INJURY SURVEILLANCE DURING THE 2011 FNB VARSITY CUP RUGBY SEASON

by
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DECLARATION

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October 2013

Explanatory Memo:

This thesis would not have been possible without the role of Dr Kertih Aginsky from the Faculty of Health Sciences, School of Therapeutic Sciences, University of the Witwatersrand, Johannesburg, South Africa as initial supervisor of this project.

ABSTRACT

OBJECTIVES: The primary objective was to establish and compare the injury incidence in forwards and backline players during the 2011 FNB Varsity Cup season. The secondary objective was to establish and compare the injury prevalence in forwards and backline players during the 2011 FNB Varsity Cup season. Lastly, to establish and compare the different training loads, types of injuries and injury rates amongst the various rugby teams during the 2011 FNB Varsity Cup.

STUDY DESIGN: A retrospective, descriptive study was done to assess injury prevalence and incidence during the 2011 FNB Varsity Cup rugby (premier division) competition.

PARTICIPANTS*:* Male rugby playing students, from eight teams. The total number of observed rugby players from the seven teams consisted of ±23 – 30 players, all between the ages of 18 and 25 years (23 ± 1.2 years). All players had to qualify according to the rules of the Varsity Cup[23,45].

METHODS: The data collection procedure and injury definitions were aligned with the respective consensus statement for rugby injuries[12]. The injury surveillance included all injuries that were reported on the standardized IRB injury form (Addendum D), by each rugby team's medical support staff. There were eight rugby teams partaking in the 2011 FNB Varsity cup, premier division tournament. The FNB Varsity cup took place at eight University venues in South Africa. The FNB Varsity Cup round robin began in February 2011 where games were played every Monday evenings over a seven to nine week period, on a home and away basis. The play-offs of the top four teams followed for two more weeks. Injury surveillance statistics were calculated and compared with training loads and the number of hours of exposure. Injury rates are expressed as the number of injuries sustained per 1000 hours a player is at risk. Descriptive statistics were used to report the prevalence and incidence of all injuries during the tournament. A significance level of $p<0.05$ was accepted.

RESULTS: Seven out of the eight teams participating in the 2011 FNB Varsity Cup were able to submit injury and training statistics. Of these seven teams, there were 178 (6.1 injuries per 1000 hours)

injuries in total reported throughout the season. 61 pre-season injuries were found (2.1 per 1000 hours) compared to 117 (4.0 per 1000 hours) in-season injuries reported. There were 125 match injuries (89 per 1000 hours) and 52 training injuries (1.58 per 1000 hours) which was statistically significant (p = 0.039). The total number of new injuries were 120 (4.1 per 1000 hours) with only 52 (2.0 per 1000 hours) recurrent. The lower limb was affected by 97.5% of the total injuries. Over-all the most injured sites showed a common trend, namely the ankle and foot with 15.9% and the head 15.3% of the total injuries. The shoulder (11.4%), hamstring (10.2%), knee (10.2%) and quadriceps (9.7%) were all similarly affected. The injury sites varied between forwards and backline players (forwards: 63.4% backline: 36.6%). The forwards most injured anatomical site showed a trend with the shoulder and ankle (0.5 per 1000 hours) being affected the most. The hamstring (0.4 per 1000 hours), ankle, head (0.3 per 1000 hours) and knee (0.2 per 1000 hours) were the most injured site amongst the backline players. The tackle was responsible for the cause of the majority of the injuries (total: 19.1 injuries per 1000 hours) amongst the forwards and backline players (forwards: 20.5 per 1000 hours backs: 13.6 per 1000 hours). The most common types of injuries were sprains (18.2 per 1000 hours) and strains (24.5 per 1000 hours) found amongst the forwards and backline players. The forwards had higher contusion and concussion (0.3 per 1000 hours) trend rates compared to the backline players. The backline had overall higher tendinopathy (0.2 per 1000 hours) trend rates. Amongst the forwards, the locks (15.2%) and props (12.9%) had the highest number of injuries and amongst the backline players were the wings (8.4%) and centres (9%) were the most injured players. The majority of the injuries occurred during the last part of the first half (26.7%) and the last part of the second half (30.7%).

CONCLUSION: The prevalence and incidence of match injuries was significantly higher than during training (p = 0.039). Similarly to other injury surveillance studies, the tackle was the most dangerous phase of play. The Forwards who are more engaged in a greater number of physical collisions in a game resulted in more injuries compared to backline players[71]. The backline players, due to their style of play had more running and accelerating injuries[5,24]. Fatigue and other confounding factors

such as a lack of physical conditioning, travel and academics could be a determinant to decreasing the threshold for injury's occurring during the last part of each half of the game, during matches[22]. Furthermore, the site, type and mechanism of injuries vary across individual playing positions as well as from team to team[24,26]. This suggests that different training styles for the various positions should be recommended as an addition to an injury prevention protocol at this level of rugby.

UITTREKSEL

DOELWITTE: Die primêre doel van hierdie studie was om die beserings in voor- en agterspelers gedurende die 2011 FNB Universiteitsbeker seisoen vas te stel en te vergelyk. Die sekondêre doel was om die beserings in voorspelers en agterspelers gedurende die 2011 FNB Universiteitsbeker seisoen vas te stel en te vergelyk. Laastens, om die verskillende ladingsoefeninge**,** tipe beserings en hoeveelheid beserings onder die verskillende rugbyspelers gedurende die 2011 FNB Universiteitsbeker vas te stel en vergelyk.

STUDIE ONTWERP**:** 'n Retrospektiewe beskrywende studie is gedoen waarin die geneigdheid tot, en die voorkoms van beserings gedurende die 2011 FNB Universiteitsrugby toernooi bepaal is.

DEELNEMERS: Manlike studente rugbyspelers, vanaf agt spanne. Die totale aantal rugbyspelers wat geanaliseer was, was vanaf slegs sewe spanne, bestaande uit ± 23 - 30 spelers in elke span. Hierdie spelers was almal tussen die ouderdomme van 23 ± 1.2 jaar. Al die spelers moes 'n geregistreerde student by een van die agt deelnemende universiteite gewees het gedurende die toernooi regoor Suid-Afrika in 2011.

METODE**:** Die data insamelingsproses en beseringsdefinisies is in lyn met die onderskeie konsensus ooreenkomste vir rugby beserings[12]. Die besering opname sluit alle beserings in wat deur elke rugbyspan se mediese personeel op die gestandardiseerde IRB beseringsvorm aangedui is. Daar was agt deelnemende rugbyspanne in die 2011 FNB Universiteitsbeker-toernooi. Die FNB Universiteitsbeker het plaasgevind by agt Universiteit kampusse regoor Suid-Afrika. Die FNB Universiteitsbeker rondomtalie het in Februarie 2011 begin waar wedstryde elke Maandagaand, oor ‘n tydperk van sewe tot nege weke, gespeel is. Die uitspeelwedstryde van die top vier spanne het daarop gevolg vir ‘n verdere twee weke. Beide, die voorkoms van beserings en die frekwensies daarvan is aangeteken en vergelyk volgens die oefenprogramme en die hoeveelheid blootstellingsure van die spelers. Beseringsfrekwensies is gerraporteer as die aantal beserings per 1000 uur waar ‘n speler blootgestel word aan die risiko. Beskrywende statistiek is gebruik om die

geneighdheid tot, en die voorkoms van alle beserings aan te meld tydens hierdie toernooi. Betekenisvolheidsvlak was geneem op p <0.05.

RESULTATE: Sewe van die agt deelnemenede spanne aan die 2011 FNB Varsity Cup was in staat om besering- en oefenstatistiek in te dien. Van hierdie sewe spanne, was daar 178 (6.1 beserings per 1000 ure) beserings in totaal aangemeld regdeur die seisoen. Een en sestig voor-seisoenale beserings is gerapporteerd (2,1 per 1000 ure) in vergelyking met die 117 (4,0 per 1000 ure) in-seisoense beserings wat aangemeld is. Daar was 125 wedstrydbeserings (89 per 1000 ure) en 52 beserings tydens oefeninge (1,58 per uur 1000) wat statisties betekenisvol (p = 0,039) was. Die aantal nuwe beserings was baie hoër as die herhalende voorkoms van ‘n besering. Die totale aantal nuwe beserings was 120 (4,1 per 1000 ure) met slegs 52 (2,0 per 1000 ure) herhalendes. Dit was die onderste ledemaat wat in die meerderheid beseringsgevalle (97.5%) geraak is. Oor die hele spektrum was die enkel en die voet die mees beseerde area (15,9%), met die kop (15,3%), skouer (11,4%), dyspier (10,2%), knie (10,2%) en kwadriseps (9,7%) wat soortgelyk geraak is. Areas vir individuelebesering het gewissel tussen voor-en agterspelers. Die voorspelers se mees beseerde anatomiese area was die skouer en enkel (0,5 per 1000 ure). Die dyspier (0,4), enkel-, kop (0,3) en knie (0,2) was die mees beseerde area onder die agterspelers. Die takel was verantwoordelik vir die meerderheid van die beserings (48.1%) onder die voor- en agterspelers. Die mees algemene vorme van beserings was verstuitings en spierverrekking onder die voor- en agterspelers. Die voorspelers het ‘n hoër voorkoms van kontusie en harsingskudding (0,3) in vergelyking met die agterspelers. Die agterlyn dui ‘n algehele hoër tendinopatie (0,2) aan. Onder die voorspelers het die slotte (15,2%) en die stutte (12,9%) die hoogste aantal beserings aangeteken en onder die agterspelers was die vleuels (8,4%) en die senters (9%) die mees beseerde spelers. Die meerderheid van die beserings het plaasgevind gedurende die laaste deel van die eerste helfte (26,7%) en die laaste deel van die tweede helfte (30,7%).

GEVOLGTREKKING: Die prevalensie en insidensie van wedstrydbeserings was aansienlik hoër as tydens oefentye. Soortgelyk aan ander beseringsopname studies, was die takel die mees gevaarlike fase van die spel. Die voorspelers wat meer betrokke is in die fisiese kant van die spel het meer beserings in vergelyking met die agterspelers aangeteken[71]. Die agterspelers, as gevolg van hul styl van die spel het meer hardloop en versnel beserings aangeteken[5,24]. Moegheid en 'n gebrek aan fisiese kondisionering kan 'n faktor wees in die meerderheid van hierdie beserings wat gedurende die laaste deel van elke wedstrydshelfte aangeteken word. Verder, die area, tipe en meganisme van beserings wissel oor individuele spelerposisies[24,26]. Dit dui daarop aan dat verskillende oefenstyle vir die verskillende posisies aanbeveel moet word as 'n strategie vir besering voorkoming.

A GAME OF RUGBY IS A WORK OF ART….

(DANIE CRAVEN)

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The rugby players from each university for their willingness to take part in the study.

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LIST OF ABBREVIATIONS

1. **IRB**: Sport governing body known as the International Rugby Board[1]
2. **MIE**: Match Injury Exposure
3. **TIE**: Training Injury Exposure
4. **ACL** – Anterior cruciate ligament
5. **MCL** – Medial cruciate ligament
6. **SARU**: South African Rugby Union
7. **VC**: FNB Varsity Cup, premier division, rugby tournament
8. **FNB**: First National Bank, the main sponsor of VC
9. **TRIPP**: Translating Research into Injury Prevention Practice
10. **RWC**: Rugby World Cup

LIST OF TERMS & DEFINITIONS

1. **Injury**: any physical complaint sustained by a player during a training session or during a match, irrespective of the need for medical attention or time-loss from rugby activity[12].
2. **Medical attention injury**: an injury that occurs where a player needs medical attention[12].
3. **Time-loss injury**: an injury that results in a player not being able to fully participate in training or a match[12].
4. **Recurrent injury**: an injury of the same type at the same site that occurs after the player has returned to play from the original injury[12].
5. **Injury severity**: the number of days that have conceded from the date the injury occurred to the date of full participation again (training or match)[12].
6. **Injury classification**: slight (0-1 day absent), minimal (2-3 days), mild (4 -7 days), moderate (8 -25 days), severe (> 28 days), career-ending / non-fatal catastrophic injury and fatal (never returning to play)[12].
7. **Match exposure**: play between teams from different clubs/ areas/ universities[12,52].
8. **Training exposure (training Load)**: team based and individual physical performance under the management of the team's coaching or fitness staff. Training is aimed to maintain or improve a player's skills and physical condition[12].
9. **Rugby Union**: is a game that is played by two teams that consist of 15 players each (eight forward players, seven backline players). These two teams contest for the ball in order to score points within the laws of the game[12].
10. **Rugby League**: is a similar notion to rugby union except it consists of 13 rugby players (six forwards, seven backline players). The game is played over two 30-40minute halves with a ten minute break in-between[12].
11. **Forward players**: are involved in scrumming, tackling, rucking and mauling (especially as a pack). They are commonly known as the tight five and more involved in the contact and collisions phases of the game[24,78]
12. **Backline players**: are actively involved in attacking and defending but more specifically in the running, kicking and passing phase of the game[24,78].

13. **Rehabilitation:** treatment or an Exercise program aimed at reducing the signs and symptoms associated with an injury[78].
14. **Prehabilitation**: preventative exercise programs aimed to decrease the risk of injury[78].
15. **Prevalence of Injury**: the rate at which the number of injuries occur within a population. This usually amounts to how many injuries, who is affected, where and when did the injuries occur[12].
16. **Incidence of Injury**: the number of new or recurrent injuries that amount over a period of observation, within a population[12].
17. **Injury Rates**: injury rates are expressed as the number of injuries sustained per 1000 hours a player is at risk[12].
18. **Training Volume**: training time multiplied the number of training sessions (pre-season and in-season hours)[12].
19. **Round Robin Tournament**: each team plays every other team once in the competition.
20. **Intrinsic risk factors for injury**: Factors that form part of the Athlete's make-up, predisposing them to an injury. Such as: age, gender, body composition, health and previous injury, physical fitness, anatomy, skill level [55].
21. **Extrinsic risk factors for injury:** Factors that make an athlete susceptible to injury. Such as: human factors (e.g. team mates, opponents, referee), protective equipment (e.g. scrum cap, shoulder pads, knee brace), sports equipment (e.g. rugby ball), environment (e.g. weather, surface type, maintenance, altitude, travelling across time-zones)[55].

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CHAPTER 1

1. INTRODUCTION

The game of rugby is a contact sport where injuries commonly occur due to its physical nature[1,39]. The physicality of the game due to a higher level of play increases a players risk and exposure to injuries[39,59].

Rugby union has a large participation percentage which creates substantial health burdens, and highlights the importance of injury prevention strategies[69]. Van Mechelen's (1992)[55] sports injury model, which is the most widely used in the field of sport injuries and prevention, provides such a framework to engage in research and also prevention strategies. Briefly, the standard public health prevention model was translated into a sport injury context (Robertson, 2007)[80]. This model was put forward as a valuable assessment and screening tool to guide those within the sporting world as well as future injury research[55,68].

Targett (1998)[5] had reported 45 injuries per 1000 hours amongst the New Zealand rugby teams in the Super 12 season. During the 2003 Rugby World Cup, amongst 20 of the rugby teams, the number of injuries almost doubled to 83.9 injuries per 1000 hours[6]. Also, Brooks *et al.* (2005)[7] reported an injury rate of 218 injuries per 1000 hours amongst the England rugby team. Holtzhausen (2006)[2] stated that South Africa's rugby playing population was growing nationwide, and together with this, reported that rugby union is a sport with one of the highest injury rates not only in South Africa but also world-wide[2]. Furthermore, he stated that during the 2003 RWC, the number of injuries, the South African team had encountered, increased from 43 injuries per 1000 hours compared to the 62 injuries per 1000 hours during the super 12 rugby season in 2006[2,3].

During the 2007 RWC, Fuller *et al.* (2008)[8] reported an escalated 83.9 injuries per 1000 hours world-wide compared to in 2005/6, where during the Super 14 rugby season another elevated 96.3 injuries per 1000 hours were recorded[8]. In 2011, Fuller (2012)[1] indicated a similar injury trend during the

RWC with 89.1 injuries per 1000 hours. To date, there are on average 69 to 218 injuries per 1000 playing hours amongst all rugby teams[2,10]. These studies confirm that rugby continues to have high injury incidence rates. This is a major concern for any medical support team who are responsible for the welfare of players[55].

Comparisons before 2007, cannot be achieved between South African rugby surveillance studies with other sports, or with other rugby union playing countries due to the lack of injury surveillance studies, a lack of consensus statement, as well as previous variations and discrepancies in the data collection procedures[2,12]. Fuller *et al.* (2007)[12] have established a world-wide standard consensus statement pertaining to injury definitions and data collections process, which has already been implemented by FIFA for football. This consensus has been adopted by the IRB, and implemented in all rugby union environments, allowing for comparisons to be made amongst more recent, as well as future surveillance studies[12].

Fuller *et al.* (2007)[12], standardized the injury definitions and procedures for data collection due to the differences in results and conclusions from various injury surveillance studies[12]. Rugby players are more prone to injury due to the re-occurring stages of collisions or contact phases, as well as moving at a wider range (frequencies) of velocities and changing of directions[2].

The importance of injury prevention and injury management in a contact sport like rugby is vital, not only in South Africa but all rugby unions, for the wellbeing and safety of the players and the responsibility of all involved (coaches, medical support staff and administrators). The last studies done in South African, focusing on Super 12 rugby, had high injury rates with reported 84 injuries per 1000 hours in 1999[2], 30-38 injuries per 1000 hours from 2002-2004[48], and in 2011, amongst youth (under 16 and under 18 age group) provincial rugby players, 23.1 injuries per 1000 hours[67]. Holtzhausen (2001)[3] confirmed these injury rates amongst professional rugby players in a review, stating that on average observed was 86.4 injuries per 1000 hours. The rate at which injuries occur, increases with the level of play, which is due to the increase in the number, intensity and types of

tackles, or collisions experienced over the 80 minutes of play[2,10]. It is suggested by Brooks and Kemp (2010)[24] that injury prevention models need to be implemented, particularly in the pre-season for all teams. Thus to implement injury prevention models, there is a need for more current injury surveillance studies particularly in South Africa (as well as at VC level), to aid in good practice in all levels of rugby[55,68].

An injury prevention model as described by Van Mechelen (1992)[76] should be easily applied by each University's medical support staff involved in the VC. The model follows an easy four step approach to injury prevention (diagram 1). This would involve the monitoring of the injury risk and the documenting of all injuries, on a daily basis, throughout both the pre-season and competition period. The risk factors and mechanisms of how the injury occurred would also need to be documented, aiding in identifying the common causes of injuries. Once these types of injuries and causes of injuries have been identified an intervention needs to be implemented into the training schedule, in order to prevent re-occurrence of injuries and/or combat similar injuries from occurring in other players. The final step would be to assess the success of the intervention by repeating the initial step taken[55,68]. During the 2011 FNB VC only steps 1 and 2 were implemented due to limited man-power, resources and infrastructure.

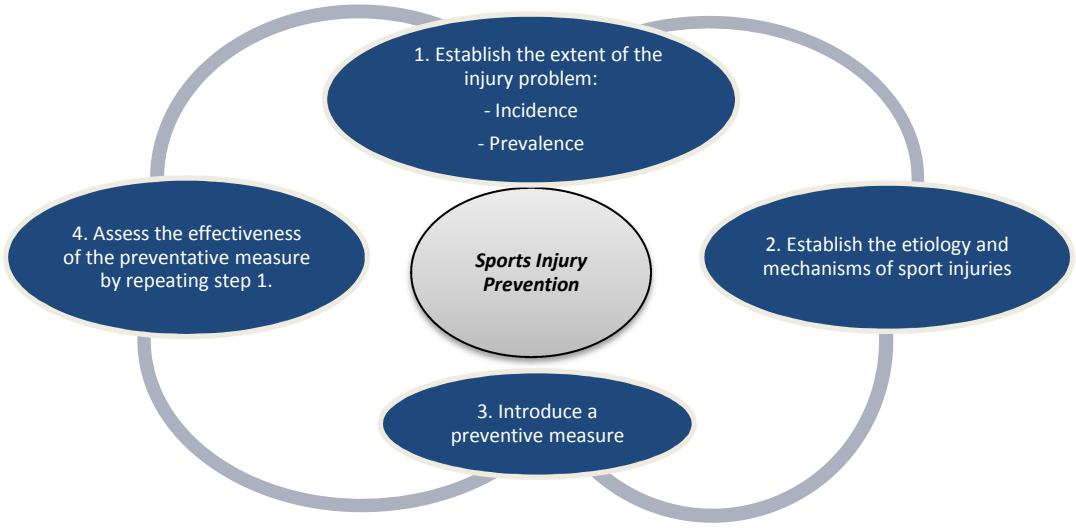

Diagram 1: Injury prevention model[55]

During the 2003 RWC, within the England Rugby team, forwards had 67 injuries per 1000 playing hours and backline players 78 injuries per 1000 playing hours[7]. During the 2007 RWC, Fuller *et al.* (2008)[8] reported that amongst all participating rugby teams, the forward players incurred similar injury rates compared to the backline players, with 84 injuries per 1000 playing hours and 83.7 injuries per 1000 playing hours, respectively. During training the forwards and backline players too had similar injury rates, with 3.5 injuries per 1000 hours for the forwards and 3.6 injuries per 1000 hours amongst the backline players. The lower limb was the most injured site amongst these players, with muscle and ligament injuries mainly. The tackle was also responsible for the majority of the injuries[8].

In a study by Brooks & Kemp (2010)[24] the most common sites of injury amongst forward players were the shoulder, knee and ankle; where backline players experienced shoulder, hamstring and knee injuries predominantly. Numerous other studies show similar findings however with a lack of differentiation between specific positional injury rates (forwards vs backline) as well as associated types of injuries[7,27]. Holtshausen *et al.* (2006)[2] reported similarly that concussions and bone fractures were the most commonly occurring injuries; whereas face lacerations were in the minority in both. They reported that professional level injury rates were generally greater compared to semi-professional rugby. Researchers propose this outcome to be associated with various confounding factors that are associated with the different levels of rugby. It is common that more than one factor contributes to an injury. Thus it is important to assess other confounding factors that can be related to the injured player or the mechanism of the injury; such as the opponent, the protective or sporting equipment and the environment (e.g. weather, surface)[22]. The intrinsic factors too need to be taken into account and documented as these factors can predispose an athlete to an injury. In order to prevent injuries at the different levels of rugby the confounding factors need to be understood, documented and a preventative measure needs to be put into place to reduce injuries as prescribed in the Meeuwese model[55].

Mahaffey *et al.* (2006)[71] showed sprains and strains as the most common injury found in their rugby surveillance study as did, Oluwatoyosi & Owoeye (2010)[63] within their study; particularly stating 36.4% of all injuries were muscular in nature, which is similar within the rugby environment.

Despite the different levels of play, tackles (46.3%)[6] remained the most common cause of injury, with differences only found in the number; type of tackles and collisions that occurred[28]. In other studies reported professional rugby players have increased injury rates in terms of incidence, site and types compared to amateur players[26].

Garraway *et al* (2000)[59] explained that injury prevalence and incidence vary in relation to positions, specifically forward players compared to backline players. Despite the evidence depicting this, the vast majority of injury surveillance studies fail to report specific positional injuries or incidences[51]. Noakes *et al.* (1998)[25] reported injuries amongst the South African rugby team during the 1995 RWC and found that the loose forwards were the most injured players (25%), followed by the centres and wings (20%) and props and halfbacks (16%). These findings are similar to those found during the 2007 and 2011 RWC[1] after the consensus statement was passed in 2007. This differed amongst elite Australian rugby players, where despite forward players' injury incidence being higher than backline players, locks and fly halves were the most commonly injured players[10].

It is important to take into account the changes (game tactics, laws etc.) that have taken place within the game of rugby which could account for the discrepancies between positional injuries over a period of time[14,59]. Injury incidence densities and 95% confidence intervals (95% Cls) are calculated for the number of injuries per 1000 hours of match play and comparisons are reported with statistical significance (p-value).

In order to reduce the number of injuries, the laws of Rugby Union have been adjusted in both number and complexity, from an amateur level to the professional level in which the game is currently played[14]. The demands placed upon each player increases yearly as the game evolves and

greater expectations are placed upon players in terms of the degree of skill, strength and power they require[2]. There are several other none-physical demands placed on players (junior and senior) such as the effects of travel (including time-zones), and other environmental conditions which altogether decrease the injury threshold[22]. This combined with the increase in match and training hours (training load) may be the leading contributors to the increased incidence and prevalence of injuries in rugby union[48]. Other possible factors influencing the prevalence of injuries are found to be: the increase in the intensity of play; stage of the game or season; phase of play; lack of recovery time and recovery strategies; combined with different surface types; environmental factors; previous injuries and the lack of wearing protective gear[22]. Lastly, the optimal training load to maintain or increase rugby performances while reducing the risk of injury, especially position specific injuries, is imperative[48].

2. RATIONALE AND MOTIVATION

Holtzhausen *et al.* (2001[2] & 2006[3]) has found that within South Africa there are minimal prospective studies illustrating the injury prevalence and incidence and causes thereof; despite the estimated 400 000 to 500 000 players countrywide and an estimated 22 catastrophic injuries per year, in South Africa. Thus, the main focus of any team's medical support staff is the wellbeing of the players to enable player safety through injury surveillance studies and implementation of prevention strategies to ensure maximal performance.

Due to the fact that there are no epidemiological studies investigating injury surveillance in the FNB VC premier division tournament, as well as little or no published research on the number and type of injuries experienced during the FNB VC, more information is required regarding the prevalence and incidence of injuries. Thus, in order to maintain the safety of the VC tournament, one needs to reduce the susceptibility to injuries and provide an injury prevention framework in which sport injuries can be researched and prevented in the game of rugby, thus similar studies need to be done.

The game played currently differs greatly to that played in the past, as rugby is becoming more competitive with more collisions and injuries every year[8,31]. Thus, to decrease the number of injuries per year, the establishment of effective preventative strategies as suggested by the TRIPP model[75], which evaluates the causal factors pertaining to injuries and their associated risk factors. These need to be documented through accurate injury surveillance reporting in order to implement successful injury prevention protocols[1].

A lack of epidemiological evidence in the VC competition served as motivation for this study.

3. AIM

The aim of this research was to describe the prevalence and incidence of injuries that occur to forward and backline rugby players during the 2011 FNB VC season.

4. OBJECTIVES

1. To establish and compare the injury prevalence and incidence in forwards and backline players during the 2011 FNB VC season.
2. To establish and compare the different training loads, types of injuries and injury rates amongst the various rugby teams during the 2011 FNB Varsity cup.

STRUCTURE OF THE THESIS

The thesis consists of six chapters. A short discussion outlines the structure and contents of each chapter.

The first chapter orientates the reader to the motivation and objectives of the study. The role that injury plays in the game of rugby as well as how it is reported and researched is briefly discussed. The concept of the framework of injury prevention research is introduced. The objective and structure of the thesis are then outlined.

The second chapter of the thesis consists of a review of the relevant literature. A simple framework for injury prevention and research is provided. The role this plays in injury prevention strategies are provided.

In Chapter 3, a detailed method section is provided.

In Chapter 4 consists of the results of the given study, after which Chapter 5 (Discussion) and 6 (Conclusions) are given with strengths and limitations of the study.

The researcher was responsible for the data collection, data entry and checked for typographical errors.

CHAPTER 2

LITERATURE REVIEW

2. INTRODUCTION

In South Africa, playing rugby union starts at a very young age, with the majority being encouraged to play from the start of primary school. The popularity of the sport is mounting worldwide due to the intense on-field competitiveness, the pressure to participate and the financial investment by large corporate companies into the sport[59]. The competitive and physical nature of the game of rugby results in reported higher injury rates compared to semi-contact or non-contact sports[39]. This is an area of concern since as there is increasing evidence that the injury rates, especially amongst professional rugby union players, are as high as 89.1 injuries per 1000 match hours[1]. A fundamental process, and typically the first step behind an injury prevention program, is an ongoing injury surveillance to implement better injury prevention strategies[55].

2.1 The Game of Rugby

The aim of the game of rugby union is for the two sides to physically contest against one another and move the ball down the field into the opposition's territory and score a try, which counts towards the team's points. The game of Rugby Union is a field-based, team sport involving two sides of 15 players challenging each other usually over two 40 minute halves (on average), with a ten (average 10-15) minute break in-between[78]. The game tends to have frequent bouts of high intensity running, passing or tackling with several short, low-intensity bouts when there are breaks in play[6]. These breaks in play are known as recovery periods and consist of light jogging or even walking. The game involves a high level of recurring phases of sprinting, rucking, mauling, scrummaging and tackling[78]. A rugby union team consists of eight forwards and seven backline players on the field at any one time, both of which are actively involved in attacking and defending[78].

The forward players consist of two props and a hooker. The locks, flanks and an eighth man are known as the loose forwards[78]. The backline consists of wings, centres, a scrumhalf, flyhalf and fullback. The forward players are more involved in scrumming, tackling, rucking and mauling, whereas the backline players are more involved in running, passing, tackling, side-stepping and kicking the ball during play[78]. Each position requires a set of specialized skills used for certain position specific tasks during the game. This prerequisite for position specific specialized skills could possibly be due to the change in the laws of rugby union or individual team tactics, which lead to the different positions (forwards and backline players) being subjected to different physiological and physical demands[78].

2.2 The FNB VC Rugby Tournament

The VC Rugby tournament first began in 2008 with the top eight University rugby teams in South Africa competing against one another. The tournament rules state that only students who abide by the VC rules, of the associated Universities' are eligible to take part. The rules further stipulate that games are to take place at each of the Universities' campuses. The first phase of the tournament is made up of round-robin matches (home and away games), with teams playing against each other; the matches begin at the start of February and end early in April. The scoring during this tournament follows the same scoring procedure as that of the Super 14 (provincial level) rugby tournament, being four points for a win, two points for a draw and a bonus point for four tries in a match or for losing within 7 points of their opponents. Following the round robin phase of the tournament, the top four teams take part in the knock-out phase of the tournament, competing for a place in the final as well as for home-ground advantage for the final.

2.3 Pre-Season Training load

2.3.1 TRAINING LOAD DEFINITION

Training load (exposure) is calculated for each team based on the number of players within the squad, who part-take in the team's training sessions; the number and length of session (minutes) as

well as the structure (field: contact, skills or conditioning training or Conditioning/Gymnasium) of the session is included (Addendum E) [12].

2.3.2 TRAINING LOAD

The pre-season is the training stage of the competition where teams prepare to compete. The VC teams have approximately a six to ten week period of pre-competition training. The preparatory phase of the pre-season generally entails anthropometric assessments, strength and conditioning tests and musculoskeletal evaluations (Addendum E). The pre-season then flows into formal strength and conditioning sessions, rugby skills development and training sessions, individual prehabilitation programs and possibly unofficial warm-up games[78]. Pre-season is the period with high training loads and greater emphasis on tackling and defensive drills over set-plays, which leads to more phases of contact[78]. Players are coached in techniques such as proper tackling and scrumming with the aim to reduce acute or severe injuries, particularly in-season[78].

2.4. In-Season Training Load

Preparation for a competitive event a rugby player undergoes systematic training which induces adaptations in the muscle, and metabolic, cardiovascular and neurological systems. The training adaptations are associated with changes in performance, such as a delayed onset of fatigue or an increase in power output[78]. This principle of training can be reduced to a simple dose-response relationship between the physiological stress associated with the load of exercise training ("dose") and the training adaptations ("response") (Borresen & Lambert, 2009)[81].

In-Season refers to the period when the competition phase of the year begins[12]. The VC competition (in-season) period starts in February, and lasts between seven and nine weeks[45]. The physical conditioning of players contributes to the majority of field or training minutes compared to game time. This highlights the importance of adequate conditioning of all players[14]. Rugby training during this part of the season is mainly attributed to field training.

The amount of time spent doing both conditioning and field training differs significantly during the pre-season to in-season[14]. The pre-season training hours are more compared to in-season, as the main focus for the in-season would be to maintain what they achieved in the pre-season and to focus on the game for the week ahead[7]. In most training load studies, where the training volume and injury rates are correlated; it is commonly found that the increase in training hours is closely associated with higher injury rates (38% of the total injuries were training injuries)[48].

During the onset of competitions, players perceived speed, strength and stamina is to be on par with their cardiovascular fitness level, together with the required skill and task acquisition associated with their specific position[24,47]. This is required in order to reduce the risk of an injury[47]. It is also essential to document the exact minute or phase during a game the injury took place, as well as whether the referee declared the injury as part of dangerous or foul-play or a violation of a law[12,14]. Documenting all of the above one can determine whether the injury was due to a pre-existing injury, pre-season preparation (or lack of) and/or whether correct coaching techniques were implemented during the pre-season[2,60]. This documentation should follow the guidelines provided by the Meeuwisse injury prevention model[55].

2.5 The definition of an injury

Fuller *et al.* (2007)[12] implemented the following definition of an injury; "*Any physical complaint, which was caused by a transfer of energy exceeding the body's ability to maintain its structural and/or functional integrity. This physical complaint was sustained by a player during a rugby match or training session, irrespective of the need for medical attention or time-loss from rugby activities*"[12]. The greatest prerequisite in injury prevention, which can be by those involved within the rugby environment, is a thorough injury assessment and management plan[24,55]. The identification of mechanisms of an injury can formulate precise interventions and progress to limiting the incidence of injuries[68].

Injuries are classified according to the severity: being, slight (player is absent for 0 – 1 day period); minimal (2-3 days absent); mild (player is absent for 4-7 days); moderate (player is absent for 8-28 days); severe (more than 28 days absent); career-ending; non-fatal catastrophic (more than 12 months absent) and fatal. These injuries can be classified further as either a time-loss injury (not being able to fully participate in training or a match) or a medical attention injury (player needs medical attention) [12].

An injury can be further sub-classified as bone, joint or ligament, muscle or tendon, skin, brain, spinal cord or a peripheral nervous system injury[12]. The injury mechanism can be classified as a result of a non-contact collision or more commonly through a contact phase (tackled, tackling, maul, ruck, lineout, scrum, collision or another mechanism)[12]. Injuries are further assessed according to their location, type, site and the mechanism of the injury[12].

Fuller *et al.* (2007)[12], implemented this process into rugby and formalized the standardization of the IRB form, globally. This form defines injuries, as well as captures the player's position, age, anthropometric measurements, use of protective gear (or lack of) and the history of previous injuries[60]. This standardized definition and methodology has allowed for data collection to follow suitable guidelines, injury patterns and the identification of associated risk factors relating to rugby. The IRB form is there to standardize the injury surveillance method, to be more consistent and allow for comparisons of outcomes that followed the framework to now be possible world-wide[4,48]. The form also looks at match and training exposure rates (training load) and the procedures for injury collection[12].

These findings can provide useful information relating to injuries, such as the most common injuries in the team, positional injury rates, common mechanisms and the phases of play injuries predominantly occur, throughout a season. Injuries are standardized to be recorded per 1000 playing hours of exposure, in order to eliminate bias. This information can be used to plan more effectively and implement improved preventative measures for the next season[55]. Identification of

the incidence, nature and causal factors associated with injury as well as accurate reporting of injuries can allow for the implementation of appropriate interventions, conditioning programs for the players and thus an attempt to reduce the number of injuries during the season[55].

To aid in global comparisons, standard data collection processes were achieved and are being utilized[12]. These injury definitions and subsequent classifications have been adapted, to formulate the new IRB injury form to assess injury surveillance in sport; thus this form was used during the 2011 VC tournament to assess and collect the tournament injuries[12].

2.6 Rugby Training Injuries

2.6.1 TRAINING INJURIES

Recent studies have all referenced the lack of a standard injury definition (McManus, 2000)[82] which results in a large discrepancy in the reported incidence of rugby injuries. A standard approach when categorizing the severity of injuries now exists in which injuries have been classified as mild (less than one week absence), moderate (more than one to three weeks absence), or major (more than three weeks absence) (Kaplan *et al*., 2008)[13].

Training injuries are usually lower than match injuries[7]. Training injuries tend to occur at the beginning of a new season as well as the latter part (last ± 15 -30 minutes) of a session[78]. Match injuries tend to take place at the end of the first half or the latter part of the game (60-80+ minutes), in-season[78]. Residual fatigue induced by a heavy pre-season training load has a greater risk for injuries than over-training[60].

Lee & colleagues (2001)[60], found that players who carried injuries into the new season were more likely to miss the majority of the new season, due to subsequent injury[60]. This illustrates the significance of pre-season medical screening, physical conditioning and elevated levels of cardiovascular fitness, as well as the implementation of effective recovery methods and player management prior to the onset of the competition phase[9,60]. It has become a more common

approach by coaches to incorporate skills and conditioning sessions in order to maintain skills in a fatigued state during games[2,60]. Research has shown that 5-39 hours per week of high intensity training can form a protective mechanism against injury but more than this can increase the risk to injury[39,60]. It is therefore essential that the training load and volume be well planned and structured to prepare the players for the physiological and musculoskeletal demands placed upon their bodies in-season and decrease the risk of injury from over-training[48,60].

2.6.2 INJURY PREVENTION MODEL

There have been attempts to standardize data collection in order to provide a more rigorous investigation of rugby injury epidemiology (Sharp *et al*., 2001)[83]. In an attempt to develop a prevention tool within the sport environment, Finch *et al*. (2006)[68] reported that a standard public health intervention model being adapted to fulfill an injury prevention tool within the sporting environment[68]. The original model, known as the translating research into injury prevention practice model (TRIPP), had four stages and was used largely in the previous era as a guide in injury research[75]. The four stages were: firstly to establish the extent of the problem or injury through an injury surveillance process; secondly, to establish the etiology and mechanism of an injury; thirdly, to develop and introduce preventative measures and lastly, to assess the effectiveness of the preventative measure by repeating stage one.

This model received bouts of criticism for having several limitations. These limitations were primarily methodological, such as invalidated surveys of self-reporting information, recall bias, poor definitions of injuries used, and statistical descriptions of data[68]. This model was then taken and modified into a six stage model. The model then took into account that an effective tool had to be evidence based in order for coaches, athletes and medical support staff to permanently adopt and implement. These safety measures had to actually prevent injuries, be tried and tested, improve play or performance and participation and not alter training or the essential nature of the sport or application of the sport[75].

The six stage TRIPP model is evidence based and aimed at "real-world" implementation. Stage one, remains an injury surveillance process, using standardized sport injury and exposure definitions. Therefore, it can also be used as a methodological tool, with appropriate statistical methods. Stage two, requires a multi-disciplinary approach to the core etiology of why injuries occur (mechanisms) and other associated factors with injury causes and severity. Stage three, identifies the potential solutions to the injury problem and develops appropriate, theoretical, multi-disciplinary preventative measures. Such as biomechanics, sports science, behavioural psychology, health promotion, sport medicine etc[68,55]. Stage four, corresponds to the intervention effectiveness assessment and is what is known as an "ideal conditions" evaluation of stage three.

Ideal conditions are primarily laboratory based testing. All variables within this environment are controlled and scheduled in a targeted manner. It is unlikely such an intervention will hold successful in a real-world setting. Many teams or clubs don't have the financial or manpower infrastructure to implement this precise intervention[68]. However, there is still scope to have it contribute to relevant knowledge in this area. Stage five, develops the understanding as to how the outcome of efficacy research (Stage four) can be translated into the real-world. Stage six, is the implementation of the intervention into the real-world and evaluating its effectiveness within. The result will be a measure of the effect and success of an injury prevention tools in the real-world, for example: such as the successful implementation in protective eye-wear into the game of Squash[69].

The TRIPP framework has shown that safety measures will be adopted successfully if it forms an integral part of a team's or clubs core businesses or part of the sporting culture and where their performance and participation levels are increased. The athletes, coaches and medical support staff need to be fully informed about the intervention being introduced, as well as its benefits. The intervention must by easy to adopt and administer[68,69].

The majority of these steps were followed in this thesis according to the model of Meeuwise[55], namely step 1 and 2, which are the establishment of the extent of the injury, the etiology and

mechanism of the injuries (Diagram 1). This was according to the resources available to each team, with the attempt to achieve the same injury prevention outcomes in the future within VC.

2.7 Risk, exposure and incidence of injury

The risk of injury to rugby players is higher than the majority of other sports due to the substantial physical strain the players' incur[21,79]. In most sports, managing injured players is based upon an early return-to-play, despite best practice principles which disregards the biological healing process that ensures absolute recovery and rehabilitation from injury[44]. The risk of re-occurrence of these injuries occurs when players return to play too early. Re-occurring injuries have been found to be more severe in terms of more days absent from the game[44]. All injuries are therefore recorded as either being first time episodes or recurrent injuries[12].

At the onset of the professional era of rugby, injury rates have increased over the years[14,59]. This is possibly due to law changes, game tactics and/or a higher intensity of play with the emphasis on speed, strength and stamina, as well as the ball being in play for longer periods of time[1,14]. Injury rates are calculated according to the number of hours that a player is exposed (at risk) to an injury[12]. As seen, by Holtzhausen (2001)[3] during 1995 – 2001 there was an average injury rate range of 67.8 – 150 injuries per 1000 hours. In another study, Brooks *et al.* (2005)[7], found a total of 6.1 injuries per 1000 training hours, compared to 218 injuries per 1000 match hours in the 2003 England World Cup team (total: 17 injuries per 1000 match hours).

Fuller *et al.* (2007)[8] reported similarly that most of the injuries occurred in the forward players compared to the backline players. These studies suggest the variation in styles of play amongst the various positions to be the reason for this[24].

In another injury surveillance study, done on elite Australian rugby players during 1994 to 1995[10] a reported 47 injuries per 1000 hours were found compared to 74 injuries per 1000 hours in the period of 1996 to 2000. In two similar studies[8,10] forwards comprised of 53.3% of the total injuries

compared to the backline players, 46.7%. In other similar studies within this particular timeframe, they suggest the high injury occurrence rates amongst forward players to be associated with the number of persistent forces or collisions sustained when they are engaging with the opposition[2,28]. The increase in these injuries could primarily be due to the onset of professionalism[59].

The vast majority of these researchers conclude this association to the onset of professionalism which is due to a higher intensity that the game of rugby is played at, as well as an over-training aspect (larger training volume) and the ball being in play for longer[1,59].

The forward players spend the majority of their time in the more physical aspect of the game, being a more bent over position, compared to backline players who are more upright during free running[58]. Furthermore, as the forwards are more involved in the contact phases of the game they often have higher injury rates compared to backline players[39,58]. Many of these studies have chosen to group injuries to forward and backline player groups and have failed to analyze injury rates pertaining to individual positions within their groups[8,10]. Two comparison studies of injury rates pertaining to specific positions have been done (world-wide), due to the rules changing regularly and thus every teams style of play differs[57,59].

2.8 Match and Training Exposure

During the 2002 – 2004 Super 12 seasons, similar results were found among the South African rugby teams[2,3]. Of the total injuries 74% (55 injuries per 1000 hours) occurred during the game with only 21% during training. The training hours fluctuated between the three years, with 2003 having the highest training load. This could explain the increase in training injuries during 2003[14]. In general, most injuries occurred during matches compared to training sessions, with match injuries (55.4 injuries per 1000 hours) and training injuries (4.3 injuries per 1000 hours)[2,14]. The training injuries reported were not as severe as those reported during matches[14]. This is usually due to the impact of play and intensity being much higher during matches[14,58]. It is speculated that the reason for the

increased training injuries in 2003, might be due to the accumulated training volume and the lack of optimal physical conditioning within the pre-season[7,60,].

During the 2008 to 2009 Super 14 seasons, the South African rugby teams on average trained for a minimum of eight hours per week (pre-season), with a weekly sum of 32 hours (average)[48]. In total, 1475 injuries occurred over these two Super 14 seasons, with the majority being lower limb injuries. The amount of minutes per week attributed to training is much larger than the number of match minutes; thus the training load (exposure) is much larger. Also, during matches the intensity of play is higher which relates to more serious match injuries compared to those found during training[7]. Players are less conditioned in the early part of the season compared to their training status at the onset of the competition phase, which leads one to equate that players are more prone to injuries during training at the start of the season[60].

2.9 Common injuries

The most common injuries found amongst forward and backline players are head injuries, concussions and lacerations[3,10.] The head and neck (1.4 per 1000 hours) being the most commonly occurring sites of injury[1,2]. Other commonly occurring types of injuries are haematoma's, contusions and strains (muscle & tendons) and joint injuries (87%)[5,10] particularly found in the lower limb[8]. Other commonly occurring types of injuries are fractures (4-14%), concussions (5-10%)[5,10] and lacerations (12-19%)[5,10].

2.9.1 MUSCULOSKELETAL INJURIES

Noakes *et al.* (1995)[25] assessed the South African injury rates during the 1995 World Cup, reporting that there were 30 musculoskeletal injuries per 1000 hours. The most commonly occurring type of injuries were ligament injuries predominantly of the knee and ankle (30%), followed by lacerations (27%) and overall lower limb muscle strains (14%). Similarly to other studies mentioned above, the majority of injuries are commonly caused by the tackle[7,8].

Bottini *et al.* (2000)[27] reported the most common rugby injuries in an injury surveillance study amongst Argentine rugby union players, during the 1991-1997 rugby seasons. There were only 2.4 injuries per 1000 hours with lower limb injuries (42.6%) being the most injured site[27]. Muscle strains were the most common type of injury (11.7%), with the knee and ankle (14%) being the most prone to injury. The majority of these injuries occurred in the second half of the game (54%) and most commonly by an open play offense or a tackle (33%). Targett (1998)[5] investigated the incidence of injuries during the Super 12 rugby season amongst the New Zealand professional rugby unions. During this Super 12 season, 45 injuries per 1000 hours had been reported, which is higher than those reported during the 1995 RWC[25] amongst the South African players (30 injuries per 1000 hours). Targett found concussions (25%), ankle-related injuries (10.2%), quadriceps haematoma's (8.2%), knee-related injuries and hamstring muscle strains (12.2%) to be the most commonly occurring musculoskeletal injuries. These injuries occurred predominantly as a result of the player being tackled[5].

During the 2011 RWC, the tackle too was the most dangerous form of play which contributed to 43.6% of the forwards total injuries as well as 45.2% of the backline players' injuries[1]. Being tackled and tackling carry an equally high risk to cause an injury, as seen during the 2003, 2007 and 2011 RWC[1,8].

Holtzhausen *et al.* (2006)[2] noted out of South Africa's 37 matches played during this Super 12 season (1999), there were 62 injuries per 1000 hours, of which 41 were match injuries (55.4 injuries per 1000 hours) and 4.3 injuries per 1000 training hours. Ligament sprains (25.8%) were the most common injury followed by muscle strains and tears (24.2%), all these injuries were commonly caused by the tackle too. In the same Super 12 competition[2], position specific data was formulated amongst the South Africa rugby teams. Backline players, namely centres and fullbacks, were the most injured position; with locks, centres and wings having the more severe injuries[2].

Bathgate *et al.* (2002)[10], in a prospective study on elite Australian rugby players at the start of the professional era, reported 69 musculoskeletal injuries per 1000 hours. When categorizing injuries according to the four main anatomical sites, lower limb injuries accounted for the majority of the total injuries (51.7%). The most injured individual site was the head (25.1%), second the knee (14%), thigh (13.6%), and the ankle (10.5%). Of all the injuries, the knee injuries accounted for the most severe cases (25%)[13]. The majority of the injuries occurred during the second half (69%) of the game.[10].

Targett (1998)[5] reported that the prevalence of injuries to the forward players amounted to 64% of the total injuries, compared to the 36% incurred by the backline players. Noakes *et al.* (1998)[25], also reported a greater occurrence of injuries in the forward players (52%) compared to the backline players (48%). A further study by, Bathgate *et al.* (2002)[10] showed that 57% of the injuries occurred in the forward players, whilst only 43% of injuries occurred in the backline players.

In an epidemiological study Brooks *et al*.[7], amongst English professional rugby players it was found that among 502 players from 11 Premiership clubs, 17 injuries per 1000 playing hours and 6.1 of the total injuries during training. The most common injuries found amongst the backline players were the hamstring, calf, hip flexor and adductor (3.4%-9.6%) muscle injuries. The majority of these injuries amongst the backline were experienced whilst running. The hamstring muscles, ankle ligaments, lumbar disc and nerve root injuries (2.0%-9.6%) were found to be the most common injuries amongst the forward players[17].

Best *et al.* (2005)[6], performed an injury surveillance of the 20 teams taking part in the 2003 RWC. In total, there were 3.7 training injuries per 1000 hours and 83.9 injuries per 1000 match hours. Of these injuries, the forward players incurred 84 injuries per 1000 hours and the backline players 83.7 injuries per 1000 hours. Lower limb injuries were the main site of injuries, particularly those involving ankle and knee ligament damage. The main cause of these injuries was by the tackle[6].

Fuller *et al.* (2008)[8] reported during the 2007 RWC season, that on average there were 83.9 injuries per 1000 hours with the majority being lower limb (muscle and ligament) injuries. In another study, during the Super 14 Rugby Tournament there were 96.3 injuries per 1000 hours with the ankle (8.7%), knee (5.4%) and hamstring (4.7%) strains being the most commonly occurring injuries; with (lower limb) muscle and tendon, joint and ligament injuries (18.8%-27.8%) just as common. All these injuries were predominantly caused by the tackle[1,8].

The forward players three main injured areas were the shoulder, knee and ankle joints (46%)[24]. Amongst the backline players the knee, hamstring and shoulder (54%) were the most commonly injured sites. This study highlighted the difference in injuries amongst forwards and backline players.

Muscle and tendon injuries are found to be the most common type of training injury, specifically among the forward players[24]. This may be due to the training specificity in which larger training adaptations and training load occur; therefore the physiological demand is greater than that of the backline players[78]. It would therefore be expected that the type of injury, severity, nature and site of injury that a forward player is more prone to, differs from that of a backline player[24].

2.9.2 KNEE INJURIES

Several studies showed that knee injuries are the most severe site of injury (20%)[10] with an average of ten knee injuries per season[42]. Knee injuries are found in most studies to be the second most commonly occurring injury amongst backline players, ranging from 4.1% - 29% of the total injuries[42]. In 2005, 546 English Rugby Union players were assessed and it was reported that knee injuries were the most commonly occurring (21%) and severe type of injury, especially ACL (29%) and MCL (25%) injuries, specifically amongst the backline players[42]. The most common mechanism of injury was during the contact phase of the game, and the majority occurred during the final 20 minutes of the game[39].

During a six year study (1991-1997) in Argentina, the most commonly occurring injuries were muscle strains in the lower limb, predominantly found at the site of the knee[27]. These injuries most commonly occurred during the second half of the games. The total knee injuries found during the Super 12 competition[2], was 12.9% of the total injuries reported, with tackling being the main cause (40%) of these injuries. The majority of knee injuries in this study occurred in the final 20 minutes of the game[2]. Five percent of a rugby squad are absent from training due to a knee injury, every year[30,42]. ACL re-injury rates ranged from 2.3% to 13%, and re-occurring injuries were generally more severe (27 days lost) than new injuries (16 days)[42,50]. Brookes *et al* (2005 and 2010)[7,24] showed that knee injuries had on average 20 days lost. They specifically reported that ACL injuries had an average of 235 days lost and knee cartilage/degenerative injury with an average of 155 days lost[7].

There may be other associated causes or risks (intrinsic factors) involved that are associated with players being more prone to knee injuries or re-injury. These factors can relate to the athlete's age, gender, body composition, health & fitness levels, anatomy and skill level (Diagram 2).

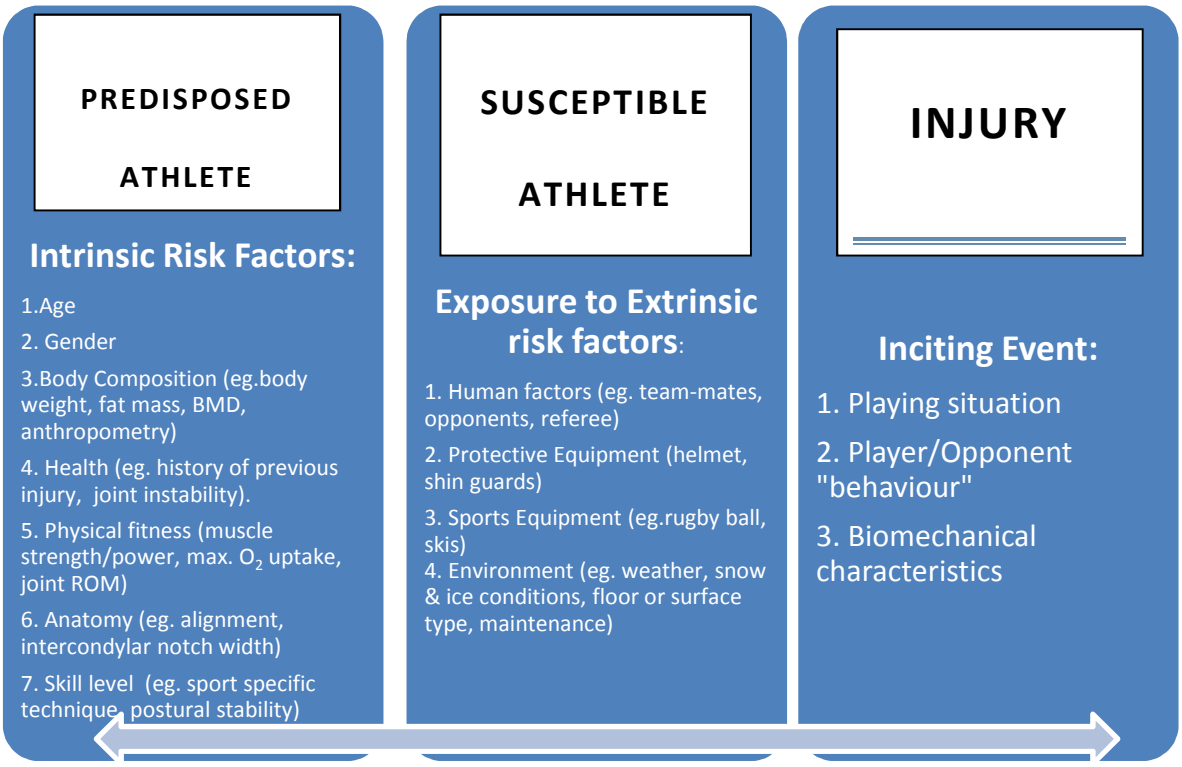

Diagram 2: A model of injury causation, adapted. (Meeuwisse, 1994; Bahr & Krosshaug, 2005)[55]

Rugby requires players to be able to change their direction and speed of running continuously, often while trying to avoid a collision, therefore players who participate in collisions or vigorously pivoting movement sports are more susceptible to anterior cruciate ligament (ACL) injuries[42]. Bathgate *et al.* (2002)[10], amongst elite Australian rugby players, knee injuries compromised of 25% of the total injuries (from 1994 to 2000). Dallalana *et al.* (2007)[42], showed that 70% of all ACL injuries in rugby also incur damage to the meniscus. Knee injuries have a larger impact upon the game of rugby than any other injury, as ACL and medial collateral ligament (MCL) injuries result in the longest period of absence from training or match play[7,36]. Therefore, knee injuries are reported as the most severe types of injuries. The most common cause of knee injuries is from a tackle particularly when the player is contacted from the front or side[28]. Dallalana *et al.* (2007)[42] studied 546 professional rugby players in England and compared the number of days that players who encountered a knee injury missed training compared to other injuries[14]. The total number of days absent due to a knee injury on average was eight months to two years compared to 37 days for other injuries. The majority of these knee injuries were found amongst backline players and as the result of being tackled, of which only 16% of these occurred during training[7,40].

2.10 Possible causes of other commonly occurring injuries

The mechanisms relating to the root cause of injuries are commonly known as, according to the consensus statement and IRB injury form (Addendum D): while accelerating or decelerating, lunge, sidestep, slipped, twisted, scrum engagement, collapsed or popped scrum, tackling or being tackled, bitten, collision, elbowed, gouged, head butt, kneed, punched, rucked, cleaned or cleaning, not supported, jumping, landing and other[12]. The most common of these mechanisms pertaining to injuries are related to the tackle, both being tackled and tackling alike[28]. This might be due to the game of rugby's multiple contact phases that occur, however, other injury mechanisms cannot be over-looked[39].

These other mechanisms are often associated with over-training, overuse or re-occurring injuries, collisions, falling, slipping or tripping as well as the shortened off-season periods, together with increased training hours and lengthened in-season periods which all lead to greater fatigue levels[2,48]. Fatigue leads to poor skills and decision making which puts players at risk of acquiring an injury[48].

Forward players have a higher tackling injury rate (56.3%) both from tackling and being tackled, compared to backline players (43.7%)[28,39]. Thus, the forward players incur more injuries (46%-64%) compared to the backline players (36%-54%), due to being involved in more phases of the game[5,7]. Forward players, who are usually more robustly built, produce greater forces that largely impact the soft tissue and joints of other players, or the player themselves which too contribute to the high risk of injuries, especially head injuries[24].

Since rugby rules have changed[14], and the game is now considered a more running game, the injury rates of backline players' (47-74 injuries per 1000 hours in 4 years)[14] have increased, and the amount of collisions by the forward players had decreased[39]. According to Garraway et al (1999)[28] of these injuries, 46% occur as a result of being tackled, whilst in a running motion or as a sudden change in direction occurs[28].

2.11 Rationale and Motivation

Injury prevention models aims to increase safer participation and lower the risk of injuries. Literature shows that injuries (70%) most often occur during the second part of each half of a rugby match[10]. The highest injury rates occur during the last part of the in-season (55.3%) and predominantly more during matches (88%) than in training (12%)[10]. This can be linked to fatigue or the increase in continuous micro traumas that may lead to a major injury[60]. This indicates the importance of aerobic fitness levels, muscle endurance and strength levels and the implementation of efficient recovery strategies[64]. Integration of the injury prevention model of van Mechelen *et al*. (1992)[76] will assist in increasing player participation and attendance rates, and thus increase performance while decreasing the number of injuries experienced every season.

Currently research indicates that the backline players' most injured anatomical site is the knee[42]. Another risk factor pertaining particularly to knee injuries and specifically, to the physical component of a rugby player is knee proprioception or ligamentous laxity[61]. This compromises complete knee functioning which is needed amongst backline players in their playing style[61]. Another cause together with these could be the imbalance of strength ratios between the quadriceps and hamstring muscle groups, which increase players risk for injury; as seen in a study done on Gaelic footballers[33,42].

Environmental conditions and bad playing surfaces create a greater injury risk for all players[22]. For example, head and neck injuries are increased during play on wet surfaces[22]. Lee and Garraway (1999)[28] did a study that showed a linear relationship in the increase of injuries on hard pitches, specifically relating to the start of the season.

This could be due to the decrease in pre-season training on the hard surfaces or their efficiency upon the surface[60,76]. On hard surfaces the risk of injury amongst all sport codes, is greater due to larger external ground reaction forces that impact the body directly, especially with a fall or tackle to the ground[76]. On hard surfaces the increase in injuries can be due to the increase in running speeds compared to speeds on wet surfaces, which may result in injuries pertaining to greater traction experienced[22,76]. Training or match-play on hard surfaces particularly increases the risk of strains and sprains[22]. Ground conditions together with weather-related factors affect the risk of injury amongst athletes, especially if the maintenance of the surface is poor[22].

There is an increase in strains and sprains pertaining to tendons and ligaments[44]; therefore, well-planned warm-ups and cool-downs are essential especially in cold conditions to reduce the risk of injury[22]. There is an association between increased fatigue levels during hot weather which may contribute to the increased risk of injury[60]. Players seem to fatigue quicker in warmer conditions, especially when there is a lack of hydration and recovery periods within the game[22].

Due to continuous play in a fatigued state, the player's ability to make good decisions on the field declines which increases their vulnerability of an injury[22]. Interestingly, the increase in wind has shown to have a decreased risk of injury due to the increase in kicking and back play within a game, thus the amount of tackles that are made are less[22]. However, an inadequate number of studies have been done to prove that playing surfaces or weather conditions influence the increased risk of injury significantly[22,28].

Injury prevention and management protocols as described by Finch[68] as well as by Engebretsen and Bahr[55], during competition or training sessions, is the first step to a successful injury prevention programs. The protocol establishes the extent of the injury first (incidence and severity); then establishes the etiology and mechanism; followed by introducing a preventive plan and then assessing the plans effectiveness by re-assessing the extent of the injury. This model is adopted in order to make the game of rugby safer for all participants[55].

Identifying the above factors within this study will assist coaches, medical support teams and athletes alter training patterns and prehabiliation programs to lower the risk of injuries[68]. The points above suggest the significance of epidemiological data, as there is evidence that injury prevention programs and rule changes have been successful in decreasing the number of catastrophic injuries in rugby football union (MacQueen & Dexter, 2010)[73].

CHAPTER 3

METHODS

3.1 Study Design

This retrospective study analyzed epidemiological data collected and analyzed from the 2011 VC Rugby competition. The study further described injury prevalence and incidence during matches and training of the 2011 VC rugby competition.

3.2 Setting (Site of Study)

The 2011 VC took place at eight University venues in South Africa, namely the University of Cape Town (cape town), Stellenbosch University (Stellenbosch), University of Pretoria and the Tshwane University of Technology (Pretoria), University of Johannesburg (Johannesburg), Free State University (Bloemfontein), North-West University (Potchefstroom) and Nelson Mandela Metropolitan University (Port Elizabeth). Each team played their matches either at home or away, depending on the draw of the competition.

All data was collected at the venue each team played at. The VC round robin began in February 2011 where games were played every Monday night over a seven to nine week period. The play-offs of the top four teams followed for two more weeks, where the teams played for home ground semi-final and final games.

3.3 Study Population and Sampling

All participants were male students across all races, between the ages of 18 and 25 years (22.2 ± 1.2 years). Each squad consisted of approximately 20 to 30 players, in which 23 were chosen each week to partake in the match-day, with a final 15-man starting line-up. All members of the squad were included in the study.

3.4 INCLUSION AND EXCLUSION CRITERIA

All rugby players were males between the ages of 18 and 25 years old, who took part in the 2011 VC. The majority of the players were students of one of the eight Universities that took part in the rugby tournament. The only exclusion criterion was if the player did not comply with the VC competition rules, such as being over the age of 25 years[23,45].

3.5 Testing procedures

3.5.1 DATA COLLECTION

Each player received an information leaflet detailing the study (refer to Addendum A). On commencement of the study, permission was obtained from the governing body of South African Rugby, SA Rugby (Addendum B) to utilize the routinely collected and available data from each University. Prior to participation in the study each subject was required to complete an informed consent form (Addendum C) where they were informed that their participation was voluntary and that they were able to withdraw from the study at any time.

All injuries sustained during the tournament were recorded on the IRB injury surveillance form by each of the Universities' medical support team (refer to Addendum D) and captured and saved on MS Office 2010 Excel spreadsheet by the researcher. The injury surveillance form used in the study was verbally explained to the subjects by their own medical support team. Each medical team member recording injury data received reminders regarding data collection and submission dates *via* phone calls and emails by the researcher. The first submission of injury records followed at the end of the pre-season and again at the completion of the tournament.

Each team followed a different schedule in terms of training and recovery sessions within the in-season. This information was recorded on a training data sheet, completed by the training staff (refer to Addendum E).

In this study, the data collection procedure and injury definitions were aligned with respective consensus statements for rugby injuries[12]. According to Fuller *et al.* (2007)[12] an injury was classified as any condition that prevented full training or match participation, or as a result the athlete required specific medical treatment. First episode, and re-occurring injuries were recorded according to the guidelines in the IRB injury surveillance form. The type, site and mechanism of the injury were recorded together with phase of the match or training it occurred in, as well as what part of the season in which the injury occurred. Each team's training loads, volumes and types of training were recorded. Each team's medical support staff completed a questionnaire reporting the different conditioning programs, pre-season physical assessment results, training volume, recovery time and any injury prevention strategies that they had implemented (Addendum E).

3.5.2 CALCULATION OF INJURY RATES

Injury rates are expressed as the number of injuries sustained per 1000 hours a player is at risk[12]. Match injuries rates were formulated according to the described methods by Best *et al.* (2005)[25] with the knowledge that at this level of play games last on average 80 minutes, with 15 players on the field at any given time. According to Brooks & Fuller (2006)[57], training injuries are calculated according to the total training exposure time. Therefore, the match and training injury rates are multiplied by the amount of games or training hours over a season. The following formulae were used to calculate the injury rates[12,48]:

1. Match injury exposure (MIE) was calculated as followed: hours per game (1.33) x number of players (15) x number of matches played.
2. Match injury rates was calculated by dividing the number of injuries during matches by the match injury exposure (MIE) and then multiplying it by a 1000.
3. Training injury exposure (TIE) was calculated by multiplying the hours of field training by the number of players in squad (23-30).
4. Training injury rates were calculated as: (number of training injuries / TIE) x 1000.
5. The total injury rates are calculated as: [total number of injuries / (MIE+TIE)] x 1000.

3.6 STATISTICAL ANALYSIS

The Statistica 12 software programme (Statsoft, USA) was used to determine means and standard deviations and 95% confidence intervals (95% CI). Descriptive statistics were used to report the prevalence and incidence of all injuries during the tournament. These were expressed as means and standard deviations. The Mann-Whitney u-tests were used to determine the means and medians for the differences in injury prevalence, incidence and rates between the forward and backline players. Contingency tables with Pearson chi-squared tests were used to determine the association between two categorical variables, being training loads, types of injuries and injury rates across the 2011 FNB VC teams were determined. A significance level of $p<0.05$ was accepted.

3.7 ETHICAL CONSIDERATIONS

This study was approved by the Human Ethics Research Committee of the University of the Witwatersrand (Addendum F). All subjects were informed about the procedures of the research study and that participation is voluntary. All participants as well as the medical support staff of each University (Addendum G) signed an informed consent form prior to the study. There were no risks or immediate benefits involved in the participation of this study for any of the athletes. All athletes involved in this study as well as the identity of each team remained completely confidential.

CHAPTER 4

RESULTS

4. INTRODUCTION

Seven out of the eight teams participating in the 2011 FNB VC were able to submit injury and training statistics. According to the data collected, there were 178 (6.1 injuries per 1000 hours) injuries in total reported throughout the season. Sixty one pre-season injuries were found (2.1 per 1000 hours) compared to 117 (4.0 per 1000 hours) in-season injuries reported. Overall, there were 125 match injuries (89 per 1000 hours) and 52 training injuries (1.58 per 1000 hours), of which both showed statistically significant increased injury rates ($p = 0.039$). The number of new injuries was higher than recurrent episodes. The total number of new injuries were 120 (4.1 per 1000 hours) with only 52 (2.0 per 1000 hours) recurrent. The tackle was responsible for the cause of the majority of the injuries (19.1 per 1000 hours) amongst the forwards and backline players. The prevalence of the injuries was the highest in the last 20 minutes of the first half and the last 20 minutes of the second half (26.7% and 30.7%).

4.1 SECTION A: INJURY OCCURRENCE

4.1.1 DEMOGRAPHIC INFORMATION

One hundred and sixty eight players (forwards: 91; backs: 77) consented to take part in this study (on average 24 players per squad/teams). The average age of the total number of players was 22.2 ± 1.2 years old; with an average height measurement of 1.9 ± 0.1 meters (m) (forwards: 1.88 ± 0.52m; backs: 1.80 ± 0.11m) and an average weight of 103 ± 14.1 kilograms (kg) for the entire 2011 VC group (forwards: 110.52 ± 9.44kg; backs: 86.52 ± 5.6kg). Forwards were significantly taller and heavier than the backs ($p < 0.001$).

4.1.2 INCIDENCE AND OVERALL EXPOSURE

All teams except one submitted match and training exposure and injury report forms. One hundred and seventy-eight injuries were found during the tournament period, of which 125 occurred during matches (forwards: 62; backs: 36; unknown: 27) and 53 occurred during training (forwards: 28; backs: 16; unknown: 9). Furthermore, of the total injuries recorded, 58 were recurrent injuries (forwards: 50; backs: 34) and 120 (forwards: 40; backs: 17; unknown: 37) were first episode injuries.

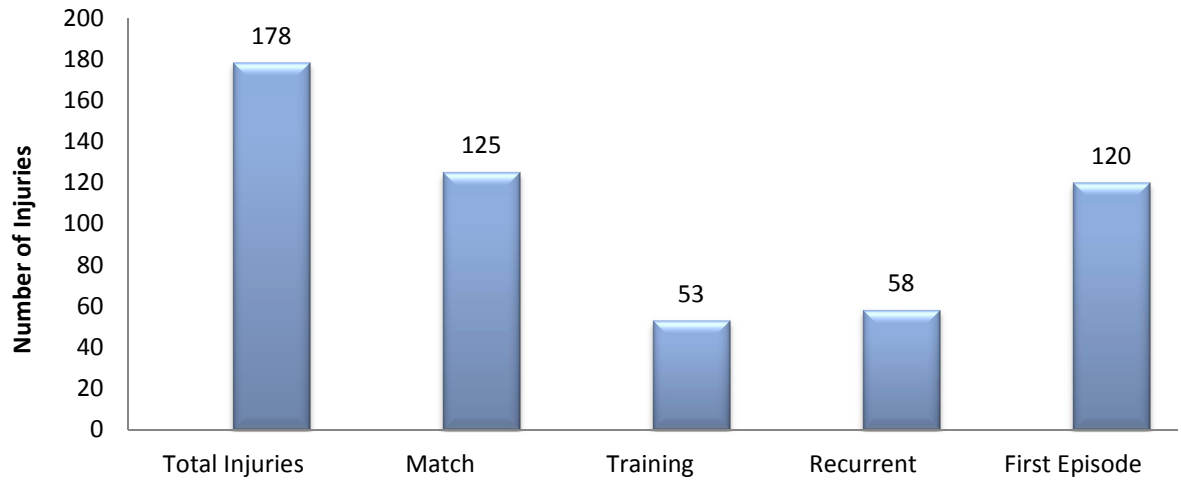

Figure 1 Incidence and overall exposure of injuries during the FNB Varsity cup

As seen in Figure 1, a total of 178 total injuries were recorded over the tournament period (Match: 125, Training: 53). Additionally, as seen in Table 1, there was an accumulation of 1100 player-match hours over the competition period, which equated to a statistically significant incidence rate ($p = 0.039$) of 89.1 injuries/1000 player-hours (95% CI: 93.6 to 133.6). There was a total of 27 888 player-training hours recorded throughout the tournament, with 1.6 (95% CI: 1.4 to 2.4) injuries/1000 player-hours ($p = 0.2071$). The majority of these injuries were first time injuries (67.4%), with some recurrent injuries (35.6%) and no catastrophic injuries.

Table 1. Incidence of pre-season and in-season injuries throughout the tournament.

Match Injuries	Incidence, injuries/1000 player-hours (95% CI)
All Players	89.1 (93.6 - 133.6)
Forwards	105.7 (79.4 -132)
Backline players	70.1 (47.2 - 93)
Unspecified positions	24.5 (71.4 - 106.6)
Match (MIE): Hours' exposure	1100
P-value (MIE)	0.039*
Training Injuries	Incidence, injuries/1000 player-hours (95% CI)
All Players	1.6 (1.4 - 2.4)
All Forwards	1.9 (1.2 - 2.5)
All Backlines players	1.3 (0.6 - 1.9)
Unspecified positions	0.3 (0.1 - 0.5)
Training (TIE): Hours' exposure	27888
P-value (TIE)	0.2071

* statistically significant $p = < 0.001$

Table 2 summarizes the prevalence of pre- and in-season injuries. In total there were 61 (2.0 per 1000 hours) pre-season injuries, and 117 (106.3 per 1000 hours) in-season injuries. The forward players' sustained 34 (2.3 per 1000 hours) pre-season injuries and 56 (95.4 injuries per 1000 hours) in-season injuries, compared to the backline players who sustained only 21 (1.6 per 1000 hours) pre-season injuries and 31 (60.4 per 1000 hours) in-season injuries. There were 36 injuries with unspecified positions, of which 6 (0.2 per 1000 hours) were during the pre-season and 30 (27.3 per 1000 hours) during the in-season.

Table 2. Prevalence of Pre-season and In-season injuries amongst forwards, backline and unspecified position players.

Incidence, per 1000/hours (95% CI)		Forwards	Backline	Unspecified positions
Pre-Season	2.0 (1.6 - 2.7)	2.3 (1.49 - 3.01)	1.6 (0.94 - 2.35)	0.2 (0.3 - 0.4)
In-Season	106.3 (87.1 - 125.6)	95.4 (70.5 - 120.5)	60.4 (39.1 - 81.7)	27.3 (17.5 - 37.0)
Total Injuries	**178**	**90 (50.6%)**	**52 (23.6%)**	**36. (20.2%)**

4.1.3 INCIDENCE AND NATURE OF INJURY

All teams submitted match, as well as training injury report forms. Each team trained on average for eight weeks before the onset of the tournament began in 2011. This equated to 27 888 player-trainer hours (forwards: 15 106; backline: 12 782). At the onset of the tournament, there were seven matches played per team with an extra game or two for the semi-final and final teams. This equated to 1100 player-match hours per team (forwards: 586.7; backs: 513.3).

The injuries are grouped into four main locations being the; 1) head and neck, 2) trunk, 3) upper limb and 4) lower limb. An overview of the injury distribution according to their anatomical location is provided in Table 3.1 and 3.2. During the 2011 FNB VC, premier division, the lower limb (97.5%) showed trends; being the most commonly injured location, followed by the head/neck (34.2%) and upper limb (33.2%) anatomical sites. Lower limb injuries were common amongst forward (71.2%) and backline players (48.9%). There were only trends observed in cases where a large number of head injuries were recorded amongst the forward players (18.9%) compared to the backline players (11.5%).

Table 3.1: Match injuries per grouped anatomical location.

	Match injuries Incidence, Injuries / 1000 hours (95% CI)			
Body Part Injured	**All injuries**	**Forwards**	**Backline**	**Unspecified positions**
1. Head/Neck	24.5 (15.3 - 33.8)	9.1 (3.5 - 14.7)	2.7 (-0.4 - 5.8)	9.1 (3.5 - 14.7)
2. Upper limb	24.5 (15.3 - 33.8)	2.7 (-0.4 - 5.8)	5.5 (1.1 - 9.8)	2.7 (-0.4 - 5.8)
3. Trunk	1.8 (-0.7 - 4.3)	1.8 (-0.7 - 4.3)	0.0 (-)	0.0 (-)
4. Lower Limb	50 (36.8 - 63.2)	25.5 (16.0 - 34.9)	11.8 (5.4 - 18.2)	12.7 (6.1 - 19.4)
TOTAL	**n=125**	**n=62**	**n=22**	**n=27**

Table 3.2: Training injuries per grouped anatomical location.

Training injuries Incidence, Injuries / 1000 hours (95% CI)				
Body Part Injured	**All injuries**	**Forwards**	**Backline**	**Unspecified positions**
1. Head/Neck	0.6 (0.3, 0.9)	0.9 (0.4, 1.3)	0.0 (-)	0.1 (0.0, 0.2)
2. Upper Limb	0.3 (0.1, 0.5)	0.2 (0.0, 0.4)	0.0 (-)	0.2 (0.0, 0.3)
3. Trunk	0.2 (0.0, 0.4)	0.3 (0.0, 0.3)	0.0 (-)	0.1 (0.0, 0.2)
4. Lower Limb	0.0 (0.6, 1.4)	1.1 (0.5, 1.6)	0.8 (0.3, 1.3)	0.1 (0.0, 0.2)
TOTAL	**n=53**	**n=28**	**n=16**	**n=9**

Table 4: Incidence of match injuries per individual anatomical sites.

Injury Location		Match Injuries Incidence, injuries/1000 player-hours (95% CI)			
Main group	**Sub-group**	**All players**	**Forwards**	**Backs**	**Unspecified positions**
Head/Neck	All injuries	24.5 (15.3, 33.8)	12.7 (6.1, 19.4)	2.7(-0.4, 5.8)	9.1 (3.5, 14.7)
	Head	20.9 (12.4, 29.5)	18.7 (7.7, 29.8)	5.8 (-0.8, 12.5)	8.2 (2.8, 13.5)
	Neck / cervical spine	3.6 (0.1, 7.2)	5.1 (-0.7, 10.9)	0.0 (-)	0.9 (-0.9, 2.7)
Upper limb	All injuries	24.5 (15.3, 33.8)	16.4 (8.8, 23.9)	5.5 (1.1, 9.8)	2.7 (-0.4, 5.8)
	Shoulder	18.2 (10.2, 26.2)	23.9 (11.4, 36.4)	7.8 (0.2, 15.4)	1.8 (-0.7, 4.3)
	Upper arm	0.9 (-0.9, 2.7)	1.7 (-1.6, 5.0)	0.0 (-)	0.0 (-)
	hand/wrist	5.5 (1.1, 9.8)	5.1(-0.7, 10.9)	3.9 (-1.5, 9.3)	0.9 (-0.9, 2.7)
Trunk	All injuries	1.8 (-0.7, 4.3)	1.8 (-0.7, 4.3)	0.0 (-)	0.0 (-)
	lower back	1.8 (-0.7, 4.3)	3.4 (-1.3, 8.1)	0.0 (-)	0.0 (-)
Lower Limb	All injuries	50 (36.8, 63.2)	25.5 (16, 34.9)	11.8 (5.4, 18.2)	12.7 (3.5, 14.7)
	hip /pelvis	3.6 (0.1, 7.2)	3.4 (-1.3, 8.1)	3.9 (-1.5, 9.3)	0.0 (-)
	Hamstring	9.1 (3.5, 14.7)	3.4 (-1.3, 8.1)	11.7 (-1.6, 9.4)	1.8 (1.2, 9.8)
	Quadriceps	10 (4.1, 15.9)	8.5 (1.1, 16)	0.0 (-)	5.5 (1.1, 9.8)
	Knee	11.8 (5.4, 18.2)	17.0 (6.5, 27.6)	5.8 (-0.8, 12.5)	0.0 (-)
	lower leg	0.9 (-0.9, 2.7)	1.7 (-1.6, 5.0)	0.0 (-)	0.0 (-)
	ankle/foot	11.8 (5.4, 18.2)	11.9 (3.1, 20.8)	1.9 (-1.9, 5.8)	4.5 (0.6, 8.5)
	Toe	2.7 (-0.4, 5.8)	1.7 (-1.6, 5.0)	0.0 (-)	0.9 (-0.9, 2.7)
Injury location not identified		12.7 (6.1, 19.4)	0.0 (-)	27.3 (13, 41.6)	0.0 (-)
All injury locations		113.6 (93.7, 133.6)	56.4 (42.3, 70.4)	20 (11.6, 28.4)	24.5 (15.3, 33.8)

Table 4, illustrates more specifically, the injured individual anatomical locations with statistical trends. During matches, the head was the most commonly injured site, with an injury rate of 20.9 per 1000 hours (95% CI: 12.4 to 29.5) for all players. Of these, head injuries, concussions and lacerations injuries were mostly common trends. The forwards were more at risk of these head injuries (forwards: 18.7, backs: 5.8). The shoulder was the second most commonly injured site, with 18.2 injuries per 1000 hours (95% CI: 10.2 to 26.2) with forwards having an injury rate of 23.9 and the backline 7.8 injuries per 1000 hours.

Ranked third, knee and ankle/foot injuries were also a commonly occurring trend, with 11.8 injuries per 1000 hours. The forwards accounted for 17.0 knee injuries per 1000 hours and the backline only 5.8, whereas with the ankle/foot injuries; the forwards had 11.9 injuries compared to the backline 1.9 injuries per 1000 hours. There was also a large amount of hamstring and quadriceps injuries, 10 (95% CI: 3.5 to 14.7) and 9.1 injuries per 1000 hours (95% CI: 4.1 to 15.9) respectively. The backline had much higher hamstring injuries (11.7 per 1000 hours) compared to the forwards (3.4 per 1000 hours).

There were 23.9 shoulder injuries per 1000 hours (95% CI: 11.4 to 36.4) and 18.7 head injuries (95% CI: 7.7 to 29.8) which accounts for the most commonly injured site amongst the forwards. There were also 17.0 knee injuries (95% CI: 6.5 to 27.6) and 11.9 ankle/foot injuries per 1000 hours (95% CI: 3.1 to 20.8) amongst the forwards. Amongst the backline players, the hamstring accounted for 11.7 injuries (95% CI: -1.6 to 9.4) and 7.8 shoulder injuries per 1000 hours (95% CI: 0.2 to 5.4). These accounted for the most common sites of injuries experienced by the backline. The knee and the head had 5.8 injuries per 1000 hours (95% CI: -0.8 to 12.5), which accounted for the second most commonly injured sites. Although none of the above was statistically significant, however was observed as trends.

Table 5: Training injury prevalence by anatomical location and different playing positions.

Injury Location		Training Injuries		
		Incidence, injuries/1000 player-hours (95% CI)		
Main group	**Sub-group**	**All players**	**Forwards**	**Backs**
Head/Neck	All injuries	0.6 (0.3, 0.9)	0.9 (0.4, 1.3)	0.0 (-)
	Head	0.1 (0.0, 0.2)	0.1 (-0.1, 0,3)	0.0 (-)
	Neck / cervical spine	0.1 (0.0., 0.3)	0.2 (0.0, 0.4)	0.0 (-)
Upper limb	All injuries	0.3 (0.1, 0.5)	0.2 (0.0, 0.4)	0.0 (-)
	Shoulder	0.0 (-)	0.0 (-)	0.0 (-)
	Forearm	0.2 (0.0., 0.4)	0.1 (-0.1, 0.2)	0.0 (-)
	hand/wrist	0.1 (0.0, 0.2)	0.1 (-0.1, 0.3)	0.0 (-)
Trunk	All injuries	0.2 (0.0, 0.4)	0.3 (0.0, 0.3)	0.0 (-)
	lower back	0.1 (0.0, 0.3)	0.3 (0.0, 0.5)	0.0 (-)
	sacrum/SIJ	0.0. (0.0, 0.1)	0.0 (-)	0.0 (-)
Lower Limb	All injuries	0.0 (0.6, 1.4)	1.1 (0.5, 1.6)	0.8 (0.3, 1.3)
	hip /pelvis	0.1 (0.0, 0.3)	0.1 (-0.1,0.3)	0.1 (-0.1, 0.2)
	Hamstring	0.2 (0.0, 0.3)	0.1 (-0.1,0.3)	0.2 (0.0, 0.5)
	Quadriceps	0.1 (0.0, 0.2)	0.1 (-0.1,0.3)	0.1 (-0.1, 0.2)
	Knee	0.0 (0.0, 0.1)	0.1 (-0.1, 0.2)	0.0 (-)
	lower leg	0.0 (-)	0.0 (-)	0.0 (-)
	ankle/foot	0.4 (0.2, 0.7)	0.4 (0.1, 0.7)	0.4 (0.0, 0.7)
	Toe	0.1 (0.0, 0.2)	0.2 (0.0, 0.4)	0.0 (-)
Injury location not identified			0.2 (0.0, 0.4)	0.5 (0.1, 0.8)
All injury locations			3.0 (2.4, 3.7)	1.3 (0.6, 1.9)

Table 5 & 6 illustrates how the prevalence of injuries fluctuated across the different playing positions. The forward players had higher injury rates in general compared to the backline players (forwards: 63.38%; backline: 36.62%). There was a common trend that the Locks (positions 4 & 5) were the most commonly injured positions with 37.5 injuries per 1000 hours (95% CI: 21.8 to 53.2). The props (positions 1 & 3), centres (12 &13) and flanks (7&8) had the second highest injury rates. Please refer to the tables below for the injuries / per 1000 player-hours.

Table 6: Incidence of injuries per playing position.

Playing Positions	Match Injuries	Training Injuries	Playing Positions	Match Injuries	Training Injuri
	Incidence, injuries/1000 hours(95% CI)			Incidence, injuries/1000 hours(95% CI)	
All Forwards	105.7 (79.4, 132.0)	1.9 (1.2, 2.5)	All Backline	70.1 (47.2, 93.0)	1.3 (0.6, 1.9)
Props	23.9 (11.4, 26.4)	0.7 (0.3, 1.1)	Scrumhalf	5.8 (-0.8, 12.5)	0.2 (-0.1, 0.4)
Hookers	15.3 (5.3, 25.4)	0.4 (0.1, 0.7)	Fly half	9.7 (1.2, 18.3)	0.2 (0.0, 0.5)
Locks	37.5 (21.8, 53.2)	0.3 (0.0, 0.6)	Centres	23.4 (10.2, 36.6)	0.3 (0.0, 0.6)
Flanks	22.2 (10.1, 34.2)	0.5 (0.1, 0.8)	Wings	17.5 (6.1, 29.0)	0.5 (0.1, 0.8)
Eight Man	6.8 (0.1, 13.5)	0.0 (-)	Fullback	13.6 (3.5, 23.7)	0.1 (-0.1, 0.2)
p Value	***0.399***	***0.799***			
(all forwards vs backs)					
All Players	89.1 (71.5, 106.7)	1.6 (1.1, 2.0)			

The majority of the forward and backline players injuries occurred during the in-season period (forward players: 21.8%, backline player: 39.4%) compared to the pre-season (forwards: 14.8%, backline: 23.9%). As collected on the IRB forms (refer to Addendum D), the forward players had 28.2% recurrent injuries whilst the backline players reported only 11.9%. The forwards had 35.2% first episode injuries and the backline players with 24.7%. Of these injuries, 36.5% indicated that the players continued with the game despite their injury. 44.5% indicated that they were forced to discontinue with the game due to the severity of the injury. The remaining injuries, which accounted for 14.6% indicated they discontinued play for precautionary reasons, and 4.4% discontinued for a short-period of time due to blood (blood-bin), as seen in figure 2.

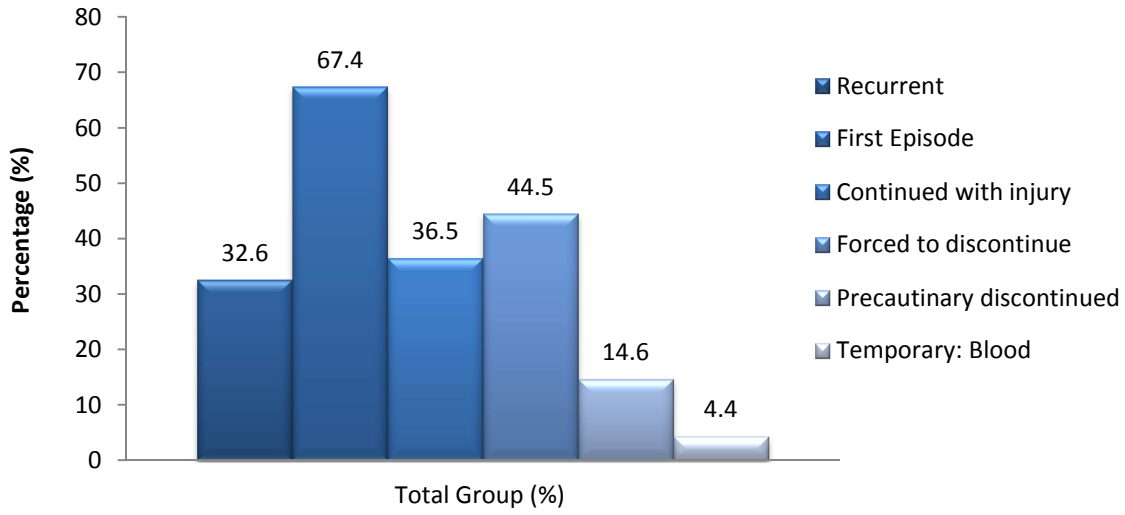

Figure 2: Type, and severity of injury occurrence amongst the 2011 FNB VC group.

4.1.4 PREVALENCE OF TYPES OF INJURIES

Figure 3 shows the types of injuries that occurred during the rugby tournament. These injuries are expressed as a percentage of the total number of injuries. Soft tissue injuries accounted for the majority of the injuries (47%), namely muscle strains (18.9%), sprains (18.3%) and contusions (10.9%). Concussions (9.1%) were a common injury type found amongst the 2011 FNB VC.

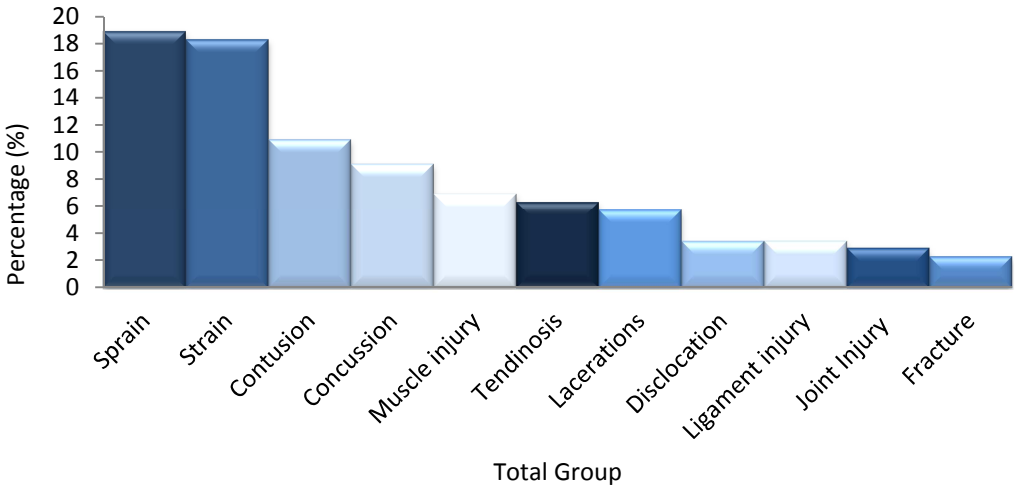

Figure 3: Type of Injuries amongst 2011 FNB VC group

After strains and sprains, concussions (4.6%) and contusions (4.6%) were another common type of injury amongst the forward and backline players; with tendinopathies (3.4%), and muscle injuries (2.9%) also a common type of injury amongst the backline players.

Table 7: Types of match injuries between the different playing positions.

Injury Type		Match Injuries			
		Incidence, injuries/1000 hours(95% CI)			
Main Group	**Sub Group**	**Forwards**	**Backline**	**Unspecified Positions**	**All Players**
Bone	Fracture	1.7 (-1.6, 5.0)	1.9 (-1.9, 5.8)	0.9 (-0.9, 2.7)	4.5 (2.8, 13.5)
Joint (non-bone) /	All injuries	30.7 (16.5, 44.9)	17.5 (7.5, 27.6)	8.2 (2.8, 13.5)	26.4 (8.4, 44.4)
Ligament	Dislocation	6.8 (0.1, 13.5)	0.0 (-)	1.8 (-0.7, 4.3)	9.1 (3.5, 14.7)
	Sprain	13.6 (4.2, 23.1)	11.7 (2.3, 21.0)	3.6 (0.1, 7.2)	18.2 (10.2, 26.2)
	Cartilage	1.7 (-1.6, 5.0)	0.0 (-)	0.0 (-)	1.7 (-1.6, 5.0)
	Ligament Injury	6.8 (0.1, 13.5)	3.9 (-1.5, 9.3)	0.0 (-)	5.5 (1.1, 9.8)
	Joint Injury	1.7 (-1.6, 5.0)	1.9 (-1.9, 5.8)	0.0 (-)	1.8 (-0.7, 4.3)
Muscle / Tendon	All Injuries	25.5 (30.0, 65.4)	18.2 (19.1, 49.0)	18.2 (31.0, 46.9)	60.9 (46.3, 75.5)
	Rupture	1.7 (-1.6, 5.0)	0.0 (-)	4.5 (0.6, 8.5)	4.5 (0.6, 8.5)
	Strain	11.9 (3.1, 20.8)	17.5 (6.1, 29.0)	10.0 (4.1, 15.9)	24.5 (15.3, 33.8)
	Tendinopathy	3.4 (-1.3, 8,1)	7.8 (0.2, 15.4)	0.0 (-)	5.5 (1.1, 9.8)
	Bursitis	5.1 (-0,7,10.9)	0.0 (-)	0.0 (-)	5.1 (-0,7,10.9)
	Impingement	1.7 (-1.6, 5.0)	1.9 (-1.9, 5.8)	0.0 (-)	1.8 (-0.7, 4.3)
	Contusion	13.6 (4.2, 23.1)	7.8 (0.2, 15.4)	3.6 (0.1, 7.2)	14.5 (7.4, 21.7)
	Muscle Injury	6.8 (0.1, 13.5)	3.9 (-1.5, 9.3)	0.0 (-)	7.3 (2.2, 12.3)
Skin	Laceration	5.1 (-0.7, 10.9)	3.9 (-1.5, 9.3)	0.0 (-)	4.5 (0.6, 8.5)
Brain	Concussion	13.6 (4.2, 23.1)	5.8 (-0.8, 12.5)	0.0 (-)	10.0 (7.7, 29.8)
Other		6.8 (0.1, 13.5)	1.9 (-1.9, 5.8)	0.0 (-)	4.5 (1.1, 16.0)
All injury types		105.7 (79.4, 132.0)	70.1 (47.2, 93.0)	24.5 (15.3, 33.8)	89.1 (71.5, 106.7)

Table 8: Types of training injuries between the different playing positions.

Injury Type		Training injuries			
		Incidence, injuries/1000 hours(95% CI)			
Main Group	**Sub Group**	**Forwards**	**Backline**	**Unspecified positions**	**All Players**
Bone	Fracture	1.7 (-1.6, 5.0)	1.7 (-1.6, 5.0)	0.0 (-)	3.4 (-1.3, 8.1)
Joint (non-	All injuries	0.7 (7.7, 29.8)	0.4 (1.1, 16.0)	0.0 (-)	0.6 (13.9, 40.6)
bone) /	Dislocation	0.1 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.1 (-1.6, 5.0)
Ligament	Sprain	0.6 (5.3, 25.4)	0.3 (0.1, 13.5)	0.0 (-)	0.9 (10.1, 34.2)
	Cartilage	0.0 (-)	0.0 (-)	0.2 (0.0, 0.4)	0.2 (0.0, 0.4)
	Ligament Injury	0.0 (-)	0.0 (-)	0.0 (-)	0.0 (-)
	Joint Injury	0.1 (-1.6, 5.0)	0.1 (-1.6, 5.0)	0.0 (-)	0.1 (-1.3, 8,1)
Muscle /	All Injuries	0.9 (-11.6, 13.4)	0.8 (-9.8, 11.3)	0.0 (-)	0.9 (24.5, 57.3)
Tendon	Rupture	0.1 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.1 (-1.6, 5.0)
	Strain	0.5 (3.1, 20.8)	0.3 (0.1, 13.5)	0.0 (-)	0.4 (-10.7, 11.5)
	Tendinopathy	0.3 (0.1, 13.5)	0.2 (-0.7, 10.9)	0.0 (-)	0.3 (-8.6, 9.1)
	Compartment Syndrome	0.1 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.1 (-1.6, 5.0)
	Impingement	0.1 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.1 (-1.6, 5.0)
	Contusion	0.0 (-)	0.0 (-)	0.0 (-)	0.0 (-)
	Muscle Injury	0.0 (-)	0.2 (-0.7, 10.9)	0.0 (-)	0.2 (-0.7, 10.9)
Skin	Laceration/abrasion	0.1 (-1.6, 5.0)	0.0 (-)	0.0 (0.0, 0.1)	0.1 (0.0, 0.2)
Brain	Concussion	0.0 (-)	0.0 (-)	0.1 (0.0, 0.2)	0.1 (0.0, 0.2)
	Neuropathy	0.1 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.1 (-1.6, 5.0)
Other	Unknown/Unsure	0.0 (-)	0.0 (-)	0.0 (-)	0.0 (-)
All injury types		1.9 (-15.8, 19.5)	1.3 (-12.1, 14.6)	15.3 (5.3, 25.4)	1.9 (-22.4, 26.2)

Tables 7 & 8 illustrate the trends according to the most common types of injuries experienced throughout the VC season; as well as the types of injuries more common amongst the forward and backline players, per 1000 hours.

Strains were the most common type of injury with 24.5 injuries per 1000 hours (95% CI: 15.3 to 33.8), closely followed by sprains with 18.2 injuries per 1000 hours (95% CI: 10.2 to 26.2). Contusions

were just as common with 14.5 injuries per 1000 hours (95% CI: 7.4 to 21.7) as well as concussions, 10.0 injuries per 1000 hours (95% CI: 7.7 to 29.8).

Strains and sprains were found to be the most common types of injuries experienced by both the forward (9.1% and 8.6% respectively) and backline (7.4% and 5.7% respectively) players during matches. The backline players had a slightly higher strain incidence trend rate, 17.5 injuries (95% CI: 6.1 to 29.0) compared to the forwards, 11.9 injuries per 1000 hours (95% CI: 3.1 to 20.8). The forwards had similar number of sprains, contusions and concussions, 13.6 injuries per 1000 hours (95% CI: 4.2 to 23.1) compared to the backline players. After the large amount of strains and sprains experienced by the backs, contusions and tendinopathies were the next most common type of injury trend that occurred. Contusions and tendinopathies had 7.8 injuries per 1000 hours (95% CI: 0.2 to 15.4).

4.1.5 MECHANISM OF INJURY

The tables 9 & 10 show the variations in the mechanisms responsible for the training and match injuries.

Table 9: Mechanism of match injuries between different playing positions.

Match Injuries	Forwards	Backline	Unspecified	All Players
Mechanism	Incidence, injuries/1000 hours (95% CI)			
Tackled	20.5 (8.9, 32.0)	13.6 (3.5, 23.7)	1.8 (-0.7, 4.3)	19.1 (10.9, 27.3)
Tackling	10.2 (2.0, 18.4)	5.8 (-0.8, 12.5)	6.4 (1.6, 11.1)	14.5 (7.4, 21.7)
Collision	20.5 (8.9, 32.0)	5.8 (-0.8, 12.5)	4.5 (0.6, 8.5)	18.2 (10.2, 26.2)
Rucked	8.5 (1.1, 16.0)	3.9 (-1.5, 9.3)	0.0 (-)	6.4 (1.6, 11.1)
Kicked	0.0 (-)	5.8 (-0.8, 12.5)	0.0 (-)	2.7 (-0.4, 5.8)
Cleaned	1.7 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.9 (-0.9, 2.7)
Other	1.7 (-1.6, 5.0)	1.9 (-1.9, 5.8)	0.9 (-0.9, 2.7)	2.7 (-0.4, 5.8)
Overuse	0.0 (-)	0.0 (-)	0.9 (-0.9, 2.7)	0.9 (-0.9, 2.7)
Sidestepping	0.0 (-)	1.9 (-1.9, 5.8)	1.8 (-0.7, 4.3)	2.7 (-0.4, 5.8)
Accelerating	1.7 (-1.6, 5.0)	5.8 (-0.8, 12.5)	0.0 (-)	3.6 (0.1, 7.2)
Decelerating	0.0 (-)	1.9 (-1.9, 5.8)	0.0 (-)	0.9 (-0.9, 2.7)
Twisting	1.7 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.9 (-0.9, 2.7)
Passing	0.0 (-)	1.9 (-1.9, 5.8)	0.0 (-)	0.9 (-0.9, 2.7)
Kicking	0.0 (-)	1.9 (-1.9, 5.8)	0.9 (-0.9, 2.7)	1.8 (-0.7, 4.3)
Unknown	35.8 (20.5, 51.1)	17.5 (6.1, 29.0)	7.3 (2.2, 12.3)	34.5 (23.6, 45.5)
Foul play	1.7 (-1.6, 5.0)	1.9 (-1.9, 5.8)	0.0 (-)	1.8 (-0.7, 4.3)
Jumping	1.7 (-1.6, 5.0)	0.0 (-)	0.0 (-)	0.9 (-0.9, 2.7)
All activities	**56.4 (42.3, 70.4)**	**70.1 (47.2, 93.0)**	**24.5 (15.3, 33.8)**	**113.6 (93.7, 133.6)**

Table 10: Mechanism of training injuries between different playing positions.

Training Injuries	Forwards	Backline	Unspecified	All Players
Mechanism	**Incidence, injuries/1000 hours (95% CI)**			
Tackled	0.0 (-)	0.1 (-0.1, 0.2)	0.0 (-)	0.0 (0.0, 0.1)
Collision	0.1 (-0.1, 0.3)	0.0 (-)	0.0 (0.0, 0.1)	0.1 (0.0, 0.2)
Rucked	0.1 (-0.1, 0.2)	0.0 (-)	0.0 (-)	0.0 (0.0, 0.1)
Cleaning	0.1 (-0.1, 0.2)	0.0 (-)	0.0 (-)	0.0 (0.0, 0.1)
Cleaned	0.1 (-0.1, 0.2)	0.0 (-)	0.0 (0.0, 0.1)	0.1 (0.0, 0.2)
Other	0.1 (-0.1, 0.2)	0.0 (-)	0.0 (0.0, 0.1)	0.1 (0.0, 0.2)
Overuse	0.2 (0.0, 0.4)	0.1 (-0.1, 0.2)	0.0 (-)	0.1 (0.0, 0.3)
Sidestepping	0.0 (-)	0.2 (-0.1, 0.3)	0.0 (-)	0.1 (0.0, 0.2)
Accelerating	0.1 (-0.1, 0.2)	0.5 (0.1, 0.9)	0.1 (0.1, 0.2)	0.4 (0.1, 0.6)
Twisting	0.0 (-)	0.0 (-)	0.1 (0.0, 0.3)	0.1 (0.0, 0.3)
Unknown	1.1 (0.6, 1.7)	0.3 (0.0, 0.6)	0.0 (-)	0.8 (0.4, 1.1)
Slipped	0.0 (-)	0.1 (-0.1, 0.2)	0.0 (-)	0.0 (0.0, 0.1)
All activities	1.8 (1.1, 2.5)	1.3 (0.4, 1.7)	0.3 (0.1, 0.5)	1.9 (1.4, 2.4)

The most common cause of all injuries occurred during collisions and whilst being tackled with 19.1 injuries per 1000 hours (48.13%). According to Table 9, most injuries (22.8%) amongst the forwards occurred during tackles (30.7 per 1000 hours) and collisions (20.5 per 1000 hours). The backline players suffered just as many tackle injuries with 19.4 injuries per 1000 hours (33.3%). Tackling (5.8 per 1000 hours) and while being rucked (3.9 per 1000 hours) was just as dangerous amongst the forward players (4.4%), accounting for a great sum of the injuries. The mechanisms causing injuries amongst backline players vary in-style compared to the forward players. The second most common causal trend amongst backline players (8.3 %) however, was during collisions (5.8 per 1000 hours), while accelerating (5.8 per 1000 hours) and kicking (5.8 per 1000 hours). Over-use injuries were a minimal trend amongst all the players (2.9%) throughout the 2011 FNB VC period with 0.9 injuries per 1000 hours.

Overall tackle injuries accounted for the vast majority of the injuries, with 19.1 injuries per 1000 hours (95 % CI: 10.9 to 27.3), similarly collisions were responsible for 18.2 injuries per 1000 hours (95% CI: 10.2 to 26.2). Tackling injuries were too a common trend, with 14.5 injuries per 1000 hours (95% CI: 7.4 to 21.7). There were a great deal of injuries with an unknown mechanism source, this accounted for 34.5 injuries per 1000 hours (95% CI: 23.6 to 45.4).

Similar to the overall results, the forwards and backline had the largest number of injuries as a result of being tackled, 20.5 injuries (95% CI: 8.9 to 32) and 13.6 injuries per 1000 hours (95% CI: 3.5 to 23.7) respectively. The forwards however, had equally high frequencies of collision injuries, 20.5 injuries per 1000 hours (95% CI: 8.9 to 32) with more tackling, 10.2 injuries (95% CI: 2.0 to 18.4) and rucking injuries, 8.5 injuries per 1000 hours (1.1 to 16.0). The backline players however differed, with equal amounts of tackling, collision, kicking and accelerating injuries, 5.8 injuries per 1000 hours (95% CI: -0.8 to 12.5). We could not show statistical trends in all instances.

4.1.6 TIME PLAYED

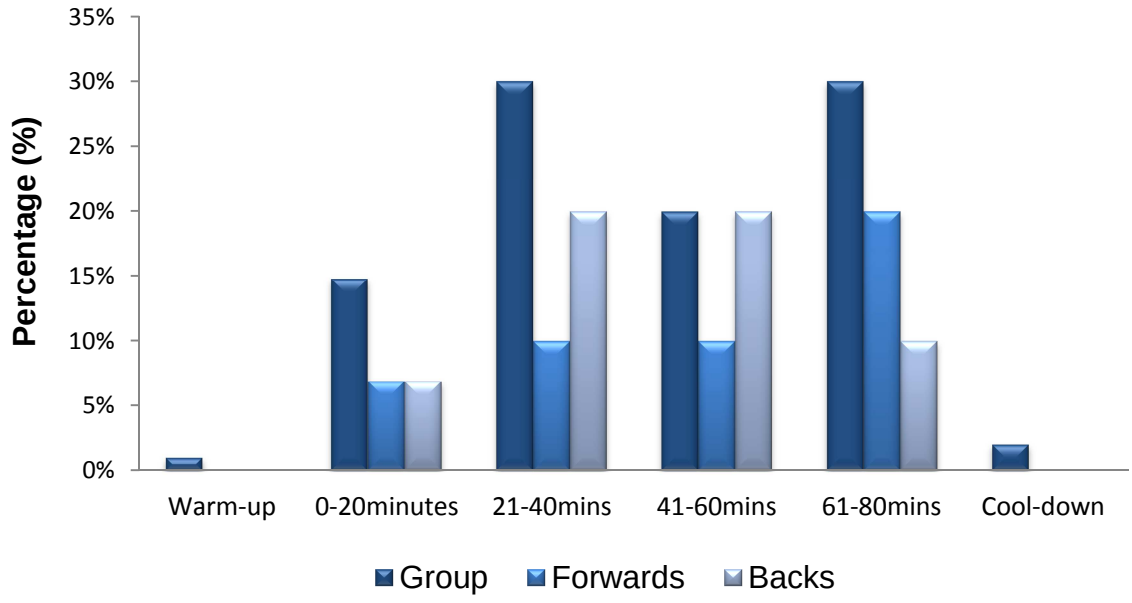

Figure 4: Time played and injury occurrence.

Injuries occurred commonly at different stages of the game (Figure 4); this is usually dependent on the intensity and style of game being played[48,59]. During the 2011 FNB VC, 1% of the injuries occurred during the warm-up, 15% occurred during the first 20 minutes of the game (0-20minutes), 26.7% occurred during the second part of the first half (21-40mins) and 24.8% occurred in the first part of the second half (41-60minutes).

The vast majority (30.7%) occurred during the last part of the game (61-80minutes) and only 2% during cool downs. Of these injuries, the forwards injury rates occurred predominantly during last part of the second half (15.1%) and the last part of the first half (12.3%). The backline players injury rates occurred predominantly in the second part of the first half (17.8%) and the first part of the second half (15.1%). We could not unfortunately show any statistically significance but clear trends.

4.2 SECTION B: COMPARISONS BETWEEN TEAMS

The overall training exposure (load) prevalence and incidence of injuries among the rugby teams that participated in the 2011 FNB VC are shown in Table 11.

Table 11: Overall training exposure (hours) per team: training Loads.

	All teams	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7
Pre-Season Exposure (TIE)	**18408**	3456	1536	2688	3456	1920	1920	3072
In-Season Exposure (MIE)	**9840**	1176	1008	1728	1536	1536	1344	1512
Overall Exposure (hours)	**28988**	4772	2684	4596	5152	3616	3444	4764
Total Injuries (number)	**178**	42	4	36	15	21	26	33
Injury Rate	**6.1**	8.8	1.5	7.8	2.9	5.8	7.5	2.6

The information is broken down into time spent within each part of the season, the overall training and match exposure (hours), the total injuries per team and the individual team injury incidence (per 1000 hours). Differences were evident in the pre-season, and in-season training loads for some teams. There was a trend in the reduction of TIE in the in-season for all teams compared to MIE.

Team 1, 3, 4 and 7 had higher training loads compared to the other teams despite variations in the number of injuries per team.

Individual injury rates per site or per position or the mechanism of play that injuries occurred could not be simplified, as Knowles *et al.*[62] stated that 95% CIs become incorrect, and thus of little value or use to the researcher when calculated on raw data values of five or less.

CHAPTER 5

DISCUSSION

5.1 DEMOGRAPHIC INFORMATION

The objectives of this study were to establish and compare the injury prevalence and incidence in forwards and backline players during the 2011 FNB VC season. Secondly, to compare the different training loads (exposure), types of injuries and injury rates amongst the various rugby teams during the 2011 FNB VC, premier division; of which male (club-level) rugby players between the ages of 18 and 25 took part.

There is a limited number of current injury surveillance studies done world-wide, specifically at club-level, that have reported on the most common injury patterns prevalent to both forward and backline players respectively[1,67]. There have been measurable differences in the injury data collection procedures, injury definitions and methodology in the available research before 2007; however with the validation and standardization of the new IRB format, the gap has been narrowed to reach consistency. This validation allows for more valid comparisons to occur especially amongst studies to come[12].

5.2 PREVALENCE OF INJURIES

Supervising the group of the players studied, and acquiring all the relevant data proved to be a complex task. This was due to the majority of the medical support teams not being permanently employed by the associated 2011 FNB VC team (university). The same medical support team was responsible for reporting the injury data, for both the pre-season and in-season. One of the teams could not compete with a medical support team, thus no data was submitted (team eight). However, injury rates per time of exposure to rugby for all the other teams were analyzed and reported.

In studies done during the 1995 and 2003 RWC competitions, match injury rates had accumulated from 1995 to 2003. Comparing these studies to studies done by Jakoet and Noakes (1998), Bathgate *et al.* (2002) and Targett (2003), match injury rates are much higher in the most recent studies. Garraway *et al.* (1995) together with several other studies, have suggested the reason for the increase in injury rates during matches to be due to a higher intensity experienced during match play[51,59], or over-training and/or the ball being in play for a longer period of time[1], as well as possibly the implementation of the new rules[14,59]. Similar results were found within the 2011 FNB VC tournament. The majority of the injuries were found during the in-season phase of the tournament, particularly during matches (89.1 injuries per 1000 hours). This finding correlates with Fuller *et al* (2008 & 2012) findings in the 2007 (83.9 injuries per 1000 hours)[8] and 2011 RWC (89.1 injuries per 1000 hours)[1].

The match injury rates were statistically significantly higher and the incidence of injury during match exposure was much greater than during training (p =0.039), as shown in tables 1 and 2. In this study according to the overall exposure (Addendum E) over-training was not a major contributor to injury occurrence rates as it has been seen in many previous studies[48]. Another possible reason for less training injuries is due to training sessions becoming a safer environment as coaches have become more responsible in controlling the activities the players are engaged in[48].

The volume and intensity of training sessions have had to be managed adequately in order to reduce training injuries[48,60]. These reasons might play a significant role in reducing the players' exposure (load) risk to injury by keeping within the range of recommended weekly training hours (5-39 hours per week)[24,48].

Of the total injuries, only 2.0 injuries per 1000 hours were recurrent injuries compared to the first episode injuries (4.1 injuries per 1000 hours). The decline in recurrent injuries could be attributed to enough recovery time being given to the players during the off-season, well planned training sessions and the implementation of recovery tools during the in-season, for example[60]. Better

player, team and injury management throughout the season, could of have led to the decrease in over-use and recurring injuries during the 2011 FNB VC, as well. According to the results (Table 11) found from each team's training sheet (Addendum E), the implementation of musculoskeletal screenings, player management and prehabilitation programs as well as individualized gym programs amongst the majority of the teams, may also have attributed to decreasing the number of recurring injuries[48,60].

Injuries were recorded per 1000 playing hours of exposure, to eradicate the possibility of bias; bias from differences in exposure (training load) by using an incidence density rather than a cumulative incidence measure. Over the 2011 FNB VC period, 6.14 injuries per 1000 hours occurred, with 89.1 injuries per 1000 playing hours of game time (MIE) and 1.61 injuries per 1000 training hours (TIE). There are similar findings amongst the previous RWC[1,8] tournaments as well as other studies by Brooks *et al* (2005)[7] and Bathgate *et al* (2002)[10].

5.3 PREVALENCE OF TYPES OF INJURIES: POSITIONAL INJURY RATES

In Table 4 & 5, it is clear that a large variety of injuries were experienced during the tournament. Typically, soft tissue injuries (Table 7 & 8) accounted for the majority of the injuries during the season as it has been seen in previous studies, namely strains and sprains together with contusions[2,40]. In two other studies amongst club and professional rugby players, the predominance of injuries is mostly related to muscles, ligaments and joint injuries[10,40].

The majority of these injuries were muscular in nature, with the second most common to be concussions, tendinopathies and lacerations (Figure 3). In Table 7 and 8, amongst both the forwards and backline players, sprains and strains were the most common type of injuries experienced. Concussions and contusions were also a common type of injury amongst the forwards, with tendinopathies and muscle injuries more common amongst the backline, as seen in Tables 7 & 8.

Previously, the lack of importance placed upon concussions, and the knowledge pertaining to identifying concussions led to the under reporting of this type of injury[19,23]. However, due to concussions being common in contact and collision sports, SARU has implemented the BOKsmart concussion awareness program (2009) country-wide[23].

5.4 SITE OF INJURY

Similarly to other research, the 2011 FNB VC injuries showed that injury rates occurred predominantly in the lower limb (table 3.1). More specifically in table 4, the ankle and foot was the most common structures injured which is similar to other studies[37]. The second most common injuries were the head, shoulder, hamstring, knee and quadriceps injuries, respectively (table4 & 5), which too was similar to other studies[5,10].

According to Table 4 & 5, lower limb injuries were most common amongst both forwards and backline players which is a similar to finding to Fuller (2012)[1]and Bathgate *et al* (2002)[10] findings amongst other rugby players The amount of head injuries showed a greater trend amongst the forwards. This finding is consistent with Fuller (2008 and 2012)[1,8] findings amongst amateur and professional rugby players. The amateur rugby players, who are the same level as VC (club level), experienced only 10% of their total injuries to be contributing to head injuries[10]. The ankle, foot and shoulder were the most common injury site amongst the forwards (table 4 & 5), followed by the head and knee. Amongst the backline (table 4 & 5), hamstring injuries were the most occurring trend followed by the ankle, foot, knee and head injuries. Shoulder injuries were not as common among the backline players as they were amongst the forward players; this is possibly due being less engaged in the contact phases of the game[28,39]. Amongst the backline players, the head injuries were mainly lacerations compared to the forwards, where concussions were the most common type of head injury experienced, although only statistical trends. This finding is similar to findings during the RWC in 2007 and 2011[1,8].

Deutch (2007)[58] originally stated that the understanding of meticulous movement prototypes and physiological loads associated with the different positions, will allow for appropriate training programs to be developed and implemented in accomplishing specific prerequisites. Other researchers have also suggested this, however they have added that due to the various law changes, associated intrinsic and extrinsic factors (Diagram 2)[55] as well as environmental factors which influence the style of rugby being played every year, the association of movement prototypes specific to a position has become difficult[22,24,] Further studies need to be done to associate injury trends amongst the positional groups, namely forwards and backline player alone. This information can provide similarities, related risk factors, specific mechanisms and other intricate information to design and implement more specific injury prevention programs (protocols)[55] and decrease the amount of injuries, particularly within the Varsity cup.

5.5 MECHANISM OF INJURY

It has been proposed by research that more attention need to be placed upon the intrinsic and extrinsic risk factors (diagram 2), to reduce injuries. Following these measure will reduced susceptibility[55,68]. Injuries differ a great deal between the positional groups (forwards vs. Backline). The forwards game plan evolves merely around set pieces, collisions, rucks and mauls which is known as the contact phases of the game[2,39]. This creates susceptibility amongst the forward players' to be more prone to injuries compared to backline players. The backline players' game plan generally revolves more around running (accelerating, decelerating, side-stepping) as well as kicking compared to contact phases of the game[2,78]. Within this study, the results (tables 1 and 2) were no different to that within current research[1,8]. Forwards therefore held notably higher injury trends compared to backline players. Forwards and backline players contribute equally to the overall injury rates, together with an increased training load and a lack of individual attention[48,64].

Injuries vary not only across forward and backline players but across the front row and the loose forwards, as well as the outside and inside backline players. There has been a lack of this type of

clarification in past research in relation to specific injuries and injury rates[27,40,]. During the 2011 FNB VC there were various trends amongst the individual positions. The locks were the most commonly injured position (Table 6), with props having the second highest injury rates, although only statistically trends could be shown. Amongst the backline players, wings and centre's were the most commonly injured backline players followed closely by the flyhalves and fullbacks. These trends are similar to the findings by Kaplan *et al.* (2008)[13] where the forwards had higher injury rates compared to backline players.

This study, similarly to what is reported in other rugby studies[8,10], the major mechanism behind the source of injuries during the 2011 FNB VC was the tackle. Collisions were the second most common source of injury. Previously there was a lack of differentiation between being tackled and tackling injuries[28]. Majority of these injuries occurred whilst being tackled compared to tackling, with the second most common phase of play was whilst running, followed by rucks and mauls. These findings correlate with the findings during the 2003, 2007 and 2011 RWC competitions[1,6]. Less injuries occur during rucks and mauls with the implementation of the new, stricter rules in 2007[14]. It has been suggested by Jakoets & Noakes (1998), and Holtzhausen (2006) *et al.* that safer falling and tackling techniques should be coached to all players in order to reduce susceptibility towards injuries[3,25].

In Table 9 and 10, most injuries amongst the forward players occurred during collisions (18.2 injuries per 1000 hours). During matches, the second most dangerous form of play (Table 9), experienced by backline and forward players, was while being tackled (19.1 injuries per 1000 hours). Tackling and rucking appeared to make the forward players just as susceptible to injury (10.2 & 8.5 injuries per 1000 hours respectively), accounting for a great deal of their injuries. The mechanism of injuries amongst backline players vary in-style compared to the forward players.

The second most common cause of injury amongst backline players occurred while accelerating, with side-stepping and kicking following, which continually illustrates their style of play. Gabbett

(2005) suggested that backline players are more susceptible to injuries during tackling phases due to them moving at higher velocity's against a greater force or a sudden or quick change in direction[78].

5.6 TIME PLAYED

Injuries occur at different stages of the game; this is usually dependent on the intensity and style of the game being played[78]. During the 2011 FNB Varsity cup, a minimal amount of injuries occurred during the warm-ups, the first half of the game and the cool-downs, as seen in figure 4. The main phase of the game that injuries occurred was in the last part of each half of the game (20-40+ and 60-80+ minutes), which is presumably due to fatigue[78]. Amongst the forward players, the last part of the first half and the last part of the second half had the highest rate of injuries. This is similarly found in other studies, suggesting that the contributing factors are a lack of physical conditioning, fatigue or repetitive micro trauma, as well as other environmental factors[22,60]. The backline players' injury trends differed slightly where the majority of their injuries occurred during the first part of the second half (40-60 minutes) instead of the last part. This is suggestive of either a lack of recovery during half-time or reduced concentration after half-time; it can also be due to the changes in playing intensity which may influence injury rates[22,60]. Coaches need to implement drills during a fatigued state to instill appropriate decision-making in a fatigued state within a game[48]. This will aid in decreasing the injury threshold as well as the frequency of injuries experienced towards the end of each half in a game[64].

This study confirms high injury rates reported within the rugby union environment[1,8] as well as depicting similar values as reported for elite club competitions, globally[14,40].

CHAPTER 6

6. CONCLUSION, LIMITATIONS & RECOMMENDATIONS

6.1 Summary

This study has outlined and illustrated the prevalence and incidence of injuries amongst the forward and backline players of the 2011 FNB VC, which was the primary objective. The study also aimed to report on the different training loads (exposure), types of injuries and injury rates amongst the various teams that submitted data.

The results of this study, discussed and argued above, lead to the following conclusions:

- There are numerous and extensive injuries encountered by forwards and backline players. The establishment of a consensus surrounding injury definitions and data collection provides a fuller understanding on the epidemiology of rugby injuries. This also provides a platform for the most recent as well as future studies to be compared to one another and a clearer classification of the vulnerabilities within the sport.

Rugby union involves several stages of play which results in different types of injuries occurring from various mechanisms.

- Injuries occur during training and matches, where match injuries tend to be higher in most cases. This is possibly due to players exerting larger forces during matches than at training[2,7]. An increased training volume at the onset of the in-season could be significantly correlated to more injuries during matches, as well[48]. Fatigue and a lack of physical conditioning could be a determinant to the majority of injuries occurring during the last part of each half during matches (20-40+ & 60-80+ minutes). Furthermore, there is a trend, not statistically defined, obvious trend regarding the site, type and mechanism of injuries which vary across the

grouped positions (forwards and backline). This suggests that different training styles for the various positional groups together with other intrinsic factors should be recommended as an injury prevention strategy to reduce the number of injuries every VC season.

The familiarity of injury definitions could possibly take several attempts at data collection to acquire the reporting of all injuries.

To our knowledge, this study is the first to document injuries on VC level rugby players, premier division. The reporting of injuries was perhaps a first time venture for many medical support teams, which possibly led to under reporting of several components such as the demographic information and some injuries, specifically those more minor in nature or injuries within the pre-season.

More recent awareness of concussions through the BOKsmart regularities probably led to more reporting of concussions within this study compared to previous research[23]. The majority of the medical support teams were not permanently employed by the Universities they were involved in. Thus, the reporting on the severity of injuries post-injury deemed limiting due to the referring of players to external medical personnel as well as possible post-match assessments, or lack thereof.

Similarly to other injury surveillance studies, the tackle was the most dangerous phase of play. The forwards who are more engaged in the contact phases of the game resulted with more injuries compared to backline players. The backline players, due to their style of play had more running and accelerating injuries. The tackling mechanism seems to be consistent in most studies as the most dangerous form of play due to being commonly associated with injuries[28,]. Injury prevention strategies targeting reducing tackle injuries will fundamentally modify the contact nature of the game[39]. During open play players are more at risk of injury which is consistent with players association in the tackling phase of the game. Soft tissue damage is common amongst rugby injuries particularly of the lower limb. Most head injuries tend to be lacerations (4.5 injuries per 1000 hours) and within this study, concussions (10.0 injuries per 1000 hours) too were a common trend.

With rugby being such a popular sport with a high incidence of injury, more studies alike, should be done to collect and compare epidemiological data on rugby related and position (forwards and backline) specific injuries. Meeuwisse[69] proposed a multi-disciplinary model (1994), to create neuromuscular injury prevention program, this model could be implemented by all rugby teams and clubs. These programs need to be established and implemented, the program's effectiveness must be measured and continuously introduced into real-world settings, as mentioned by Finch[68,69]. Such studies and implementation of injury prevention (TRIPP) models could provide adequate scientific information and recommendations for more specific training methods, evidence-based rehabilitation and yearly improve upon injury prevention models implemented. It is essential to follow Van Mechelen's (1992) guidelines in order to guide injury surveillance studies in the future, identify and document injuries accurately as well as other contributing factors; identify the most effective intervention (prevention tactic) and regularly asses the effectiveness of the intervention in limiting the players risk to injury, reducing the number of injuries and aiding in the performance of each team within the VC competition period[75].

6.1 Severity

Unfortunately, insufficient information was provided to report on the severity of these injuries.

6.2 Study limitations

Retrospective cohort studies are particularly useful for unusual exposures or occupational exposures.

6.2.1 The recording of the details concerning causes and mechanisms of injuries is still a very challenging issue, since most of the players do not remember concisely what caused their injuries. In addition, during training, there is no video coverage for clarification. This is a classical disadvantage of using a retrospective study design.

6.2.2 Not all medical support personnel are employed by the University they are involved in, thus the collecting of the data from each team was a challenging situation as this task was not the medical supports personnel's main priority. Therefore teams lacked the financial or manpower infrastructure needed to accomplish this task.

6.2.3 The large reliance on the each teams medical support personnel (team doctor or physiotherapist) to provide clinical judgment in terms of the severity and type of injury after each game, could potentially compromise the level of comparability.

a. Inaccurate reporting of injuries specifically in the pre-season could have resulted in under-reporting of injuries, time-loss injuries in particular.

b. Players could have chosen not to report injuries after their last game as they might have preferred to see another doctor or physiotherapist.

6.2.4 Unless the associated universities make the resources and man-power available to their team, it will continue to limit the medical support staff from implementing the full TRIPP model, thus there is a lack in complete information. The majority of these steps were followed in this thesis, namely step 1 and 2, according to the resources available to each team. In an attempt to achieve the best injury prevention outcomes, the full model including steps 3 and 4, would need to be implemented in the future within VC. These steps follow implementing an injury prevention intervention as well as ensuring that the intervention is successful. This would aid in preventing injuries amongst all of the teams involved in the VC tournament.

6.2.5 The retrospective nature of this study leads to the reporting of injuries that are no longer current.

6.3 Recommendations

It is recommended that further research can be initiated based on the current study and findings. It can be used as a reference for prospective studies based on Bahr's sequence for

injury prevention studies and Meeuwesse model, as well as in comparisons to other injury surveillance studies. The current findings can also now assist VC medical and support staff with their planning, management and implementation of improved injury prevention strategies.

The second recommendation is that this study showed that this type of injury surveillance per team should become an integral part of the tournament according to SARU and Varsity Cup regulations. Thus, each year's outcomes can be compared and the necessary strategies or models can be implemented to reduce injuries and make the playing field a safer environment. The third recommendation is that this study can provide sufficient evidence that due to the high rates of head injuries (more reporting), the implementation of the "brain bin" or experimentation thereof, possibly should also form part of the VC in order to assess and treat concussions effectively and to prevent complications. This would require more financial and manpower infrastructure at all matches[68]; it might be more beneficial to implement efficient pitch side management of head injuries.

The third recommendation is made accordingly as a result of research which has shown that 5-39 hours per week of high intensity training can form a protective mechanism against injury but more than this can increase the risk to injury[60]. Thus, training hours should adhere within this parameter.

Lastly, the field sessions need to be further classified and documented into whether full-contact, semi-contact or no-contact was the focus of the session. This indicates the intensity of the session and gives a better picture of training load (exposure). GPS units can be used to accurately document training load by reporting on the exact length (minutes) of the session was as well as the distance (kilometers) covered and the speed-zones (m/sec) that each player reached during the session. This can aid in better monitoring of a team's training load and the implementation of the necessary recovery strategies in order to maintain the minimal occurrence of over-training injuries.

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Addendum A: INFORMATION LEAFLET TO PLAYER

Dear Varsity Cup Player

I would like to cordially invite you to partake in a study during the FNB Varsity Cup tournament. The study entails documenting all injuries that take place within the Varsity cup period. Your team's medical personnel will document all details pertaining to the injury. We would require your permission, if you were to be injured during the 2011 FNB Varsity Cup, to use your data for our study. In such a case, please ensure your medical personnel have all the details of your injury and how it happened. This data will be used in a Masters Research study on the injury surveillance during the 2011 FNB varsity cup, conducted by Melissa Hillhouse from the University of Witwatersrand.

The study will focus on the injuries during Varsity Cup and the most commonly occurring injuries found during the Varsity Cup. As well as comparing the injuries across forwards and backline players and possibly comparing the injury rates from each university that takes part.

There is no research done during the Varsity Cup, to date and this is a tournament that has been running for 3 years in which the population group is of similar age and level of rugby. With this information we can in the future put together a prehabilitation program as a preventative tool to decrease injuries. If this is successful then players at all levels could become more aware the importance of more specific training compared to a generalized program.

You will remain anonymous within the study and all data will be confidential. If you were to get injured during training or during a match your team physiotherapist or trainer or doctor will complete an IRB injury surveillance form and submit it to me.

Risks and Benefits

Please note there are no invasive procedures (e.g. Needles, drawings of blood and so forth) that will be done or the administration of any substances. Thus, you will not be negatively impacted in any way through this study.

Participation is completely voluntary, thus you are able to withdraw from the study at any time. There are no costs involved in this study.

If you have any questions please don't hesitate to contact me.

Kind Regards

Melissa Hillhouse – 083 454 1089

Addendum B: SA RUGBY CONSENT FORM

Mr Jurie Roux

CEO SA Rugby /Chairman of Varsity Cup board

INCIDENCE OF INJURIES DURING THE 2011 VARSITY CUP RUGBY SEASON

Dear Mr Roux

I am currently busy with my MSc (Med) in Biokinetics degree at the University of Witwatersrand. The focus of my study will be an injury surveillance study during the 2011 FNB Varsity Cup. This study will determine the most common injuries found between forward and backline players of the eight participating universities.

No research on injury injuries has been done on the Varsity Cup tournament since it was founded in 2008. The results of this research will hopefully in the future aid university rugby teams in the prevention of injuries through a structured prehabilitation program. This information can also help us with further research topics and injury prevention programs and strategies.

The medical support staff from the teams taking part in the Varsity Cup will be asked to compile recent injury statistics as valid information pertaining to this topic. The medical support staff of each university would be asked to record their injury statistics using the International Rugby Board (IRB) injury surveillance form. All statistical injury data collected will be held confidential. Injury surveillance will be done on a weekly basis from the start of pre-season training to the end of the tournament. All injury surveillance data will be compiled at the end of the competition and be submitted to the researcher. Medical teams will also be required to provide information regarding training methods and training loads.

All statistical injury data collected will be held confidential.

In order for this study to take place, I would like to ask the permission from the SA rugby board and Varsity cup board to go ahead with this study and accumulate the required information from each university.

With this permission is granted to Melissa Hillhouse to acquire and use the injury data during the 2011 Varsity Cup period, for her Masters Research study.

Signed at (place) _____ on (date/year) _____

CEO of SA Rugby, Signature _____, _____ (name printed)

Addendum C: INDIVIDUAL CONSENT FORM

TEAM:_____ POSITION:_____

I, _____ (NAME), [ID. NUMBER:_____] from (team and town) _____(for example: UCT) _____ (for example: Cape Town).

INCIDENCE OF INJURIES DURING THE 2011 VARSITY CUP RUGBY SEASON

Confirm that:

I was invited as a member of a team partaking in the FNB Varsity Cup. If I were to get injured then this data will be used in a research study on the injury occurrences during the FNB Varsity Cup tournament, conducted by Melissa Hillhouse from the University of WITS.

It was explained to me that I will remain anonymous within the study, as well as the fact that I am able to withdraw from the study at any time. It was also explained to me that if I were to get injured during training or during a match that an injury surveillance form will be completed and that I need to partake in at least 80% of the Varsity Cup period.

I understand that there are no invasive procedures (e.g. Needles, drawings of blood and so forth) that will be done nor the administration of any substances. I have been told that I will not negatively impact in any way through this study.

I was informed that the information obtained through the study will be held confidential but the data compiled will be used in a general outcome in a Masters Theses research project. Participation was explained to me to be completely voluntary and that there will be no costs involved.

With this I volunteer to participate in the above-mentioned project.

Signed at (place) _____ on (date/year) _____

Subjects Signature _____

Addendum D: IRB INJURY SURVEILLANCE FORM / 2011 FNB VARSITY CUP INJURY SURVEILLANCE FORM.

BokSmart

National Rugby Safety Program

VARSITY CUP 2011 INJURY SURVEILLANCE DATA CAPTURE FORM

1. PERSONAL DETAILS

Team Name:		**Date of birth (dd/mm/yyyy):**	
Player code:		**Date of injury (dd/mm/yyyy):**	
Known as (nickname):		**I.D. Number:**	
Ethnic origin:		**Gender:**	
Height (cm):		**Weight (kg):**	**Age (yrs/months):**
Provincial Union:		**Date of Return from injury (dd/mm/yyyy):**	
Do you have medical insurance?		**Number of days missed due to injury:**	
Did the player consult with a medical professional regarding their injury?			
If an old injury, was a rehab program followed?			

Team	Age Group	Pitch conditions	Weather conditions	Mechanism of injury	Type of injury
School	Junior (<U13)	**Option1:**	Hot	Acceleration	Concussion
Club	U13	Soft	Dry	Deceleration	Spinal cord injury
U16 Elite squad	U14	Firm	Light rain	Lunge	Broken bone/fracture
U17 Elite squad	U15	Hard	Heavy rain	Sidestep	Joint injury
U18 Elite squad	U16	Very hard	Overcast	Slipped	Ligament injury
U19 Elite squad	U17	**Option2:**	Cold	Twisted	Muscle injury
Grant Komo week U16 squad	U18	Even	Windy	Scrum engagement	Muscle cramp
Craven week U13 squad	U19	Uneven	Other	Collapsed scrum	Tendon injury
Craven week U18 squad	U20	**Option3:**	**Body location**	Popped scrum	Bruise
Academy week U18 squad	U21	Muddy	Head/face	Tackling behind	Skin abrasion
SA U18 Academy squad	U23	Slippery	Neck/cervical	Tackling front-on	Laceration
SA Schools U18 squad	Senior	**Option4:**	Sternum/ribs	Tackling side-on	Other injury
Provincial U19 squad	**Position**	Medium grip	Upper back	Tackled from behind (regulation)	Unsure/do not know
Provincial U20 squad	1 - Loose head prop	Solid footing	Stomach	Tackled front-on (regulation)	**Nature of injury**
Provincial U21 squad	2 - Hooker	**Where injury occurred**	Low back	Tackled side-on (regulation)	New injury
SA U19 squad	3 - Tight head prop	Warm-up	Sacrum/pelvis	Double tackle (regulation)	Old or previous injury
SA U20 squad	4 - Lock	Cool-down	Shoulder/collarbone	Tackled from behind (high)	**Protective gear**
SA U21 squad	5 - Lock	Match	Upper arm	Tackled front-on (high)	Mouth guard
SA U23 squad	6 - Open side flank	Weight training	Elbow	Tackled side-on (high)	Shoulder pads
Provincial amateur squad	7 - Blind side flank	Fitness conditioning	Forearm	Double tackle (high)	Headgear
SA Amateur squad	8 - 8th man	Rugby skills (non-contact)	Wrist	Bitten	Shin-pads
Emerging Boks	9 - Scrum/inside half	Rugby skills (semi-contact)	Hand/finger/thumb	Collision	Strapping
SA (A) squad	10 - Fly/outside half	Rugby skills (full-contact)	Hip/groin	Elbowed	Other
Springboks	11 - Left wing	Other	Front of thigh	Gouged	**Injury definition**
Emerging Women's 7's squad	12 - Inside center	**Time in match when injury occurred**	Back of thigh	Head butt	Time loss injury
Women's provincial U20 squad	13 - Outside center	Warm-up	Knee	Kicked	Medical attention injury
Women's provincial seniors	14 - Right wing	0-20min	Lower leg	Kneed	
Women's Bok squad	15 - Full back	21-40+min	Ankle	Punched	**Estimated severity**
Provincial 7's squad	**No. of years at this position**	41-60min	Foot/toe	Rucked	Slight (0-1 day missed)
Emerging 7's squad	0-1yr	61-80+min	**Injury event**	Cleaned	Minimal (2-3 days missed)
National 7's squad	1-2yrs	Cool-down	Scrum	Cleaning	Mild (4-7 days missed)
League	2-4yrs	**Post-injury decision**	Lineout	Not supported	Moderate (8-28 days missed)
Super League A	5-10yrs	Continued	Open play	Jumping	Severe (>28 days missed)
Super League B	>10yrs	Discontinued, forced	Tackle	Landing	Career-ending
Premier League A	>20yrs	Discontinued, precautionary	Ruck	Other	Non-fatal catastrophic
Premier League B	**Game status within team**	Discontinued, blood	Maul		Fatal
Division 1	Started match	**Stage of season**	Kicking		
Division 2	Substitution	Off-season	Running		
Division 3	**Pitch type**	Preseason			
Division 4	Grass	In-season			
Division 5	Synthetic	**INSTRUCTIONS FOR USE**: Circle the relevant answer in each section. For "Pitch Conditions", circle one selection under each "Option" provided. Under "**Injury Definition**" the following definitions should be used: A "**Time-loss injury**" is defined as an injury that results in **more** than one (1) day absence from training and/or match play. A "**Medical attention injury**" is defined as an injury that simply requires medical attention.			
	Sand				
	Gravel				
	Other				

Addendum E: 2011 FNB VARSITY CUP TRAINING DATA FORM.

TRAINING DETAILS: To be complete by a member of the medical team (this form only needs to be complete once)	
How many days per week do you train:	
How many hours of field training (speed etc) per day do you do?	
How many hours of gym training per day?	
How many field sessions with coach per day?	
Do you have a general gym program? **Or a position specific program (fwd/backs)?** **Or a individualised program?**	General: Position: Individualized:
Have you done any strength and fitness tests?	
How often do you get tested?	
Have your players had musculoskeletal assessments?	
Have your players been on a prehab program?	
How many hours of field training per week (pre-season) and per week (in-season):	**Pre-season:** **In-season:**
How many hours of gym training per week (pre-season) and per week (in-season):	**Pre-season:** **In-season:**
What strength & fitness tests were done?	
How often were they done? (dates)	
Were recovery strategies implemented? (types)	**Pre-season: Yes: No:** **Types:** **In-season: Yes: No:** **Types:**
How often? (times per week/minutes)	
What is the average amount of minutes played by each player?	
What is the average amount of games played by each player?	

Addendum F: ETHICS FORM

M110534

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Miss M Hillhouse

CLEARANCE CERTIFICATE	M110534
PROJECT	Injury of Surveillance during the 2011 Varsity Cup Rugby Season
INVESTIGATORS	Miss M Hillhouse.
DEPARTMENT	Centre for Exercise Science and sports Medicine
DATE CONSIDERED	27/05/2011
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 27/05/2011 CHAIRPERSON .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr Kerith Aginsky

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Addendum G: MEDICAL STAFF CONENT FORM

Statement of Medical staff undertaking to complete the injury surveillance forms

INCIDENCE OF INJURIES DURING THE 2011 VARSITY CUP RUGBY SEASON

Name + Surname: _____

TEAM: _____

Profession: _____

The focus of my study will be on the injury occurrence during the 2011 FNB Varsity Cup. This study will determine the most common injuries found between forward and backline players of the eight participating universities .The data will be held confidential and purely used in a research study on the injury occurrences during the 2011 FNB Varsity Cup tournament, conducted by Melissa Hillhouse for her Masters theses, from the University of Witwatersrand.

No research on injury surveillance has been done on the FNB Varsity Cup tournament since it was founded in 2008. The results of this research will hopefully in the future aid all university rugby teams in the prevention of injuries through a structured prehabilitation program. This information can also help us with further research topics and injury prevention programs and strategies.

The medical support staff from the teams taking part in the FNB Varsity Cup will be asked to compile recent injury statistics via the IRB injury surveillance form, as valid information pertaining to this topic. The medical support staff of each university would be asked to record their injury statistics using the International Rugby Board (IRB) injury surveillance form. All statistical injury data collected will be held confidential. Injury surveillance will be done on a weekly basis from the start of pre-season training to the end of the tournament. All injury surveillance data will be compiled at the end of the pre-season and submitted to the researcher; and again at the end of the competition. Medical teams will also be required to provide information regarding training methods and training loads as well.

I (or we) _____ declare that I/we have explained the information contained in this document to the participant. I (or we) have requested the subject to ask questions if anything is unclear.

Signed at (place) _____ on (date/year) _____

Medical staff Signature _____

Medical staff (witness) _____