- Question 1 changed from 'For each injury indicate the body site that was injured by ticking the appropriate box.' to 'For each injury indicate the body site that was injured by ticking the most appropriate box.'
- Question 3 changed from 'For the injury, indicate the type of injury by ticking the appropriate box.' to 'For the injury, indicate the type of injury by ticking the most appropriate box.'.

Section C: Facilities

- The last word in Question 2 was changed from 'injuries' to 'injury'.
- Question 2.2 changed from 'Did you consult with them?' to 'Did you consult with them at the facility?'.

Section D: Protective Equipment

- In order to make each section more legible, the lines between sections were made thicker.

[redacted]

Dr Grant Matkovich
Research Supervisor

[redacted]

Researcher

Appendix L: Final questionnaire – main study

QUESTIONNAIRE FOR ICE HOCKEY PLAYERS

Thank you for your participation in this study. Please do not write your name, contact details or any other identifying marks on this questionnaire. All answers are strictly confidential. Please be as honest as possible and tick one box per question, unless otherwise stated.

Section A: Patient Information

1. Age (Years):	18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	>57
2. Gender:	MALE	FEMALE	**3. Ethnicity**		ASIAN	BLACK	COLOURED	INDIAN	WHITE
4. How much money do you spend (in Rands) on ice hockey equipment in a season?									
<500	500-1000	1000-2000	2000-3000	3000-5000	5000-7000	7000-9000	9000-11000	>11000	
5. What is your height in metres?									
<1.55m	1.55-1.59	1.6-1.64	1.65-1.69	1.7-1.74	1.75-1.79	1.8-1.84	1.85-1.89	1.9-1.94	1.95-1.99	>2m
6. What is your weight in kg?									
<55	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100	>100
7. What province do you play in?	Gauteng	KwaZulu-Natal	Western Province						
8. Which league do you play in?	1st Division	2nd Division	Ladies	Intermediate	Premier	u20			
9. What position do you play?	Defense	Forward	Goalkeeper						
10. How many years have you been playing ice hockey?									
<2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	>20
11. How many hours of training per week did you attend in the last season?									
<1	1	2	3	4	5	>5			
12. How many games did you play in the last season?	0-4	5-9	10-14	15-19	20-24	25-29	30+		
13. At which ice rink do you mostly play?									
Festival Mall	Forrest Hill	Galleria	Grand West	The Grove					
14. Do you play any other sport? (you may tick more than one answer)	Field Hockey	Indoor Hockey	Rugby	Crossfit					
Soccer	Indoor Soccer	Cycling/Mountain Biking	Other						

Have you had any injuries in the last season? YES ☐ NO ☐ **If NO, move on to Section D.**

Section B: History of Injury in the last season

For the questions below, please answer with the information from the last season.
Please base all answers on the three most severe injuries you sustained last season. If you have had one injury, fill in one block. If you have had two injuries, fill in two blocks. If you have had three injuries, fill in three blocks.

1. For each injury indicate the body site that was injured by ticking the most appropriate box.					
INJURY ONE (Most Severe)		**INJURY TWO (Second Most)**		**INJURY THREE (Additional)**	
Head	Hand	Head	Hand	Head	Hand
Face	Abdomen	Face	Abdomen	Face	Abdomen
Neck	Groin	Neck	Groin	Neck	Groin
Chest	Hip	Chest	Hip	Chest	Hip
Back	Thigh	Back	Thigh	Back	Thigh
Shoulder	Knee	Shoulder	Knee	Shoulder	Knee
Upper arm	Lower leg	Upper arm	Lower leg	Upper arm	Lower leg
Elbow	Ankle	Elbow	Ankle	Elbow	Ankle
Lower arm	Foot	Lower arm	Foot	Lower arm	Foot
Wrist		Wrist		Wrist	

1

2. Have you injured this area before?

INJURY ONE		INJURY TWO		INJURY THREE	
YES	NO	YES	NO	YES	NO

3. For the injury, indicate the type of injury by ticking the most appropriate box.

INJURY ONE		INJURY TWO		INJURY THREE	
Concussion	Dental	Concussion	Dental	Concussion	Dental
Dislocation	Fracture	Dislocation	Fracture	Dislocation	Fracture
Joint/Cartilage Injury	Ligament Injury	Joint/Cartilage Injury	Ligament Injury	Joint/Cartilage Injury	Ligament Injury
Muscle Injury	Open Wound	Muscle Injury	Open Wound	Muscle Injury	Open Wound
Severe Bruising	Other.....	Severe Bruising	Other.....	Severe Bruising	Other.....

4. How would you describe the injury?

INJURY ONE			INJURY TWO			INJURY THREE		
Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe

5. The onset of the injury was:

INJURY ONE		INJURY TWO		INJURY THREE	
Sudden	More than 3 months	Sudden	More than 3 months	Sudden	More than 3 months
Continually ongoing		Continually ongoing		Continually ongoing	

6. The injury occurred during a:

INJURY ONE		INJURY TWO		INJURY THREE	
Warm up (off ice)	Warm up (on ice)	Warm up (off ice)	Warm up (on ice)	Warm up (off ice)	Warm up (on ice)
Training	Game	Training	Game	Training	Game

7. What was the mechanism of injury? (More than one answer is possible)

INJURY ONE		INJURY TWO		INJURY THREE	
Boards	Goal Net	Boards	Goal Net	Boards	Goal Net
Ice	Overuse	Ice	Overuse	Ice	Overuse
Player	Puck	Player	Puck	Player	Puck
Shooting	Skating	Shooting	Skating	Shooting	Skating
Stick		Stick		Stick	
Other.....		Other.....		Other.....	

8.1. What treatment did you receive for the injury? (More than one answer is possible)

INJURY ONE		INJURY TWO		INJURY THREE	
Biokineticist	Chiropractic	Biokineticist	Chiropractic	Biokineticist	Chiropractic
First aid	GP	First aid	GP	First aid	GP
Orthopedic Surgeon	Physiotherapy	Orthopedic Surgeon	Physiotherapy	Orthopedic Surgeon	Physiotherapy
None		None		None	
Other.....		Other.....		Other.....	

8.2. Was a diagnosis given by a professional?

INJURY ONE		INJURY TWO		INJURY THREE	
YES	NO	YES	NO	YES	NO

8.3. If yes, what was it?								
INJURY ONE			INJURY TWO			INJURY THREE		
.....			.....			.....		
9.1. Did the injury keep you out of playing?								
INJURY ONE			INJURY TWO			INJURY THREE		
YES	NO		YES	NO		YES	NO	
9.2. If so, how long?								
INJURY ONE	0-7 Days	1-3 Weeks	3-5 Weeks	5-8 Weeks	2-3 Months	3-6 Months	6-12 Months	>1 Year
INJURY TWO	0-7 Days	1-3 Weeks	3-5 Weeks	5-8 Weeks	2-3 Months	3-6 Months	6-12 Months	>1 Year
INJURY THREE	0-7 Days	1-3 Weeks	3-5 Weeks	5-8 Weeks	2-3 Months	3-6 Months	6-12 Months	>1 Year

Section C: Facilities

1. Which ice rink were you playing at when the injury was sustained?					
INJURY ONE		INJURY TWO		INJURY THREE	
Festival Mall	Forrest Hill	Festival Mall	Forrest Hill	Festival Mall	Forrest Hill
Galleria	Grand West	Galleria	Grand West	Galleria	Grand West
The Grove		The Grove		The Grove	
2. Were there medical professionals available at the time of your injury?					
INJURY ONE		INJURY TWO		INJURY THREE	
YES	NO	YES	NO	YES	NO
2.1. If so, who?					
INJURY ONE		INJURY TWO		INJURY THREE	
Biokineticist	GP	Biokineticist	GP	Biokineticist	GP
Chiropractic	Physiotherapist	Chiropractic	Physiotherapist	Chiropractic	Physiotherapist
First Aid	Self Treatment	First Aid	Self Treatment	First Aid	Self Treatment
Sports Massage	None	Sports Massage	None	Sports Massage	None
Other.....		Other.....		Other.....	
2.2 Did you consult with them at the facility?					
INJURY ONE		INJURY TWO		INJURY THREE	
YES	NO	YES	NO	YES	NO
2.3 If yes, who did you choose to see?					
INJURY ONE		INJURY TWO		INJURY THREE	
Biokineticist	GP	Biokineticist	GP	Biokineticist	GP
Chiropractic	Physiotherapist	Chiropractic	Physiotherapist	Chiropractic	Physiotherapist
First Aid	Self Treatment	First Aid	Self Treatment	First Aid	Self Treatment
Sports Massage	None	Sports Massage	None	Sports Massage	None
Other.....		Other.....		Other.....	

Section D: Protective Equipment

Please tick the relevant boxes regarding the details of your current protective equipment.

	HELMET	MOUTH GUARD	SHOULDER PADS	ELBOW PADS	PANTS	PELVIC PROTECTOR	SKATES	SHIN PADS / LEG PADS	GLOVES / MITT & BLOCKER
	Visor: Full / Half / None	Custom-made / Shop Bought / I don't wear one							
Year:	<2005	<2005	<2005	<2005	<2005	<2005	<2005	<2005	<2005
	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008	2006 - 2008
	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011	2009 - 2011
	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014	2012 - 2014
	2015	2015	2015	2015	2015	2015	2015	2015	2015
How would you rate it?	Entry Level	Entry Level	Entry Level	Entry Level	Entry Level	Entry Level	Entry Level	Entry Level	Entry Level
	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Top of the Range	Top of the Range	Top of the Range	Top of the Range	Top of the Range	Top of the Range	Top of the Range	Top of the Range	Top of the Range
How often do you wear this equipment during a training session?	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)
	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)
	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)
	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)
	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)
How often do you wear this equipment during a game?	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)	Always (100%)
	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)	Very Often (75%)
	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)	Sometimes (50%)
	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)	Not Often (25%)
	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)	Never (0%)
Were you wearing this equipment during the injury?									
INJURY ONE	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO
INJURY TWO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO
INJURY THREE	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO	YES / NO

Thank you for your time in completing this questionnaire.

Appendix M: Letter of information – main study

LETTER OF INFORMATION

Dear Participant

Thank you for your time and consideration to participate in this study. Please read this information carefully.

Title of the Research Study: An injury profile of ice hockey players in South Africa.

Name of Supervisor: Dr. G. Matkovich (031 201 8204)
M.Tech.: Chiropractic

Name of Research Student: Donne Oxenham (031 5634064)
B. Tech.: Chiropractic

Name of Institution: Durban University of Technology

Purpose of the Study:

Internationally there have been a number of studies conducted on various ice hockey teams which have shown that ice hockey players are at a high risk of injury due to the aggressive, fast-pace nature of the game and frequent collisions with the boards, nets, sticks, pucks and other players. In South Africa we have a unique ice hockey environment in comparison to the rest of the world, which may place the players at a greater risk of injury. Therefore this study aims to determine a profile of ice hockey injuries in South African players.

Outline of the procedures:

This study will involve you filling out a questionnaire, which will take approximately 20 minutes to complete. Please do not make any markings on the questionnaire which will identify who you are. Participation in this study is entirely voluntary and there will be no remuneration for completion of the questionnaire.

Risks or Discomforts to the Participant:

Participation in this study will pose no risk to any of the participants. All information gathered will be kept confidential; no individual will be identified in the data. The results will be combined and analysed as a group therefore no individuals will be singled out.

Benefits:

The results of this study may be made available to the public in the form of a published article in a journal and a dissertation that will be available in the Durban University of Technology library. Should any of the participants be interested in the results the researcher can be contacted and the results obtained.

Reason/s why the Participant May Be Withdrawn from the Study:

You are free to withdraw from the study at any time. There will be no adverse consequences for the participant should you choose to withdraw.

Remuneration:

No participants will receive any form of remuneration.

Costs of the study:

There will be no cost for participating in this research.

Confidentiality:

Any of the information that is gained will be kept confidential at all times. All completed questionnaires will be placed in sealed box that only the researcher and supervisor will have access to. The box will only be opened once data collection has been completed and only done so by the researcher. All data will be coded: each questionnaire will be numbered with no personal information of the participant appearing on the questionnaire. All data will be kept in storage for a period of fifteen years. Thereafter, it will be shredded.

Risks/Discomforts/Research-related injury and costs:

There are no risks/discomforts/research-related injuries or cost involved from participation in this study.

Persons to Contact in the Event of Any Problems or Queries:

If you require any further information or there are any queries in this regard, please contact the researcher, Donne (Tel no. 072 604 4134), my supervisor, Dr Grant Matkovich (Tel no. 031 201 8204), or the Institutional Research Ethics administrator on 031 373 2900.

Yours sincerely,

Donne Oxenham
Researcher
B.Tech: Chiropractic

Appendix N: Consent form – main study

CONSENT

Statement of Agreement to Participate in the Research Study:

I hereby confirm that I have been informed by the researcher, Miss Donne Oxenham, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: 132/15.

I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.

I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.

In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.

I may, at any stage, without prejudice, withdraw my consent and participation in the study.

I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

I, Donne Oxenham, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**
_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**

Appendix O: Ethics approval

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

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2900
Fax: 031 373 2407
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

24 November 2015

IREC Reference Number: **REC 132/15**

Ms DC Oxenham
15 Romsey Grove
Durban North
4051

Dear Ms Oxenham

An injury profile of ice hockey players in South Africa

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.

Kindly ensure that participants used for the pilot study are not part of the main study.

Yours Sincerely

[redacted]

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY

2015 -11- 24

INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA