



**The Relationship between Reported Coaching
Behaviours and Learning Resources on Youth Rugby
Players'
Attitudes towards Injury Prevention and Performance
in the Tackle.**

By

DANIEL GARNETT

SUBMITTED TO THE UNIVERSITY OF CAPE TOWN

**IN PARTIAL FULFILMENT (COURSEWORK AND DISSERTATION) OF THE
REQUIREMENTS FOR THE DEGREE**

MASTER OF PHILOSOPHY IN SPORTS PHYSIOTHERAPY

DEPARTMENT OF HEALTH AND REHABILITATION SCIENCES

UCT/MRC EXERCISE SCIENCE AND SPORTS MEDICINE

GROOTE SCHUUR HOSPITAL, ANZIO ROAD, OBSERVATORY,

SOUTH AFRICA

Date of submission 19 February 2018

Supervisor: Dr. Sharief Hendricks

Faculty of Health Sciences

UNIVERSITY OF CAPE TOWN

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

Declaration

I, Daniel Garnett, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Signature:

Signed by candidate

Date: 14 February 2018

Acknowledgements

- ❖ To my daughters, Kate and Rebecca, you make me strive to be the best version of myself every day.
- ❖ To my wife, Caroline, you are and have always been my rock through everything.
- ❖ I would like to thank my family for their support, especially my mother Allison.
- ❖ To Dr. Sharief Hendricks, thank you for your patience and perseverance in supervision of this dissertation.
- ❖ To Dr. Theresa Burgess, thank you for wisdom and support.
- ❖ To Nate, Viki and Erik, thank you for encouragement throughout this process.

Table of Contents

Declaration	2
Acknowledgements	3
List of Tables.....	6
List of Figures	7
Glossary of Terms	8
Abstract	9
Chapter 1. Introduction and Scope of the Thesis	12
Chapter 2. Literature Review	16
2.1. Introduction.....	17
2.2. Injury Prevention Models in Sport.....	19
STEP 1: Identify the Problem to Establish the Extent of the Sports Injury.....	20
• Rugby Union and the Nature of the Game.....	20
• Definitions of Injury in Rugby.....	24
• Epidemiology and Risk of Injury in Rugby.....	25
• The Tackle in Rugby.....	30
STEP 2: Establish Etiology and Mechanisms of Injury.....	31
• Risk Factors for Injury.....	31
• Tackle Injury Risk Factors.....	33
STEP 3: Develop, Evaluate, and Implement Intervention	35
• Preventative Measures	36
• The Role of the Coach in Prevention of Injury.....	37
• Knowledge, Attitudes and Behaviours	37
• Coaching Behaviours and Methods	40
• Coach Education	40
STEP 4: Re-evaluate the Effect of Intervention via Continued Surveillance ..	42
2.3. Summary	44
The Research Study.....	46
Introduction	47

Chapter 3. Methods	49
3.1. Aims and Objectives	49
3.2. Participants.....	50
3.3. Questionnaire Developmental Process	50
3.4. Question Scale Definition and Item Format	51
3.5. Questions Domains and Layout.....	52
3.6. Statistical Analyses	53
Chapter 4. Results	54
Chapter 5. Discussion	57
Chapter 6. Practical Applications	61
Chapter 7. Conclusion.....	65
7.1. Strengths and Limitations.....	65
References	67
Appendix A- Questionnaire	80
Appendix B - Parent Informed Consent.....	87
Appendix C - Player Informed Assent	88

List of Tables

Table 1. Injury incidence, injury definitions and tackle-related injury rates reported in Rugby Union over twenty years (1995-2015).....	22
Table 2. The association between reported coaching methods and players' attitudes towards injury prevention and performance in the tackle.	55
Table 3. The association between rugby learning resources and players' attitudes towards injury prevention and performance in the tackle.....	56

List of Figures

Figure 1: van Mechelen's four-step injury prevention model.....	20
Figure 2. An example of the question scale and items to assess player attitude.....	51
Figure 3. An example of the question scale and item to assess player behavior.....	52

Glossary of Terms

Attitude:	Personal feelings or emotions towards an object or topic.
Ball carrier:	The player who has possession of the rugby ball.
Behaviour:	The actions and mannerisms of a person.
Coach:	A person with the necessary skills and tools to coach a rugby player or number of rugby players according to the rules of rugby.
Injury:	Any physical complaint which exceeded the body's ability to maintain its structural and/or functional integrity sustained by a player, irrespective of the need for medical attention or time-loss from rugby activities.
Injury Risk:	The likelihood that harm will occur with exposure to or participation in a particular activity.
Knowledge:	Information acquired through experience or education.
Rugby:	The less formal name of the sport of Rugby Union. A field-based team sport, also called rugby, with 30 players in two teams of 15 each competing for at least 80 minutes at the senior levels.
Rugby Union:	A field-based team sport, also called rugby, with 30 players in two teams of 15 each competing for at least 80 minutes at the senior levels.
Safety:	Reducing the risk of injury.
Scrum:	A contact phase of Rugby where opposing groups of players arrange in a set formation to compete for possession of the ball.
Tackle:	Any event where one or more players attempt to stop or impede the ball carrier whether or not the ball carrier was brought to ground (Fuller, Ashton, Brooks, Cancea, Hall & Kemp 2010).

Abstract

Background: Involvement in sports has numerous well-documented physiological and psychological benefits but also carries a risk of injury. Due to the contact nature of Rugby, involvement in the game carries a greater risk of injury compared to other sports. The tackle phase of the game has resulted in the most number of injuries in all levels of the game. Coaches are key elements in developing players and implementing injury prevention programmes. Certain coach behaviours may influence a player's attitude, in turn the player's behaviours, when implementing tackle techniques during training sessions and matches. Player behaviour has previously been identified as a risk factor for sustaining, or causing, an injury during a tackle.

Objective: To examine the relationship between reported coaching behaviours and learning resources on players' attitudes and behaviours towards injury prevention and performance in the rugby tackle.

Methods: This cross-sectional survey used a questionnaire comprising a 5-point Likert scale to assess junior rugby players' (n=164) attitudes (importance) and behaviours (frequency and quantity). The main outcome measurements were the relationships between reported tackle coaching methods and the players' tackle training attitudes and behaviours using the χ^2 test and Cramer's V.

Results: Player-rated importance of injury prevention was positively correlated with verbal instruction from the coach to the individual player (29% somewhat important-

very important, $\chi^2 (16)=30.41$, $p<0.05$, Cramer's $V=0.22$, moderate) and to the entire team (34% somewhat important-very important, $\chi^2 (16)=34.05$, $p<0.01$, Cramer's $V=0.23$, moderate). The more time spent by the coaches on teaching proper techniques to prevent injuries, the higher players rated the importance of injury prevention (28% somewhat important-very important, $\chi^2 (16)=29.13$, $p<0.05$, Cramer's $V=0.21$, moderate). Training books as a learning resource was positively associated with how important players rated tackle injury prevention (27% somewhat important-very important/much-very much, $\chi^2 (16)=28.67$, $p<0.05$, Cramer's $V=0.21$, moderate) and performance (32% somewhat important-very important/much-very much, $\chi^2 (16)=27.22$, $p<0.05$, Cramer's $V=0.21$, moderate). Training videos, as a learning resource, was also positively associated with the importance of tackle performance (32% somewhat important-very important/much-very much, $\chi^2 (16)=27.22$, $p<0.05$, Cramer's $V=0.21$, moderate) but not injury prevention (39% somewhat important-very important/much-very much, $\chi^2 (16)=21.50$, $p<0.05$, Cramer's $V=0.18$, weak)

Conclusions: This research reports on the association between reported coaching behaviours and learning resources on players' attitudes and behaviours towards injury prevention and performance in the tackle in rugby. Reported coaching behaviours, which incorporated individual and team verbal instructions when teaching tackle techniques to prevent injuries, resulted in more risk adverse player attitudes towards injury prevention when performing the tackle skill in training and matches. When the goal was to improve tackle performance, more importance is given to training proper technique in the tackle when compared to the goal of preventing injury. Players identified training videos and training books as the most preferential learning

resources for improving tackle performance. Training books were also identified as an important learning resource with regards to tackle-related injury prevention attitudes and should be explored further.

Keywords: *Rugby Union, tackling, coaching, injury prevention, attitude, knowledge, behaviour.*

Chapter 1.

Introduction and Scope of the Thesis

Rugby Union (henceforth called “Rugby”) is a contest between two teams of 15 players each that lasts 80 minutes at the senior level (Fuller, Taylor, & Raftery, 2015). Due to the nature of this contact sport, it is common for players to be involved in high impact collisions resulting in a greater injury incidence compared to other sports (Williams, Trewartha, Kemp, & Stokes, 2013). These high impact collisions are as a result of the attacking teams attempting to gain points by physically moving the ball into the opposition’s territory and the defending team attempting to stop this advance using bodily contact and force (Hendricks, Den Hollander, Tam, Brown, & Lambert, 2015). The defending players are permitted to tackle the ball carrier to stop the advancement of the attacking team towards their goal-line (Burger, Lambert, Viljoen, Brown, Readhead & Hendricks, 2016). A tackle is “*the method of holding a ball-carrier and bringing that player to the ground*” (World Rugby, 2018, p. 22) or “*when the ball-carrier was contacted (hit or held) by an opponent without reference to whether the ball-carrier went to ground*” (Quarrie & Hopkins, 2008, p.3). The ability of a player to endure and contest the tackle phase is imperative for safe and successful participation in rugby (Gabbett & Kelly, 2007).

In rugby, the majority of injuries occur in the contact phases of play namely: tackling, scrumming, rucking and mauling and taking the ball into contact situations. (Bathgate, Best, Craig, & Jamieson, 2002; Burger et al., 2014; Fuller, Brooks, Cancea, Hall, & Kemp, 2007a; Roberts, Trewartha, England, & Stokes, 2015; Moore, Ranson, & Mathema, 2015). There appears to be an equal risk of injury to both the

attacking and defending player during the tackle facet (Wilson, Quarrie, Milburn & Chalmers, 1999, Burger et al., 2014), although previous studies found ball carriers to be at a higher risk (Palmer-Green, Stokes, Fuller, England, Kemp & Trewartha, 2013; Nathan, Goedecke, & Noakes, 1983, Nicol, Pollock, Kirkwood, Parekh & Robson, 2010).

A player's knowledge, attitude and/or behaviours may play a role in injuries sustained to, or caused by a player (Gianotti, Quarrie, & Hume, 2009), thus improving player injury prevention attitudes and behaviours should reduce the risk and incidence of injury in sport (Brown, Gardner-Lubbe, Lambert, Van Mechelen, & Verhagen, 2015; Finch, McIntosh, & McCrory, 2001; Gianotti, Hume, Hopkins, Harawira, & Truman, 2008; Hendricks et al. 2015). It is assumed that knowledge will influence attitudes and behaviours of an player, although, behaviours may also be able to adapt the attitude of an player (Eime, Owen, & Finch, 2004; Lund & Aarø, 2004; Van Tiggelen, Wickes, Stevens, Roosen, & Witvrouw, 2008). Attitude refers to "*the knowledge and beliefs of a person concerning the specific consequences of a certain form of behavior*" (Kok & Bouter, 1990 pg. 603). Behaviour is the action of performing activities and can be considered planned or unconscious (Eime et al., 2004).

One form of intervention strategy to reduce the incidence of injury in rugby is player and coach education. This refers specifically to how correct tackle contact techniques should be performed (Gabbett & Ryan, 2009; Hendricks & Lambert, 2010). This information is usually disseminated via web-based resources, educational videos and international outreach programmes (McCrory, Meeuwisse, Dvorak, Aubry, Bailes, Broglio, ... & Vos. 2017). Educational injury prevention programs that promote

correct tackling scrumming and techniques are associated with improving injury prevention behaviour of players (Brown et al., 2015) and with a substantial decline in serious injuries in junior players, although this decline was not seen in senior players (Brown, Verhagen, Knol, Van Mechelen, & Lambert, 2016).

The coach has been recognized as a significant influence in player development (Carter & Muller, 2008; Gianotti et al. 2009) and important for implementing scientific evidence off the field into real-world skill development on the training field (Saunders et al., 2010; Twomey, Finch, Roediger, & Lloyd, 2009). Coaches are responsible for the content of training sessions and management of players during matches to ensure that injury risk to a player, or caused by a player, are reduced (Hendricks & Lambert, 2010; Hendricks & Sarembock, 2013; Hendricks et al. 2015). Coaches and players tend to place more emphasis on performance when training tackling skills than injury prevention even though the importance of training the tackle and amount of time spent on this skill have been associated with behaviours that may reduce injuries during match play (Hendricks, Jordaan, & Lambert. 2012; Hendricks et al. 2015).

Accurate knowledge, positive attitudes and appropriate behaviours towards injury prevention are important components to successful injury prevention programmes however; there is little research that identifies coaches' training components that impact player's knowledge, attitudes and behaviours towards injury prevention in rugby (Finch, Donohue, & Garnham, 2002; Hendricks et al., 2012; Brown et al., 2015; Hendricks et al. 2015,). There is sparse evidence about the relationship between training for the tackle contest and executing this skill in match play, and the

relationship of players' and coaches' knowledge, attitudes and behaviours towards injury prevention whilst executing this skill (Hendricks et al. 2015). Due to the nature of rugby, partaking in the sport puts an individual at a high risk of injury most commonly occurring in a tackle to the ball carrier or tackler (Williams et al., 2013). Players' attitudes and behaviours towards injury prevention are risk factors for injury when executing a tackle (Gianotti et al., 2009).

Efforts to reduce or prevent injury in all levels of rugby are important, however it should be a higher priority than player performance in children in age-group rugby. The hypothesis for this study contrasts this statement, as it is believed that increased significance is given towards improving tackle performance, compared to reducing injuries when training the tackle at all levels of the game. The primary aim of this study was to examine the relationships between reported coaching behaviours and learning resources on players' attitudes and behaviours towards injury prevention and performance in the tackle. The objectives were to gain insight into the perspectives of South African rugby players around the tackle in training using a 5-point Likert scale and to identify the coaching behaviours and learning resources that are most important to this cohort.

Chapter 2.

Literature Review

Players' Attitudes and Behaviours and Coaches' Knowledge and Behaviours in Tackle Safety and Performance in Rugby.

2.1 Introduction

Despite the established benefits, involvement in sports encompasses a risk of injury which may result in lost training time, lost revenue, increased costs in the form of medical treatment for the player and may ultimately reduce morale (van Tiggelen et al. 2008). Regular involvement in sport is associated with several psychological and emotional benefits, a better quality of life and a reduced risk of morbidity through improved cardiovascular health (Maffulli, Longo, Gougoulias, Caine, & Denaro, 2011; Merkel 2013; Van Mechelen, Hlobil, & Kemper, 1992). Sporting activities have further social benefits that may promote pro-social behaviour, fair play and personal responsibility (Maffulli, Longo, Spiezia, & Denaro, 2010). International sports federations have demonstrated the ability to successfully encourage physical activity on a global scale, for example FIFA Medical Assessment and Research Centre (F-MARC) in football and Fédération Internationale de Natation (FINA) in aquatics (Mountjoy et al., 2018).

In rugby there is a higher injury incidence than other sports due to the frequent high-impact collisions during play (Williams et al., 2013). These collisions are responsible for the most injuries, with the greatest risk of injury being from collisions occurring in the tackle phase of the game in senior rugby (Fuller et al., 2007a, Williams et al., 2013). Similarly in youth rugby, the tackle phase is responsible for the most injuries with higher numbers of moderate and severe injuries occurring in the more senior age groups (U16-U17) than in the younger age groups U9-U10 (Haseler, Carmont, & England, 2010). In contrast in South African youth rugby, overall injury risk decreased with increasing age (Sewry, Verhagen, Lambert, van Mechelen, Marsh, Readhead, Viljoen and Brown. 2018). Mixed findings have been reported regarding

concussions in South African youth rugby. Previously, a higher incidence of concussion has been identified in older age groups (U16-U18) than younger age groups (U13) (Brown, Verhagen, Viljoen, Readhead, Van Mechelen, Hendricks, Lambert. 2012), however more recently it was the younger age groups (U13 and U16) that reported higher incidence than the senior age group (U18) (McFie, Brown, Hendricks, Posthumus, Readhead, Lambert, Alison & Viljoen. 2016). In South African youth rugby, the tackle was also been associated with the highest risk of injury regardless of age (Sewry et al., 2018).

The Players' attitudes and behaviour towards injury prevention have been highlighted as risk factors for injury in rugby (Gianotti et al., 2009; Hendricks et al., 2015). While successful injury prevention strategies will be dependent on players adopting these behaviours towards safety, they may be achieved by increasing player awareness and the promotion of these attitudes (Lund & Aarø 2004; Gianotti et al. 2009).

Although there is a growing body of research on the knowledge, attitudes and behaviours in rugby players (Hendricks et al., 2012; Brown et al., 2015), there is little evidence on coaches' knowledge, attitudes and behaviours of coaches and how these affect the players behaviours towards injury prevention programmes (Murray, Murray, & Robinson, 2014; Carter & Muller, 2008).

The purpose of this literature review is to establish a theoretical framework that presents a scientific discussion of the factors that may promote safety in rugby. The aims are to identify the risk factors for injury and to provide a better understanding of effective injury prevention training programmes for rugby players.

Injury Prevention Models in Sport

Several theoretical injury prevention models have been described which identified measures to prevent injuries and improve the understanding of injury aetiology (Bahr & Krosshaug, 2005; Finch, 2006; Meeuwisse, , 1994; van Mechelen, Hlobil, & Kemper, 1992; Kok & Bouter, 1990). Meeuwisse's model (1994) describes the interaction between different factors that may lead to an injury. Bahr and Krosshaug (2005) further propose that an injury is not exclusively caused by the injury mechanism, but rather as a result of the intricate network of intrinsic and extrinsic risk factors. van Mechelen et al. (1992) offered a four-step injury prevention model: (1) identify the problem, (2) establish aetiology and mechanisms, (3) develop, evaluate, and implement interventions, and (4) re-evaluate the effect via continued surveillance (Figure 1). Finch (2006) expanded on van Mecehelen's four step model and introduced the Translating Research into Injury Prevention Practice (TRIPP) model, which aims to better understand the application of injury prevention.

In this literature review, the four-step "sequence of prevention" model proposed by van Mechelen et al. (1992) is used to establish the association between reported tackle coaching methods and players' tackle training attitudes and behaviours.

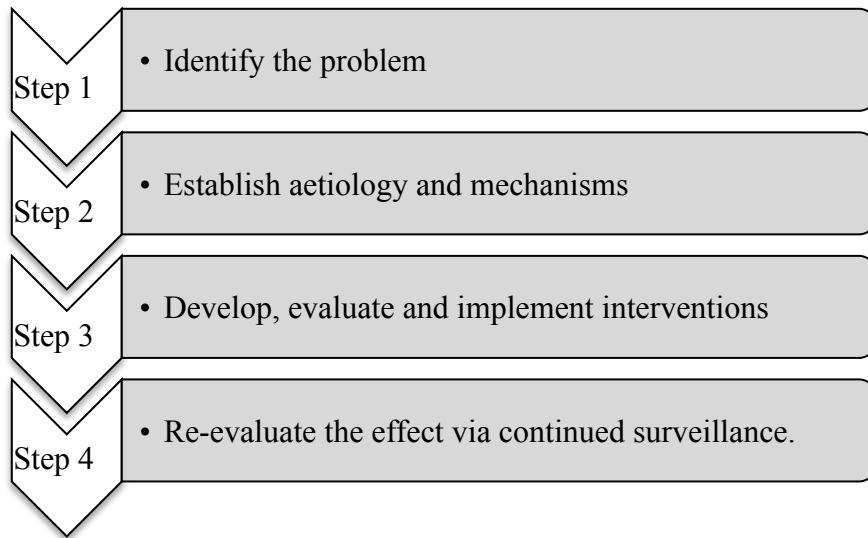


Figure 1: van Mechelen's four-step injury prevention model.

STEP 1: Identify the Problem to Establish the Extent of the Sport Injury

Primarily, the problem must be acknowledged and explained with regards to the incidence and severity of injuries in rugby (van Mechelen et al., 1992). Fuller et al. (2007b) describes the current and most widely used methods and injury definitions of reporting on sports injuries in Rugby. Next, data are collected to establish the localization and magnitude of tackle injuries in Rugby (van Tiggelen et al., 2008).

Rugby and the Nature of the Game

Rugby is played in 121 countries around the world and in 2016 included over 8.5 million players (World Rugby, 2016). Rugby is a field-based team sport with 30 players in two teams of 15 each competing for at least 80 minutes at the senior levels (Quarrie & Hopkins, 2008). Players may be involved in multiple contact situations as the attacking and defending teams attempt to gain territory (Patricios, 2014). Depending on the positional roles in the team, players may engage in as many as 10–25 tackles during a match (Deutsch, Kearney & Rehrer, 2007; Quarrie & Hopkins, 2008). A key determinant for success in this sport is the ability to contest for the ball

in the tackle (Gabbett & Kelly, 2007). Large extrinsic forces result from these collisions and tackles leading to a high proportion of musculoskeletal injuries (Gabbett & Ryan, 2009), with rugby accounting for some of the highest incidence of musculoskeletal and neurologic injuries compared to other sports (Brooks, Fuller, Kemp, & Reddin, 2005a). All players are at risk of injury in rugby, irrespective of professional or amateur status (Garraway, Lee, Hutton, Russell, & Macleod, 2000) although professional players are more likely to be injured (Brooks, Fuller, Kemp & Reddin, 2005b).

Table 1. Injury incidence, injury definitions and tackle-related injury rates reported in Rugby over twenty years (1995-2015).

Study	Subjects	Injury Incidence	Injury Definition	Contact and Tackle Injury
Garraway et al. (1995)	1169 senior rugby players in a study undertaken in the south of Scotland during the 1993-1994 season.	12 - 15 injuries per 1 000 player hours.		
Lee et al. (1996)	1705 players from nine Edinburgh schools and 1169 (96%) of 1216 eligible players from all 26 senior Scottish Rugby Union clubs.	Schoolboy match injuries were 86.8 per 1000 player-seasons. Senior club match injury 367 per 1000 player-seasons.	An injury sustained on the field during a competitive match, during a practice game, or during training activity directly associated with rugby football, which prevented the player from training or playing rugby football from the time of the injury or from the end of the match or practice session in which the injury was sustained.	Majority of match injury episodes in schoolboys were associated with tackling (40%) or with being tackled (24%).
Jakoet & Noakes (1998)	All national players at the 1995 Rugby World Cup Tournament.	32 injuries per 1000 match exposure minutes.	A rugby injury was a new injury that necessitated the player's leaving the field of play for the remainder of the game.	The tackling phase of the game accounted for 56% of all injuries.
Bathgate et al. (2002)	Australian national players over a 6-year period (1994-2000).	69 injuries per 1 000 hours. 47 per 1000 player hours before and 74 per 1000 player hours after professionalism.	An injury that forced a player to either leave the field or miss a subsequent game.	Most injuries occurred in the tackle phase 58.7%.
Junge et al. (2004)	Male, amateur players aged 14-18 years. 145 soccer and 123 rugby players over a season.	47.5 injuries per 1000 match hours.	An injury was any physical complaint caused by soccer or rugby during school training and matches.	Rugby players incurred two thirds of their injuries during contact with another player.
Brooks et al. (2005a)	England Rugby Union players during preparation for and participation in the 2003 Rugby World Cup.	17 injuries per 1000 hours of exposure (match: 218 injuries per 1000 hours; training: 6.1 injuries per 1000 hours).	Any injury that prevented a player from taking a full part in all training activities typically planned for that day and match play for a period equal to or greater than 24 h, from midnight of the day the injury was sustained.	The majority of injuries occurred to players being tackled (22%) and to a lesser degree, to players when tackling (13%).
Brooks et al. (2005b)	546 Rugby Union players at 12 English Premiership clubs professional for the two seasons 2002/2003 and 2003/2004.	91 injuries per 1000 player-match hours.	Any injury that prevents a player from taking a full part in all training and match play activities typically planned for that day for a period of greater than 24 hours from midnight at the end of the day the injury was sustained.	Contact mechanisms accounted for 72% of injuries. Most injuries sustained by ball carrier were from side on (51%) and head on (34%) tackles. Most injuries from tackling were from head on (56%) and side on (38%) tackles.
Holtzhausen et al. (2006)	75 South African professional players during the 1999 Super Rugby season.	55.4 per 1000 player match hours. 4.3 per 1000 player training hours	An injury which prevented a player from playing or squad training, or one that required special medical treatment (medication, suturing, radiographs)	Contact between players accounted for 64.5% of all injuries. The most dangerous phase of play during matches was being tackled, 46.3% of game injuries.
Fuller et al. (2007a)	645 professional Rugby Union players from 13 English Premiership Rugby Union clubs over two-seasons (2003/2004 and 2005/2006)	53.8 per 1000 hours	Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union by Fuller et al. (2007b)*.	Tackles were the game event responsible for the highest number of injuries and the greatest loss of time in Rugby Union because they were by far the most common contact event.
Quarrie and Hopkins (2008)	Professional rugby players in New Zealand between 2003-2005	12.2 per 1000 player hours	Medical injuries for which medical information for NZ based players were entered into RugbyMed by team physicians.	The impact of the tackle was the most common cause of injury.

Schrick et al. (2008)	2006 Women's RWC Teams	37.5 per 1000 player hours in matches. 3.0 per 1000 player hours in training	Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union by Fuller et al. (2007b)*.	63% (36% tackled and 27% tackling)
Fuller et al. (2009)	813 players in 2009 Super Rugby and Vodacom Cup Teams	96.3 per 1000 player match hours for Super Rugby; 71.2 per 1000 player match hours for Vodacom Cup	Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union by Fuller et al. (2007b)*.	64% (33% tackled and 31% tackling)
Taylor et al. (2011)	2010 Women's RWC teams	35.5 per 1000 player match hours	Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union by Fuller et al. (2007b)*.	38% (33% tackled and 5% tackling)
Fuller et al. (2013)	2011 RWC teams	40.1 per 1000 hours (21.9 per 1000 hours tackled; 18.2 per 1000 tackling)	Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union by Fuller et al. (2007b)*.	44%
Schwellnus et al. (2014)	152 professional South African players during the 2012 Super Rugby Union Tournament.	9.2 per 1000 player hours (83.3 per 1000 per match hours, 2.1 per 1000 hours for training)	Time loss injuries which prevented playing in matches or training for > 1 day.	Tackling (26.3%) and being tackled (23.1%) were the most common mechanisms of injury.
Williams et al. (2015)	Professional English rugby players over seven seasons		Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union as described by Fuller et al. 2007b*.	
Moore et al. (2015)	78 national Welsh Rugby Union players over a three-year period.	90 to 98 injuries per 1000 match-hours.	Any physical complaint sustained by a player during an international match or training session that prevented the player from taking a full part in all training activities or match play for more than 1 day following the day of injury, irrespective of whether match or training sessions were actually scheduled.	78% of all match injuries due to contact events compared with 26% of all training injuries. Of match contact injuries, the majority occurred during tackle-related events (31%).
Fuller et al. (2017)	639 international rugby players representing 20 countries at the 2015 RWC	90.1 per 1000 player-match-hours and 1.0 training injuries per 1000 player-training-hours	Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union as described by Fuller et al. (2007b)*.	46% (25% tackled and 21% tackling)

**Any physical complaint, which was caused by a transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, that was sustained by a player during a rugby match or rugby training, irrespective of the need for medical attention or time-loss from rugby activities. An injury that results in a player receiving medical attention is referred to as a 'medical-attention' injury and an injury that results in a player being unable to take a full part in future rugby training or match play as a 'time-loss' injury. (Fuller, et al. 2007b, p. 178)*

Definitions of Injury in Rugby

In rugby studies, the currently accepted definition of injury is:

“Any physical complaint, which was caused by a transfer of energy that exceeded the body’s ability to maintain its structural and/or functional integrity, that was sustained by a player during a rugby match or rugby training, irrespective of the need for medical attention or time-loss from rugby activities” (Fuller et al., 2007b p. 178).

Fuller et al. (2007b) further describes types of injuries as follows:

“Injury that results in a player receiving medical attention is referred to as a ‘medical-attention’ injury and an injury that results in a player being unable to take a full part in future rugby training or match play as a ‘time-loss’ injury” (Fuller et al., 2007b p. 178).

Injury severity defined as follows:

“Injury severity is based on time, calculated in days lost from competition and practice. Injuries are grouped as slight (0–1 days), minimal (2–3 days), mild (4–7 days), moderate (8–28 days), severe (28 days), career-ending, and non-fatal” (Fuller et al., 2007b, p. 178).”

Epidemiology and Risk of Injury in Rugby

Rugby has been portrayed as having a greater risk of injury to a player (69 – 81 injuries per 1000 hours) compared to other sports, such as cricket (2 injuries per 1000 hours) or soccer (28 injuries per 1000 hours) (Bathgate et al. 2002; Williams et al. 2013).

Table 1 outlines the injury incidence, injury definition and proportion of contact and tackle injury in the literature over the past 20 years. The studies are reported chronologically: Garraway & Macleod (1995) reported a low injury incidence in senior Scottish rugby players of 12-15 injuries per 1000 player hours. Jakoet & Noakes (1998) showed an average of 32 injuries per 1000 match exposure minutes of all international teams at the 1995 Rugby World Cup (RWC), whilst Lee & Garraway (1996) identify Scottish schoolboy match injuries of 86.8 per 1000 player seasons and an extremely high senior club match injury prevalence at 367 per 1000 player hours. Holtzhausen, Schweltnus, Jakoet & Pretorius (2006) reported an injury incidence of South African professional players during the 1999 Super Rugby season identifying 55.4 injuries per 1 000 player match hours and training injuries of 4.3 per 1000 player training hours. Bathgate et al. (2002) described 69 injuries per 1000 hours' exposure in Australian professional players over a six-year period. Junge, Cheung, Edwards, & Dvorak, (2004) reported a rate of 47.5 injuries per 1000 player game hours in amateur players in New Zealand. Brooks et al. (2005a) reported a very high incidence of 218 per 1000 hours of player exposure during matches in the national English players at the 2003 Rugby World Cup (RWC). Brooks et al. (2005b) further reported a much lower incidence of injury of 91 injuries per 1000 player match hours in professional English rugby players for the 2002/2003 and 2003/2004 Premiership seasons. Fuller

et al. (2007a) reported a rate of 53.8 per 1000 hours in English Premiership Rugby Union clubs over the two-seasons of 2003/2004 and 2005/2006. Schick, Molloy & Wiley (2008) reported a comparatively lower incidence of 37.5 per 1000 player match hours in international female players during the 2006 Women's Rugby World Cup (WRWC). Similar findings, 35.5 per 1000 player match hours, are found at the 2010 WRWC (Taylor, Fuller, & Molloy, 2011). Quarrie & Hopkins (2008) report a significantly lower incidence of 12.2 per 1000 player hours in professional New Zealand players. Fuller, Raftery, Readhead, Targett & Malloy (2009) reported on South African professional rugby players and found that participation at a higher level of competition resulted in a higher incidence of injury (96.3 injuries per 1000 match hours compared to 71.2 per 1000 match hours). Schweltnus et al. (2014) later reported 83.3 per 1000 match hours in the same top tier tournament in South Africa in 2012. Moore, Ranson & Mathema (2015) reported injury incidences of 90-98 injuries per 1000 player match hours for all international teams at three RWC tournaments (2003-2011). Fuller, Taylor, Kemp & Raftery (2016) reported similar findings of 90.1 match injuries per 1000 player hours for international players in all teams at the 2015 RWC.

To record team match exposure, "the total player-match exposure time in hours for a team is given by $\{NM \cdot PM \cdot DM / 60\}$ where NM is the number of team-matches played, PM is the number of players in the team (normally 15), and DM is the duration of the match in minutes (normally 80 minutes)" (Fuller et al., 2007b, p. 80).

According to World Rugby (n.d.), the Rugby World Cup and Women's Rugby World Cup are the highest level of the game and occur every four years. The conditions at the RWC's and WRWC's are ideal settings for monitoring injuries and allow trends to be identified. The range of incidence of injury for female players was lower at the

2006 and 2010 WRWCs (35.5-37.5 per 1000 player match hours vs. 32-98 per 1000 player hours) compared with a much larger range in male international players of at the Rugby World Cups from 1995-2015 (Jakoet & Noakes, 1998; Best, McIntosh, & Savage, 2005; Schick et al., 2008; Taylor et al., 2011; Fuller, Sheerin, & Targett, 2013; Moore et al. 2015; Fuller et al. 2016). The large difference in research findings may be due to differing research methods or injury reporting, injury definitions, law changes and potentially player awareness to report injury.

However, the transformation of rugby from amateur to professional status is believed to be the biggest factor affecting an increase in injury incidence in rugby and has resulted in an increased level of competition, aggression and foul play with longer periods of match play and longer seasons (Bathgate et al. 2002; Brooks et al. 2005a Gabbett, 2003; Quarrie et al., 2017). The changes to the game and players have made it increasing more difficult to score a 'try' (crossing the opponents line to gain five points) and the number of tries in the Six Nations tournament shows a steady decrease from seventy five tries in 2000 compared to thirty-seven in 2013 (International Rugby Board, 2013). It should also be noted that considerable negative associations have been identified between injuries and team success, which increases the impact that injuries have on professional players and teams (Williams et al., 2015).

Professionalism may have inclined individual player profiles to change in order to compete at a higher level as a strong association has been shown between players' mass, height and individual and team performances (Murray et al., 2014; Sedeaud et al., 2012). These anthropometric changes may result in an increased number of tackles being made involving a higher degree of momentum (mass and velocity) or

greater use of force resulting in greater collision forces that may increasing the risk of injury to the player (Garraway et al., 2000).

The nature of the game allows for multiple and common injuries. Injuries to the upper limbs are associated with the longest absence from competition than other injuries, may be more severe and account for 14% to 28% of all rugby injuries (Usman & McIntosh, 2013).

Injuries to the head are frequent and have been recorded as 6.6 per 1000 playing hours in professional players (Kemp, Hudson, Brooks, & Fuller, 2008), and 4.3 per 1000 playing hours in children (U9-U17) (Haseler, Carmont, & England, 2010). Concussion is a very common injury in rugby, with most incidents occurring during the tackle, resulting in an incidence of 4.1-8.9 per 1000 player hours in matches (Kemp et al, 2008; Cross, Kemp, Smith, Trewartha, & Stokes, 2015; Moore et al., 2015). These studies highlight the growing awareness of concussion from the 1st (Vienna 2001), 2nd (Prague 2004), 3rd (Zurich 2008) and 4th (Zurich 2012) International Consensus Conferences on Concussion in Sport respectively (Aubry et al., 2002; McCrory et al., 2005; McCrory et al., 2013; McCrory et al., 2009). Current recommendations for the appropriate management of concussion are based on the 2016 Consensus Statement on Concussion in Sport from the 5th International Conference on Concussion in Sport held in Berlin, Germany (McCrory et al., 2017). However, although this valuable evidence formed the guidelines, which improve our understanding of identification and management of concussion in sport, the implementation in real world scenarios is not guaranteed (Finch, McCrory, Ewing, & Sullivan, 2013)

Non-fatal catastrophic injuries are defined as: “Injuries to the head and neck resulting in permanent (>12 months) severe functional disability” (Fuller et al., 2007b, p. 178). The definition for catastrophic injury is: “any head, neck, spine or brain injury that is life-threatening, or has the potential to be permanently debilitating and results in the emergency admission of a rugby player to a hospital or medical care center” (Brown et al., 2013 p. 2). The rates of catastrophic injury in rugby appear to be reducing. In 2007 there were 0.6 per 100 000 players, between 2001-2005 there were 1.3 per 100 000 players per year and in the period 1996-2000 there were 2.7 per 100 000 players per year (Orchard, Leeder, Moorhead, Coates, & Brukner, 2007; Gianotti et al., 2009; Hermanus, Draker, & Noakes, 2010). Spinal cord injury (SCI) has severe physical, psychological and financial consequences for a player and has a significant negative effect on the profile of the sport (Patricios, 2014; Shelly et al., 2006).

Different playing positions require different roles and predispose players to particular different muscular damage due to these extrinsic forces (Smart, Gill, Beaven, Cook, & Blazeovich, 2008). Bathgate (2002) identified the most injuries per position were sustained in the forward players Numbers 4 and 5 (locks), followed by the Number 8's (Eighth-man). Interestingly, the Number 9 players (halfbacks), often the smallest players on the field, sustained the least injuries (Bathgate et al., 2002). More recently, the Number 2 players (hooker position), has been identified as the position in which the most frequent spinal cord injuries occur (Patricios, 2014) as the front-row forwards, numbers 1,2 and 3 (prop-hooker-prop) may be more predisposed to cervical injuries due to the loads transmitted and absorbed during scrummaging (Milburn, 1993; Brooks & Kemp, 2010). Collapsed scrum-events further increase these forces and result in considerably higher injury incidence compared to scrums that did not

collapse (Taylor, Kemp, Trewartha, & Stokes, 2014). Fuller and associates describe the scrum phase of play in rugby as having an increased risk (60%) of injury compared to the tackle phase (Fuller et al. 2007a) and is related with the most spinal cord injuries (Posthumus & Viljoen, 2008). However, conflicting studies have identified only small differences in the injury incidence and severity between forwards and back-line players (Brooks & Kemp, 2010; Williams et al., 2013). Continued research is essential to recognize the nature of injuries and contribute to the advancement of injury prevention strategies in rugby, this process should be seen as a continuum as the sport, players and injury profiles may change their characteristics over time as is currently noted.

The Tackle in Rugby

The tackle is widely accepted as the most dangerous facet of rugby and results in the greatest number of injuries, causing the most loss of time for the player (Holtzhausen et al., 2006; Fuller et al., 2007a; Fuller et al., 2009; Hendricks & Lambert ,2010; Schwellnus et al., 2014; Freitag, Kirkwood, Scharer, Ofori-Asenso, & Pollock, 2015). The tackle caused five times more injuries than other contact events at senior and elite levels of English rugby and in senior professional players in the northern hemisphere, compared to a much lower incidence in English Youth Academy and English schools players (Williams et al., 2013; Fuller et al., 2007a; Fuller et al., 2009; Palmer-Green et al., 2015). This finding is common to South African age group and senior player tackle-related injuries (Roux, Goedeke, Visser, Van Zyl, & Noakes, 1987; Clark, Roux & Noakes, 1990; Quarrie & Hopkins, 2008; Bruwer, Moss & Jacobs, 2017). In Women's rugby, Taylor et al. (2011) identified 38% of all injuries to be tackle related, with most injuries occurring to the ball carrier (33%) than compared to the defending player (5%)(Taylor et al., 2011). Schick et al. (2008) discovered nearly twice this

incidence of injuries (63%) in players at the following RWC with a more equal risk of injury to the ball carrier (36%) than to the defending player (27%) (Schick et al., 2008). This reduction in injury to the tackler may be due to the rapid progression of Women's rugby during this period, which has resulted in improvements in female players' knowledge, abilities and conditioning.

Side-on and head-on tackles have previously been described as resulting in the most injuries to the ball carrier (Brooks et al., 2005b), although conflicting results have more recently been shown (Burger et al., 2016). During the tackle phase of rugby the most frequently injured parts of the body are the upper limb (35%) followed by the head, neck and face (28%) and lastly, the lower limb (27%) (Wilson et al., 1999).

It is evident from the high incidence of tackle-related injuries that improvements are not only necessary, but also critical, during training for the tackle in practice and executing the tackle in matches to reduce injury risks and make rugby safer.

STEP 2: Establish the Aetiology and Mechanisms of Injury

The next step is to identify the factors which play a part in the incidence of rugby injuries (van Mechelen et al. 1992). The aetiology, mechanisms of the tackle injury and risk factors are recognized before commencing preventive methods in Step 3.

Risk Factors for Injury

Interactions between intrinsic (within the body) and extrinsic (outside of the body) risk factors affect the likelihood of a player sustaining an injury given a particular amount of contact (Merkel, 2013). Extrinsic (external) risk factors resulting in injury include coaching methods, training drills, player behaviour, appropriate or inappropriate equipment, training environment, level of competition, skill level, shoe

type, use of an ankle tape or brace, and playing surface (McKay, Goldie, Payne, & Oakes, 2001; Murphy, Connolly, & Beynnon, 2003). Intrinsic (internal) risk factors resulting in injury include age, sex, previous injury history, local anatomy and biomechanics, aerobic fitness, body size, limb dominance, flexibility and muscle strength, muscle imbalance and muscle reaction time, psychosocial and psychological states (Taimela, Kujala, & Osterman, 1990). Recently, Bruwer et al. (2017) established that the greatest intrinsic risk factors for lower limb injuries in rugby included pronated feet and gait, tight hamstring muscles, uneven hips, leg length differences and a tall physique. Psychological internal risk factors include competitiveness, motivation and perception of risk, all of which predispose a player to injury by affecting the risk seeking behaviour of players in game situations (Meeuwisse, 1994; Lee, Garraway & Arneil, 2001; Bahr & Krosshaug, 2005). Adverse risk behaviours have been identified in as many as 39% of NZ players who admitted to playing rugby against medical advice (Gerrard, Waller, & Bird, 1994), with the consequence of the player being more likely to be injured and face a greater absence from sport (Lee et al., 2001; Brooks & Kemp, 2010). More recently, players' attitudes and behaviours regarding safety have been highlighted as risk factors for injury in rugby (Hendricks et al., 2012; Hendricks et al., 2015). Attitude refers to "the knowledge and beliefs of a person concerning the specific consequences of a certain form of behavior" (Kok & Bouter, 1990 p. 603). Behaviour can be affected by attitudes, social factors and perceptions of self-efficacy resulting in positive or negative behaviours (Kok & Bouter, 1990; Greenlees, Nunn, Graydon, & Maynard, 1999). Examples of player behaviours are training routines, relations with match officials, other players and administrators, diet and sleep (Hendricks et al., 2012). Attitudes and behaviours of players need to be thoroughly understood before planning

injury prevention strategies, as the causal interactions need to be controlled in order to have the greatest effect and most successful outcome (Finch et al. 2002).

Tackle Injury Risk Factors

Particular elements of the tackle phase are recognized as significant risk factors for injury to the ball carrier and tackler, namely attitudes, knowledge and execution of tackle technique, physical and mental abilities, genetics, going into tackles at high speed resulting in greater impact forces, collisions and contact with a player's head or neck (Fuller et al., 2010). The tackler's general lack of skill in the tackle has been identified as a risk factor for sustaining concussions or catastrophic cervical injuries (Scher, 1991; Garraway et al., 1999). Recently, Burger et al. (2016) report that in U18 rugby players, the tackler is at a higher risk of being injured during tackle-related injury events compared to the ball carrier. Tackles executed from the side or from behind the ball carrier resulted in the highest occurrence of injury to the tackler (58%), with a lower occurrence for front-on tackles (42%) (Burger et al., 2016). Conversely in senior players, the front-on tackle has been most often associated with injury (Wilson et al. 1999; Kemp et al. 2008; Quarrie & Hopkins, 2008).

Certain techniques have been identified in the contact phase of the tackle and in preparation for the tackle that may prevent injury during execution of this skill (Fuller et al., 2007a; Quarrie & Hopkins 2008; Hendricks & Lambert, 2010; Burger et al., 2016). In preparation for contact the tackler may shorten his/her stride length to allow his/her closest shoulder to make contact with the ball carrier's centre of gravity (Burger et al., 2016). Making contact in this area of the ball carrier's body reduces the risk of impact from potentially dangerous areas such as the bony pelvis or legs (Hendricks & Lambert, 2010). The safest area of the ball carrier's body to make

contact with is the region below the sternum and above the hips, this reduces the chance of injury to both players (Burger et al. 2016). Tackles made above the shoulder line are dangerous to the ball carriers and are not permitted in the game (Fuller et al., 2007a; Quarrie & Hopkins 2008; Hendricks & Lambert, 2010). The tackler may also perform a shoulder drive after making contact with the ball carrier which has an influence towards a non-injury outcome (Burger et al., 2016). This technique is used more frequently by players who are more mature in age and playing level, demonstrating greater experience in safe and effective tackling behaviour (McIntosh, Savage, McCrory, Fréchéde, & Wolfe, 2010).

There appears to be contrasting evidence on the role of fatigue and tackle related injuries in rugby. It has been shown that most injuries in rugby occur in the last half of a match (Bathgate et al., 2002; Williams et al., 2013) which infers that correct tackling techniques reduce as player fatigue increases over the course of the match (Gabbett & Kelly, 2007; Burger et al., 2014; Williams et al., 2013). Conversely, Moore et al. (2015) reported no differences between the injury incidence and severity of injuries in either half of the game. Further, no evident decline in high intensity activity is noted for the duration of a game in elite players (Roberts, Trewartha, Higgitt, El-Abd, & Stokes, 2008). This implies that professional players are not at an increased risk of getting injured when fatigued as has been reported by others. This reduction in injury may be as a result of improved physical conditioning. However, further research into the mechanism of fatigue and the effect on player performance, both physical and cognitive, and how this relates to rugby injuries is required.

With regard to reducing tackle-related injuries to the ball carrier, McIntosh et al. (2010a) observed increased risk behaviour in younger and less experienced players who did not immediately go to ground after contact in the tackle (McIntosh, McCrory, Finch, & Wolfe, 2010). Conversely, Burger et al. (2016) showed the same action by the ball carrier and also presenting the ball towards supporting players was more risk averse behaviour towards a non-injury outcome in the post contact phase. This may have important inferences in the attacking team retaining possession of the ball and reducing risk of injury to the ball carrier. Thus it is essential to thoroughly recognize tackle injury mechanisms which may assist in the advancement of injury prevention education and ultimately, in player behaviour.

Team defensive structures may reduce tackle-related injuries as defending players rehearse roles and responsibilities during training with the input of the coach, plan with other players on the field, and personally premeditate who and how they will execute a tackle (Gabbett & Ryan, 2009; Hendricks & Lambert, 2010). This suggests that a team that defends better as a whole will reduce the stress on the individual player. Effective whole team defensive systems require sufficient knowledge and ability of the coach to educate players to ensure they are able perform their specific roles.

STEP 3: Develop, Evaluate, and Implement the Intervention

The penultimate step of the ‘sequence of prevention’ model is to initiate methods to reduce the risk of injury or the severity of injury to players in rugby. These methods should be based on data collected in the first two steps and take into account tackle injury epidemiology, mechanisms of tackle injuries and the identified risk factors for tackle injuries (van Mechelen et al., 1992).

Preventative Measures

At a player level, injury prevention programmes should be personalized and based on previous injury history, be position-specific, and allow for individual strategies of recovery (Brooks & Kemp, 2010; West et al., 2014). There should be an individual approach on the appropriate technique with emphasis on scrummaging, weight training and skills training with the goal of elevating each player's fitness and playing ability. This may have an added benefit during a match as players are substituted for others with similar attributes, resulting in a smaller effect on team performances due to personnel changes (Palmer-Green et al., 2013; Quarrie et al., 2017). Coaching correct tackle technique, improving individual competency in tackling skills and education of appropriate tackle techniques to players may reduce tackle-related injuries (Hendricks & Lambert, 2010). Correct coaching of technique in the tackle has been described as “extremely important and one of the few possible modes to reduce injuries to the head, neck, brain and spine” (Posthumus & Viljoen, 2008, p. 64). Thus, coaches should be appropriately educated and have the applicable knowledge base and skill set to prepare players for the tackle contest in order to reduce injury risk (Hendricks & Lambert, 2010).

At a global level, processes to reduce injury incidence in rugby have included equipment trials, law changes and nationwide educational initiatives that include a specific focus on reducing non-fatal catastrophic injuries to the cervical spine (Quarrie, Cantu, & Chalmers, 2002; Posthumus & Viljoen 2008; Fuller et al. 2010; Hendricks, Lambert, Brown, Readhead, & Viljoen, 2014; Taylor et al., 2014). Thus, improving the knowledge base of coaches through education of appropriate techniques for tackling is important for injury prevention strategies, especially at the

junior level of sport including rugby (Carter & Muller, 2008; Hendricks & Sarembock, 2013).

The Role of the Coach in the Prevention of Injury

Coaches are responsible for preparing their players for the technical and physical requirements of their sport (Van Tiggelen et al. 2008) and coach education has been identified as a fundamental component of sports injury prevention and risk management models (Chalmers, Simpson & Depree, 2004; Carter & Muller, 2008; Posthumus & Viljoen, 2008; Twomey et al., 2009; Hendricks & Sarembock, 2013; White et al., 2013)

The coach and the training session is an effective delivery platform to translate scientific evidence into practice in order to implement strategies to reduce the injury risk (Twomey et al., 2009; Hendricks & Lambert, 2010; Saunders et al., 2010; Hendricks et al., 2015). This finding indicates how coaches affect players' attitudes and behaviours regarding well-being and interactions with match officials and other players. There appears to be limited research with specific focus on the coach's role towards reducing injuries in rugby and only little information regarding training the tackle and the effect on player behaviour in matches (Saunders et al., 2010; Hendricks & Sarembock, 2013; Hendricks et al., 2015).

Knowledge, Attitudes and Behaviours

Hendricks & Sarembock (2013) highlight the knowledge, attitude and behaviour of coaches as important components to injury prevention strategies in junior rugby. In the context of rugby, the relationship between player knowledge, attitudes and behaviours may be understood with the assumption that adjustments to player

knowledge will adapt player attitude and this change in attitude could result in modified player behaviour (Lund & Aarø, 2004; Eime et al., 2004). Change in knowledge is achieved by improving the understanding of injury risks and explaining the advantageous effects of injury prevention, which may lead to a reformed attitude and potentially influence safety behaviours (van Tiggelen et al., 2008).

Although player behaviour is an important influence on achieving injury prevention in sport (Gianotti et al., 2009), it remains under researched in sports injury prevention (Finch, 2006; Timpka, Ekstrand & Svanstrom, 2006; Verhagen, van Stralen, & van Mechelen, 2010). Van Tiggelen et al., (2008) reported that the most applicable method to change behaviour is to assimilate appropriate behaviour into the player's skills training at an early stage and to emphasize it until it becomes an established part of their routine. Eime, Finch, Sherman & Garnham (2002) further support this by stating that substantial incentives serve as effective stimuli to desired behaviour. However, even with an early start incorporating appropriate behaviours, the level of these learnt behaviours regress in adolescent players, despite having a better understanding of risk situations, compared to younger players (Finch et al., 2001).

In general, it is important to have a detailed understanding of the types of knowledge to be able to illicit the desired effect on the subject or topic. Dexter (1999 p. 283) defines declarative knowledge, procedural knowledge and strategic knowledge in sport as: "declarative knowledge refers to the rules, procedural knowledge refers to the techniques and tactics, and strategic knowledge is knowing how to learn or remember". Carter & Muller (2008) stated that coaches' knowledge of mechanisms of injury improves with coaching experience and qualification. This may account for the finding that rugby players are more proficient and acquire proper tackle techniques at

older ages and greater experience (Gabbett & Ryan, 2009; Burger et al., 2014; Burger et al., 2016). Nash, Sproule & Horton (2008) and Koester (2000) assert that effective training of coaches increases their knowledge base that can be utilized for their coaching environments, making them more likely to be effective coaches. More informed and effective coaches should be able to instruct players in the correct injury preventative techniques and potentially reduce injury risk in players. However, many coaches may not have the appropriate knowledge base as the hierarchical coaching structures may result in the least experienced coaches operating at the most critical stages of player development (Carter & Muller, 2008; Hendricks et al., 2012; Nash et al., 2012). It is further noted that although coaches need an appropriate knowledge base to be effective, it is the capability of the coach to be able to use this knowledge to transfer correct information and techniques to the player that divides a knowledgeable coach from an effective one (Gilbert, Gallimore, & Trudel, 2009).

Implementation of coach education has seen a change from a traditional teaching approach to a problem based-learning approach. Traditional approaches, such as coach certification workshops, are very effective in short-term knowledge retention. However, greater long-term knowledge retention, performance assessment and learner satisfaction scores are consistently seen with a problem-based learning approach (Gilbert et al., 2009). To ensure the best acquirement of knowledge in coaches, the educational material for these workshops should be appealing and understandable (Gwadry-Sridhar et al., 2003).

Coaching Behaviours and Methods

There is limited research on the role of coaching behaviours in rugby: however, Hendricks et al. (2015) report an association between verbal instruction and demonstration, and match behaviours and recommend these to be effective methods for coaching tackling and other contact skills. Furthermore, it has been identified that the social context, timing and the approach with which a coach converses with a player, affects how a player perceives his or her own capabilities and understands technical instruction (Koester, 2000; West et al., 2014; Hendricks et al., 2015; Quarrie et al., 2017).

Coach Education

Coach education via specific rugby safety accreditation courses have been implemented to support injury prevention programmes and have proven to be effective in modifying risk factors associated with injury mechanisms, reducing the incidence of injury (Saunders et al., 2010). Examples of this include the RugbySmart and BokSmart injury prevention programmes (Gianotti et al., 2009; Brown et al., 2016). RugbySmart is New Zealand's nationwide education programme for injury prevention in rugby and was instigated in 2001. RugbySmart aimed "to systematically reduce the number and severity of injuries in community rugby by providing evidence-based information about injury risks and injury prevention strategies to coaches and referees" (Gianotti et al., 2009, p. 371). The RugbySmart programme was associated with improvements in player injury-preventing behaviours that concurrently saw a reduction in injury rates in this cohort (Gianotti et al., 2009). BokSmart is South Africa's nationwide rugby injury prevention programme, modelled on the successful attributes of RugbySmart, and was launched in July 2009 (Viljoen & Patricios, 2012).

Coach education programmes should include coach role models or peer leaders as they are considered more effective because of their instant credibility with other group members, their ability to relate to local problems or difficulties, and have first-hand experience with community-generated strategies (Gilbert et al., 2009). Coaches can also learn through informal channels, for example learning from experience and social networks to ascertain causal connections between their instructions and player outcomes (Gilbert et al., 2009; Gallimore, Ermeling, Saunders, & Goldenberg, 2009; White et al., 2013). Bloom, Stevens & Wickwire (2003) found that Canadian expert senior coaches considered informal networks to be of immense benefit compared to the formal coaching clinics. Similarly in South Africa, rugby coaches benefited from colleagues, televised rugby matches and attendance at live rugby matches to increase knowledge and develop new training drills (Hendricks & Sarembock, 2013). They reported the least preferred resources for the provision of information to be attending workshops, formal coaching or physical education courses as well as newspapers (Hendricks & Sarembock, 2013). This is in contrast to the experiences from netball coaches in Australia who acknowledge coach training workshops and accreditation courses to be the best way to encourage coaches to implement injury prevention programmes (White et al., 2013). It is imperative to understand specific coaches' preferred learning techniques and to emphasize delivery of continuing education and the processes used to transfer knowledge to their players. The goal is to make training courses more attractive and to encourage improved player engagement during training sessions (Carter & Muller, 2008; Hendricks & Sarembock, 2013; White et al., 2013). A proposal has been put forward to find other means of communicating information that may be more useful to coaches (Hendricks & Sarembock, 2013). Brooks et al.,

(2010) suggest that successful interventional methodologies used in other sports may be applicable to rugby (Brooks & Kemp, 2010) and this should be explored further.

Educational injury prevention programmes have been successful in improving correct and appropriate knowledge in coaches, although the implementation of these programmes and transfer of knowledge to the players is not always successful (Eime et al., 2004; Mountjoy et al., 2018). This has previously been observed in netball (White et al., 2013) and football (Twomey et al., 2009). However, in rugby, coaches have displayed positive attitudes with regards to preventing injury and improving performance (Hendricks & Sarembok, 2013) and that players' tackling knowledge and philosophies developed during training may transfer into match play (Hendricks et al., 2015).

STEP 4: Re-evaluate the Effect of Intervention via Continued Surveillance

The concluding phase of van Mechelen's 'sequence of prevention' model (1992) is to measure the efficacy of the interventions by repeating the first step and comparing the results, something which has also been emphasized by van Tiggelen et al. (2008). Regarding rugby, there is substantial research on injury incidence at all levels of the sport, but there is limited research regarding the effectiveness of injury prevention programmes, and even less on nationwide programmes (Gianotti et al., 2009; Saunders et al., 2010; Brown et al., 2015). The RugbySmart programme focused on amateur rugby players and identified that players were less likely to emphasize and practice safe tackling techniques during training before the programme was introduced. Comparatively, after the programme was introduced players partook in a higher frequency of safe tackle training with a concomitant reduction in spinal injuries related to scrumming (Quarrie, Gianotti, Hopkins, & Hume, 2007; Gianotti et

al., 2009; Brown et al., 2016). Limitations to these findings have been acknowledged, and Noakes and Draper (2007) argue that these findings may be due to inconsistent methodology and to changes in the nature of the game, which may be unrelated to the introduction of the RugbySmart programme in NZ.

Recently, the BokSmart programme has also been associated with improvements in players' behaviour in favour of safe tackling techniques in South Africa (Brown, Gardner-Lubbe, Lambert, Van Mechelen, & Verhagen, 2014; Brown et al., 2015). Although Patricios (2014) proposes that the reduced injury rates associated with the BokSmart programme may rather be associated with the change in scrumming laws during this period which resulted in a large increase in penalties and free kicks, 14% in 2008 vs. 31% in 2012, for scrum offences (International Rugby Board, 2012). Interestingly, the BokSmart programme was associated with a significant decline in serious injuries in junior players, but not in senior players who have a greater understanding of risk situations (Finch et al., 2001), are more proficient tacklers (Gabbett & Ryan, 2009; Burger et al., 2014) and are at an increased risk of suffering a serious injury (Brown et al., 2016).

Injury prevention models that aim to educate coaches and players in safer techniques, and training sessions that emulate match behaviours, support the current implementation of injury prevention programmes in rugby, such as BokSmart and RugbySmart (Gianotti et al. 2009; Hendricks et al., 2015; Brown et al., 2016). The current study will contribute to the broader literature in this field and will specifically address players' attitudes and preferred learning resources for safer tackle behaviours in rugby in relation to the reported tackle coaching techniques.

2.4 Summary

Player behaviour is a critical element underlying success of injury prevention programmes wherein the main goal is to reduce the incidence of injury (Gianotti et al., 2009; Lund & Aarø, 2004; Brown et al., 2015). Although the manner and timing of implementation of these programmes are dependent on the attitudes and beliefs of coaches (White et al., 2013). Only scientifically effective techniques that become regular practice will reduce injuries (Finch, 2006; Twomey et al., 2009). Thus, the success of injury prevention interventions depends on the coaches applying the appropriate knowledge and training drills into their regular training sessions at the appropriate timing and social context (Koester, 2000; van Tiggelen et al., 2009; White et al., 2013; Hendricks et al., 2015; Quarrie et al., 2017; West et al., 2014).

Due to the collision nature of rugby, there is a high incidence of injury. The application of targeted injury prevention programmes have been shown to reduce injuries in rugby, and some injuries are avoidable with safer techniques and behaviours. Changes in knowledge have the ability to modify behaviours. Coaches have been identified as having a large influence on transferring knowledge of appropriate techniques to players in order to prevent injuries by encouraging attitudes and behaviours that promote safe and effective tackle techniques. Also, the implementation of injury prevention programmes, such as RugbySmart and BokSmart, has been important in reducing injuries. To ensure the greatest positive outcomes strategies should aim to improve coaches' learning, knowledge and skills, and improve player-coach interaction. More resources should be given to incorporate safe training into formal session and to coach role models should be used to incorporate problem-based learning approaches. Coaches must be versed in

appropriate conditioning that allows for position and player-specific injury prevention exercises. The differences of junior and senior audiences should be taken into consideration when planning the context of the programmes.

There is an assumption that these injury prevention programmes influence and improve coaches' knowledge, which in turn may reduce injury rates by modifying behaviours of players. There is limited research specifically identifying players' attitudes towards safer tackling behaviours related to how coaches promote these behaviours and learning resources. In this thesis, the relationship between reported coaching behaviours and learning resources on players' attitudes and behaviours towards injury prevention and performance in the tackle is highlighted.

The Research Study

The Relationship between Reported Rugby Coaching Behaviours and Learning Resources on Players' Attitudes towards Injury Prevention and Performance in the Tackle.

Introduction

The tackle in youth rugby is a high-risk injury activity accounting for the highest number of all injuries, including concussion and half of all spinal cord injuries (Burger et al., 2014; Hendricks, Matthews, Roode, & Lambert, 2014 b; McFie et al., 2016). Players may participate in approximately 10-15 per tackles per match, and successfully dominating these physical contests is a measure of a player's performance as well as associated with the overall success of the team (Duthie, Pyne, & Hooper, 2005; Roberts, Trewartha, Higgitt, El-Abd, & Stokes, 2008; Wheeler & Sayers, 2009). Thus the two main goals when performing the tackle in rugby are to prevent injury and win the physical contest for possession of the ball.

It is widely accepted in sports that a player's attitude toward injury prevention and performance impacts their behaviour during training and matchplay (Kok & Bouter, 1990; Emery, McKay, Campbell, & Peters, 2009; Finch et al., 2001; Finch et al., 2002; Osberg & Stiles, 2000; Peterson, 2002) and has recently been further highlighted in rugby (Hendricks et al., 2012; Hendricks et al., 2016). Hendricks et al. (2016) demonstrated that attitudes of tackle technique that were attained in training sessions transfer into behaviours during a match. The current study highlights the significance of the coach in determining the player's attitude towards safety and performance during the training sessions, especially at the youth level. To date, the author is not aware of clinical research published in English to date that has evaluated the influence of reported coaching behaviour on player's attitude toward safety and performance during the tackle.

Teaching players appropriate tackling techniques has proven to be successful in reducing the incidence of injury in rugby and has been an important component of national injury prevention programmes, such as RugbySmart (New Zealand), BokSmart (South Africa) and

Rugby Ready (World Rugby) (Patricios, 2014; Quarrie et al., 2007). These programmes educate through the provision of learning resources including websites, training videos and training books to players, coaches and referees. Kerr et al. (2017) supports the use of an instructional training video in player education with regards to learning to tackle in rugby (Kerr et al., 2017). The aim of these learning resources is to have a positive influence on attitudes towards injury prevention, to result in a higher frequency of safer tackling behaviour in rugby. The learning resource that has the greatest effect towards injury prevention is yet to be determined. Therefore, the purpose of this study was to examine the relationship of reported coaching behaviours and learning resources on players' attitudes towards injury prevention and performance in the tackle.

Chapter 3 Methods

This cross-sectional study design used a questionnaire to assess the importance (attitude), quantity (behaviour) and frequency (behaviour) on a 5-point Likert scale. This study forms part of a broader study by Hendricks et al. (2012) wherein the research methods have previously been described. The purpose of this study is to evaluate the learning resources and attitude and behaviour of players in training and during matches associated with injury prevention and performance. This previous study identified that rugby players were more likely to train a skill when the objective was improving tackle performance than for preventing injury during tackling in training and match play. However, it is worth noting that attitudes towards the importance of injury prevention were also evident, but to a lesser extent. Hendricks et al. (2012) recommended that players and coaches should identify the most effective application of injury prevention and player performance drills during training.

3.1 Aims and Objectives

3.1.1 Aims

The long-range goal of the larger study was to improve the understanding and development of safe and effective tackling, which allows for a more exciting and safer game of rugby for all players. The purpose of the current study was to gain insight into the knowledge and perspectives of a sample of South African rugby players regarding the tackle in training situations by investigating the relationship between tackle coaching and learning resources and players' attitudes towards training the tackle.

3.1.2 Objectives

The objectives were:

- to gain insight into the opinions of South African rugby players around the tackle in training using a 5-point Likert scale;

- to identify the coaching behaviours and learning resources that are most important to South African rugby players.

3.2 Participants

As described by Hendricks et al. (2012), the questionnaire was administered at the Cape School's Week Rugby Festival. The Cape School's Week Rugby Festival comprises of 10 traditionally rugby playing schools from the Western, Northern and Eastern Cape regions in South Africa. Only the under 19 A (1st team) sides of each school participated in the rugby festival. Twenty-two questionnaires were administered to 10 schools, and 164 questionnaires (9 out of the 10 schools participated) were returned, representing a 75% response-rate. Three teams completed the questionnaire in exam-like conditions with the principal investigator present; two teams completed the questionnaire after a team meeting with the principal investigator present; and for the remaining four teams', the coaches or managers were handed the questionnaires, which they completed on their own and returned at a later stage. Where the researchers were not present, coaches and managers were asked to monitor the players filling out the questionnaire. In the cases where the researchers were present, players completed the questionnaire in approximately 10 – 15 minutes. Informed consent (Appendix B and C) was obtained from the coaches or managers of each team and informed assent was obtained from each player. The University of Cape Town Human Research Ethics Committee granted ethical approval for this study (Human Research Ethics Reference 161/2009).

3.3 Questionnaire Development Process

The questionnaire was developed by Hendricks et al. (2012). This development process began with the researchers compiling a list of questions relevant to the main research question. This list was reviewed by a panel of rugby coaches, administrators and sports scientists to discuss the reasoning, rationality and usefulness of each question. This process

was repeated two to three times before the final list was decided on. Next, the questionnaire was designed for structure, order, flow and answerability using robust guidelines for designing surveys and social science research methods (Czaja & Blair, 2005; Babbie, 2004).

3.4 Question Scale Definition and Item Format

Closed-ended questions were considered suitable for this study as these provide the players with a pre-specified set of answers and response categories (Czaja & Blair, 2005). This suited the aim of the study as it made answering the questionnaire less demanding for the players, and standardised the data for statistical analyses, making it more reliable and consistent over time. Each question's response category consisted of a 5-point ordinal Likert scale represented by a numerical value. Players were asked to rate the importance and quantity of each item in the questions. The player's attitude was assessed with questions that asked the player to rate the importance of an item on the following scale: (1) 'Not at all important', (2) 'Not too important', (3) 'Undecided', (4) 'Somewhat important', (5) 'Very important' (Figure 2.) (Czaja & Blair, 2005).

2. How important is coaching proper technique to you for the following?					
To indicate your answers make an X in the desired block					
	Not at all important	Not too important	Undecided	Somewhat important	Very important
Injury Prevention <i>(lowering the risk of getting injured during the tackle)</i>	1	2	3	4	5
Improved performance <i>(Preventing the ball carrier from gaining territory and the ball carrier team from retaining possession)</i>	1	2	3	4	5

Figure 2. An example of the question scale and items to assess players' attitudes.

To calculate quantifiable behaviours, the scale: (1) 'Not at all', (2) 'A little', (3) 'A fair amount', (4) 'Much', (5) 'Very much', was used (Czaja & Blair, 2005). Where necessary,

each question was provided with a ‘Not familiar’ option to prevent players from providing random answers if they were uncertain (Czaja & Blair, 2005). A ‘Further comment’ space was provided, tailored for players to give additional answers (Figure 3).

9. When doing a tackle drill during a team/squad field session, how much time is spent on the following? Answer according to the last season.					
To indicate your answers make an X in the desired block					
	Not at all	A little	A fair amount	Much	Very Much
Emphasising proper technique to prevent injuries (<i>lowering the risk of getting injured during the tackle</i>)	1	2	3	4	5
Emphasising proper technique to improve tackle performance (<i>Preventing the ball carrier from gaining territory and the ball carrier team from retaining possession</i>)	1	2	3	4	5
Further Comment (Any additional information regarding the question):					

Figure 3. An example of the question items and scale to assess players’ behaviours.

3.5 Questions Domains and Layout

The final questionnaire consisted of 12 questions on training with a total of 109 items and four match questions with a total of 52 items (see Appendix A for complete questionnaire). For the purpose of this study, the relationship between attitudes towards injury prevention and performance in the tackle was tested against reported tackle coaching behaviours and learning resources. The attitudinal question asked players to rate the importance of training tackling for injury prevention and performance (Question 2). Injury prevention was defined as “*lowering the risk of getting injured during the tackle*” and improved tackle performance was defined as “*preventing the ball-carrier from gaining territory and the ball-carriers’ team from retaining the ball*”. The coaching behaviour training question examined how much emphasis is placed on injury prevention and performance in training (2 items, Question 9), and what method of coaching was used to training the tackle in the last season (6 items,

Question 10). The learning resource question asked how much influence specific learning resources (14 items, Question 10) had on their tackle training.

3.6 Statistical Analyses

Data were collected by Hendricks et al. (2012) was used for the statistical analyses. Tackle injury prevention and performance attitudes were independently tested against each coaching behaviour item and learning resource item. To test whether attitudes were associated with coaching and learning resources, the chi-squared test (χ^2) was used with *a priori* alpha level of significance set at $p < 0.05$. The magnitude of the association was tested using Cramer's V , with values between 0-0.19 considered weak, 0.20-0.49 considered moderate, and more than 0.50 considered strong. Because the Likert data were ordinal, the order of association was also tested using tau-b. A tau-b value of less than 0.2 signifies a weak relationship, between 0.2-0.49 indicates a moderate relationship, and 0.5 and higher signifies a strong relationship. The z-test value was also determined to test the significance of the relationship, $|z| \geq 1.96$ is significant at the $p < 0.05$ level, $|z| \geq 2.60$ is significant at the $p < 0.01$ level, and $|z| \geq 3.32$ is significant at the $p < 0.001$ level. Data are reported as percentage frequencies (%). All statistics were computed using STATA 12 (StataCorp, College Station, TX USA).

Chapter 4 Results

The amount of time emphasising proper technique to prevent injuries in the tackle was associated with how important players rated injury prevention (28% = somewhat important-very important/much-very, $\chi^2 (16)=29.13$, $p=0.02$, Cramer's $V=0.21$, moderate). Similarly, the amount of time spent emphasising proper technique to improve tackle performance was associated with how important players rated improving tackle performance (54% somewhat important-very important/much-very much, $\chi^2 (16)=37.85$, $p=0.002$, Cramer's $V=0.25$, moderate).

Verbal instruction from the coach, whether to the individual player (29% somewhat important-very important/much-very much, $\chi^2 (16)=30.41$, $p=0.02$, Cramer's $V=0.22$, moderate) or team (34% somewhat important-very important/much-very much, $\chi^2 (16)=34.04$, $p=0.01$, Cramer's $V=0.23$, moderate) was associated with how important players rated injury prevention when training the tackle (Table 2). The importance of improving tackle performance was associated with verbal instruction to the individual player (37% somewhat important-very important/much-very much, $\chi^2 (16)=34.38$, $p=0.005$, Cramer's $V=0.24$, moderate); verbal instruction to the entire team (40% somewhat important-very important/much-very much, $\chi^2 (16)=32.13$, $p=0.01$, Cramer's $V=0.23$, moderate); demonstration to the entire team (47% somewhat important-very important/much-very much, $\chi^2 (16)=38.53$, $p=0.001$, Cramer's $V=0.25$, moderate); identifying an individual (55% somewhat important-very important/much-very much, $\chi^2 (16)=30.26$, $p=0.017$, Cramer's $V=0.22$, moderate) and team (52% somewhat important-very important/much-very much, $\chi^2 (16)=30.26$, $p=0.003$, Cramer's $V=0.24$, moderate) problem in tackle technique and fixing it.

Table 2: The association between reported coaching methods and players' attitudes towards injury prevention and performance in the tackle.

	d	Chi2	p-value	Cramer's V	Tau-b	ASE	z-value
Importance of training tackling for injury prevention							
1vs1 Instruction from the coach	16	30.41	0.02	0.22	0.04	0.07	0.51
Verbal instruction (entire team)	16	34.05	0.01	0.23	0.01	0.08	0.08
Individual one-one demonstration	16	19.92	0.23	0.18	0.10	0.07	1.48
Demonstration to the entire team	16	16.54	0.42	0.16	0.11	0.07	1.50
Identifying a problem in your tackle technique and fixing it	16	14.17	0.59	0.15	0.06	0.07	-0.90
Identifying a team problem in tackle technique and fixing it	16	17.87	0.33	0.17	0.06	0.07	0.83
Importance of training tackling for improving performance							
1vs1 Instruction from the coach	16	34.38	0.005	0.24	0.16	0.06	2.49
Verbal instruction (entire team)	16	32.13	0.010	0.23	0.10	0.07	1.48
Individual one-one demonstration	16	25.19	0.066	0.20	0.18	0.06	2.91
Demonstration to the entire team	16	38.53	0.001	0.25	0.21	0.07	3.15
Identifying a problem in your tackle technique and fixing it	16	30.26	0.017	0.22	0.19	0.07	2.93
Identifying a team problem in tackle technique and fixing it	16	35.85	0.003	0.24	0.16	0.07	2.46

Learning resources such as training books was associated with how important players rated tackle injury prevention (27% somewhat important-very important/much-very much, χ^2 (16)=28.67, $p<0.05$, Cramer's V=0.21, moderate) and performance (27% somewhat important-very important/much-very much, χ^2 (16)=28.67, $p<0.05$, Cramer's V=0.21, moderate) (39% somewhat important-very important/much-very much, χ^2 (16)=28.37, $p<0.05$, Cramer's V=0.21, moderate). The importance of tackle performance was also associated with training videos (32% somewhat important-very important/much-very much, χ^2 (16)=27.22, $p<0.05$, Cramer's V=0.21, moderate) (Table 3.)

Table 3: The association between rugby learning resources and players' attitudes towards injury prevention and performance in the tackle.

	d	Chi2	p-value	Cramer's V	Tau-b	ASE	z-value
Importance of training tackling for injury prevention							
Newspapers	16	15.92	0.458	0.16	-0.03	0.07	-0.44
Rugby magazines	16	15.00	0.525	0.15	0.03	0.07	0.52
Internet	16	13.48	0.637	0.15	-0.00	0.07	-0.02
Television matches	16	15.12	0.516	0.16	-0.04	0.07	-0.62
Sport/Rugby shows on television	16	11.97	0.747	0.14	0.01	0.07	0.23
Training videos	16	21.50	0.160	0.18	0.04	0.07	0.63
Training books	16	28.66	0.026	0.21	-0.02	0.07	-0.30
Relatives	16	24.78	0.074	0.20	0.01	0.07	0.18
Friends	16	23.51	0.101	0.19	-0.02	0.07	-0.23
Team mates	16	18.29	0.307	0.17	-0.10	0.07	-1.44
Experience	16	13.22	0.657	0.14	0.03	0.07	0.37
Attendance at live rugby matches	16	18.12	0.317	0.17	-0.08	0.07	-1.19
Coaching clinics	16	24.04	0.089	0.20	0.03	0.07	0.46
Rugby Icon	16	15.20	0.510	0.16	-0.10	0.07	-1.46
Importance of training tackling for improving performance							
Newspapers	16	8.47	0.934	0.12	0.01	0.07	0.14
Rugby magazines	16	13.77	0.616	0.15	0.12	0.07	1.83
Internet	16	10.90	0.815	0.13	0.06	0.07	0.83
Television matches	16	10.70	0.828	0.13	0.04	0.07	0.59
Sport/Rugby shows on television	16	17.09	0.380	0.17	0.07	0.07	1.03
Training videos	16	28.38	0.028	0.21	0.18	0.06	2.88
Training books	16	27.22	0.039	0.21	0.10	0.07	1.50
Relatives	16	19.31	0.253	0.18	0.06	0.07	0.80
Friends	16	16.28	0.434	0.16	0.01	0.07	0.21
Team mates	16	15.47	0.490	0.16	0.00	0.07	0.01
Experience	16	10.73	0.826	0.13	0.05	0.07	0.82
Attendance at live rugby matches	16	8.05	0.947	0.12	0.04	0.07	0.60
Coaching clinics	16	22.07	0.141	0.19	0.14	0.07	2.08
Rugby Icon	16	21.21	0.170	0.19	0.16	0.7	2.37

Chapter 5 Discussion

The aims of this study were to examine the relationship that reported coaching behaviours and learning resources had on players' attitudes and behaviours with regards to tackle injury prevention and performance of junior rugby players. It was inferred that significant associations have been identified in specific coach behaviours and players' attitudes and behaviours. However, the strength of these relationships is only moderate and is not convincing with regards to explaining the variability of the items. It is possible that the most effective strategy is a result of more than one technique to improve knowledge uptake and coach and player compliance in preventing injury.

When the goal of executing proper tackle technique was to improve player performance in rugby, the players in this study dedicated almost twice the time on training this skill than they did when the goal was to prevent injury. Players appeared to rank technical performance higher than the safety of themselves and their opponents. This attitude may influence injury and could be attributed to the competitive and motivated nature of these players, who elicit an increased propensity for risky behaviours (Bahr & Krosshaug, 2005; Hendricks et al., 2012; Meeuwisse et al., 1994; Finch et al. 2001; Finch et al., 2002; Fuller & Drawer, 2004). The players included within this sample are considered as 'elite' level for their age group and subsequently may place more emphasis on performance than the sub-elite or social players, who may place more emphasis on fun and enjoyment (Cope, Bailey and Pearce, 2013). However, these players still indicate pro-injury prevention attitudes when training the tackle, which suggests current rugby safety education interventions are proving to be successful. This level of awareness may be a result of the efforts of the BokSmart safety programme in South Africa, which was launched in 2009 (Patricios, 2014), and implies that the cohort in

this study would have had direct exposure to the targeted rugby safety education that it entails.

Coaching behaviours or strategies may have a positive impact on the attitudes of players towards tackle safety, which could reduce injuries by emphasizing appropriate safe tackle techniques and correcting individual deficiencies in tackling skills (Hendricks & Lambert, 2010). Furthermore, player attitudes could be changed by education on game rules and the risks and benefits of safe tackling by engaging in various verbal and non-verbal techniques (Posthumus & Viljoen, 2008, Hendricks & Lambert, 2010; Hendricks et al., 2015). The findings of the current study highlight the most significant reported behaviours that affect the attitudes of players in learning proper tackling techniques for injury prevention including, ‘individual one-on-one instruction from the coach’ and ‘verbal instruction to the entire team’. Although the associations of these behaviours are identified as significant by the values of the chi-squared test (χ^2), the magnitude of the relationship is considered only moderate according to Cramer’s *V* equations. This finding supports that the communication by the coach to the player is important in the adoption of sports injury prevention behaviours. The findings further recommends more research is required to identify the most appropriate manner, timing and social context for coach-player communication (Koester, 2000; Twomey, 2008; West et al., 2014; Hendricks et al., 2015; Quarrie et al., 2017).

Verbal instruction to the entire team also refers to instructions or strategies put into place with respect to ‘whole team’ defensive structures in which the coach plays a critical role in the development of. Effective coaching techniques would result in a team that defends better collectively, and would reduce the individual stress on the player (Gabbett & Ryan, 2009; Hendricks & Lambert, 2010). The item, ‘identifying a problem in your tackle technique and

fixing it' was considered the least important coaching behaviour with respect to preventing injury. This may further highlight the social context wherein players do not want to be identified as requiring additional technical improvement or being substandard to their peers (Emery et al., 2009).

Reported coach behaviour items which were significantly associated with 'the importance of training proper tackling technique for improved performance' were: 'verbal instruction to the individual player'; 'verbal instruction to the entire team'; 'demonstration to the entire team'; 'identifying an individual problem in tackle technique and fixing it' and 'identifying a team problem in tackle technique and fixing it'. This finding is supported by recent research, which reports specific coach behaviours, such as offering a visual game strategy prior to a match, have been associated with safe and successful behaviours in matches (Hendricks et al., 2015). In another recent study, verbal instruction from the coach was ranked as the one of the most important components for preventing injury and improving performance when coaching the tackle (Hendricks & Sarembock, 2013). Although these associations are significant and highlight the role of the coach in team performance and injury prevention, the clinical relevance is unknown. A combination of teaching techniques may produce the stronger associations.

In this study, 'individual one-on-one demonstration' was not significantly correlated with improving tackle performance. In previous studies, 'demonstration' was identified as being highly beneficial in the early stages of skill development (Hodges & Franks, 2002; Schmidt & Wrisberg, 2008). However, this reported coach behaviour may not be as effective as the players gain further experience. This may explain why this behaviour was not preferred in the players in this study as they are at an intermediate level of their careers, having an average of

eight years of rugby playing experience per player. It is important for coaches to continue to “up-skill” themselves to ensure that they are up to date and are utilizing the latest effective coaching techniques and strategies in their sessions.

When the goal is improving performance in the tackle, players place greater importance (39%) on learning resources than improving performance (27%) in the tackle than to prevent injury. Previously, some learning resources namely televised rugby matches and televised rugby shows, had a greater impact on players’ tackle technique than others, such as rugby training videos and training books (Hendricks et al., 2012). In this study however, training books as a learning resource was significantly associated with the importance of tackle performance and injury prevention. Training videos were also significantly associated with improving tackle performance. This finding supports the current administration of national injury prevention programmes, such as the RugbySmart and BokSmart which use training videos and books to ensure consistent delivery of information (Brown et al., 2011; Gianotti et al., 2009). The current study was conducted after the initiation of the BokSmart programme in South Africa and these results could be attributed to the efforts of this programme.

Chapter 6 Practical Applications

Rugby has an elevated risk of injuries due to the nature of the game, which permits large extrinsic forces to be imposed on the body during the tackle (Fuller et al., 2007a; McIntosh et al., 2010a; Brooks et al., 2005b; Wilson et al., 1999). The knowledge, attitude and behaviour of coaches and players have been highlighted as important components towards realization of successful injury prevention strategies (Carter et al., 2008; Barr & Krosshaug, 2005; McIntosh, 2005; Finch, 2002; White et al., 2013). Although there is a growing base of research on players' attitudes and behaviours towards injury prevention, there is limited knowledge on the behaviours and attitudes of the coaches towards injury prevention in rugby (Hendricks & Sarembock, 2013). The purpose of this study was to examine the relationship between reported rugby coaching behaviours and learning resources on players' attitudes towards injury prevention and performance in the tackle.

Findings in the current study support and add further evidence towards coaches as critical components for successful adoption of sports injury prevention strategies, and further highlights the manner, timing and social context of coach communication that affects players' personal perceptions of ability and understanding of technical instruction (Koester, 2000; Twomey et al., 2009; West et al., 2014; Hendricks et al., 2015; Quarrie et al., 2017). The current study improves our understanding of specific reported coaching behaviours positively linked to a reduction in tackle-related injuries and emphasizes 'individual one-on-one instruction from the coach' and 'verbal instruction to the entire team'. However, the associations are not strong and combined measures should be identified for the most effective intervention in injury prevention in rugby. The coach should not be the sole-source of injury prevention knowledge

dissemination; this responsibility should an interdisciplinary approach by parents, medical personnel, strength and conditioning trainers and administrators to prevent future injury (Williams et al., 2015).

The current study also cautions on behaviours that may limit effectiveness of player-coach interactions. Exercises for injury prevention rather than performance may be better received by players in a team setting than for individuals. Future studies should assess novel ways that may reduce the stigma of being ‘singled out at training’. A recommendation is that coaches make themselves aware of the social context of the players of this age group, to allow for the most effective communication.

Enhancements in the implementation of effective individual and team skills and strategies will result in improved performance at training and during matches. This study highlighted numerous reported coach behaviours that will contribute to improved performance namely: verbal instruction to the individual player; verbal instruction to the entire team; demonstration to the entire team; identifying an individual problem in tackle technique and fixing it and identifying a team problem in tackle technique and fixing it.

The current study revealed that if a player perceives that training the tackle would improve rugby performance; he or she may commit twice the time on this drill at training, compared to ‘preventing and injury’. The players in this study were considered elite for their age group and appeared to give greater importance to competitive success than injury prevention to themselves, or their opponents. Professionalism of rugby has permitted administrators, coaches and players to gain

financially from participation and has had an influence on their motivation and competitiveness (Garraway et al., 2000). This may predispose individuals to give greater emphasis to performance than injury prevention. However, this shift away from safer behaviours may also be indicative of the risk taking perceptions and behaviours in adolescents irrespective of the level of sport (Finch et al., 2001; Finch et al., 2002; Fuller & Drawer, 2004). This study supports and recommends that safe tackling techniques that improves tackle performance should be incorporated into skill development at an early stage and that behaviour should be reinforced to allow this to become routine practice (Van Tiggelen et al., 2008; Eime et al., 2002). This study acts as an example how tackling safety attitudes and behaviours can be improved so and should be introduced into recreational players to potentially reduce injury. Only regular appropriate behaviour that is adopted by a large number of players will result in a significant reduction in injury incidence in rugby. The players in the current study showed a tendency in their attitudes and behaviours towards improved performance, however there is still an awareness of injury prevention in tackle technique training. This may be as a result of the direct exposure and efforts of the BokSmart rugby safety program in South Africa.

The current study provides evidence towards the use of training books to improve tackle-related performance and injury prevention attitudes and behaviours in elite level junior rugby players. Training videos improved tackle performance behaviours and attitudes but did not play a significant role in injury prevention in this regard. This supports the use of these resources in the current rugby safety educational interventions but further understanding is necessary to identify the most effective method resulting in behaviour change. This approach may be a multifaceted

combination of the most suitable resources. A recommendation for future research is to broaden the understanding of electronic resources and social media platforms that may assist in improving rugby safety education, especially in the younger generations.

The current study emphasizes the need for the coach to possess appropriate knowledge capabilities to influence players to effectively apprehend and implement safe tackle techniques in rugby. Highlighting the negative association between players' injury and success for the team may prove beneficial when training techniques for injury prevention (Williams et al., 2015). However this study recommends that coaches are taught a deeper understanding of effective communication methods in adolescents, to ensure successful transfer of knowledge and application of skills, in order to ultimately reduce injuries in rugby. As for teaching in schools, coaches should be educated on the most appropriate evidence-based learning strategies for each stage of player development.

The associations that have been identified in this study are not strong or robust, and do not support a single approach or resource to change players' attitudes and behaviours. A multifaceted teaching model that incorporates multiple effective strategies and resources is necessary. Future studies using a multivariate regression should assess whether effective established learning methods or combination of done methods used in other areas may influence specific coaching behaviours on specific injury prevention, ideally over a longer period with a larger player sample

Chapter 7 Conclusion

The present study found that significant associations were identified in specific coach behaviours and attitudes and behaviours of South African youth rugby players. Reported coach behaviour items ‘verbal instruction to the individual player’; ‘verbal instruction to the entire team’; ‘demonstration to the entire team’; ‘identifying an individual problem in tackle technique and fixing it’ and ‘identifying a team problem in tackle technique and fixing it’ were significantly associated with ‘the importance of training proper tackling technique for improved performance’. Players appeared to rank technical performance higher than the safety of themselves and their opponents and dedicated almost twice the time training proper tackle technique when the goal was to improve player performance than when the goal was to prevent injury. With regards to learning resources a similar inclination towards performance is seen as players place greater importance on learning resources when the goal is improving performance in the tackle, than compared to preventing injury in the tackle. In this study, training books as a learning resource was significantly associated with the importance of tackle performance and injury prevention whilst training videos were significantly associated with improving tackle performance in youth rugby players.

7.1 Strengths and Limitations

The development, application and evaluation method of the research instrument fulfills the recommendations of Hicks (1999) for a good questionnaire for use in research although limitations to this study are noted.

The questionnaire was validated by using an expert panel to generate the questions and by performing a pilot study. The expert panel included sport scientists, rugby coaches and

administrators whose opinions were highly regarded. The test-retest administration of the questionnaire further ensured reliability of the research instrument used in this study.

The large sample size of participants (n=164) for this study adds to the external validity of this research. The player selection included age-based and merit-based criteria and represented the best players in their particular regions. For this reason, it could be argued that certain characteristics of this group, for example motivation and competitiveness, are not likely to be applicable to a large proportion of the population who may be classified as social or amateur players who may place greater importance on participation and having fun (Cope, et al., 2013). Lastly, all the teams did not complete the questionnaire under the same conditions, which may have introduced some bias.

The questionnaire was administered Cape School's Week Rugby Festival which comprises of 10 traditionally rugby playing schools from the area, it is implied that the coaches of these teams would have had a specific interest in improved performance and injury preventions to varying degrees. This may introduce further bias.

A further limitation of this study was that the questionnaire was designed to collect player information only. Information regarding the education or experience coaches' would have been valuable and this data could be correlated with the attitudes and behaviours of the players in this study. The design of this study is based on the assumption that attitudes and behaviours actually result in action by the players. Further that injury prevention programmes improve coaches' knowledge, which in turn may reduce injury rates by modifying behaviours of players. This is acknowledged and should be considered a subject, which requires further research.

References

- Aubry, M., Cantu, R., Dvorak, J., Graf-Bauman, T., Johnston, K., Kelly, J., Lovell, M., McCrory, P., Meuwisse, M. & Schamasch, P. (2002). Summary and agreement statement of the First International Conference on Concussion in Sport, Vienna 2001. *British Journal of Sports Medicine*, (1), 6–10.
- Babbie, E. (2004). *The practice of social research*. Nelson Education.
- Bahr, R. & Krosshaug, T. (2005). Understanding injury mechanisms: A key component of preventing injuries in sport. *British Journal of Sports Medicine*, 39(6), 324–329. doi: 10.1136/bjism.2005.018341
- Bathgate, A., Best, J., Craig, G. & Jamieson, M. (2002). A prospective study of injuries to elite Australian rugby union players. *British Journal of Sports Medicine*, 36(4), 265–269.
- Best, J., McIntosh, A. & Savage, N. (2005) Rugby World Cup 2003 injury surveillance project. *British Journal of Sports Medicine*, 39: 812–817. doi: 10.1136/bjism.2004.016402
- Bloom, G., Stevens, D., & Wickwire, T. (2003). Expert Coaches' Perceptions of Team Building, *Journal of Applied Sport Psychology*, 15(2), 129-143.
- Brooks, J.H., Fuller, C.W., Kemp, S.P.T., & Reddin, D.B. (2005a). A prospective study of injuries and training amongst the England 2003 Rugby World Cup squad. *British Journal of Sports Medicine*, 39(5), 288–93.
- Brooks, J.H., Fuller, C.W., Kemp, S.P.T., & Reddin, D.B. (2005b). Epidemiology of injuries in English professional rugby union: part I. Match injuries. *British Journal of Sports Medicine*, 39(10), 757–66.
- Brooks, J.H., & Kemp, S.P.T (2010). Injury-prevention priorities according to playing position in professional rugby union players. *British Journal of Sports Medicine*, 45(10), 765–775.
- Brown, J. C., Verhagen, E., Viljoen, W., Readhead, C., Van Mechelen, W., Hendricks, S., & Lambert, M. I. (2012). The incidence and severity of injuries at the 2011 South African Rugby Union (SARU) Youth Week tournaments. *South African Journal of Sports Medicine*, 24(2),49-54.
- Brown, J., Gardner-Lubbe, S., Lambert, M., Van Mechelen, W., & Verhagen, E. (2014). The effectiveness of the Boksmart intervention: The association between knowledge, education and perceptions and injury prevention behaviour in Rugby

- Union players. *British Journal of Sports Medicine*, 48(7), 575–575.
- Brown, J.C., Gardner-Lubbe, S., Lambert, M.I., Van Mechelen, W., & Verhagen, E. (2015). The BokSmart intervention programme is associated with improvements in injury prevention behaviours of rugby union players: An ecological cross-sectional study. *Injury Prevention*, 21(3), 173–178.
- Brown, J.C., Lambert, M.I., Verhagen, E., Readhead, C., Van Mechelen, W., & Viljoen, W. (2013). The incidence of rugby-related catastrophic injuries (including cardiac events) in South Africa from 2008 to 2011: A cohort study. *BMJ Open*, 3(2), 1–10.
- Brown, J.C., Verhagen, E., Knol, D., Van Mechelen, W., & Lambert, M.I. (2016). The effectiveness of the nationwide BokSmart rugby injury prevention program on catastrophic injury rates. *Scandinavian Journal of Medicine & Science in Sports*, 26(2), 221–225.
- Bruwer, E.J., Moss, S.J., & Jacobs, S. (2017). Injury incidence and selected biomechanical, postural and anthropometric characteristics contributing to musculoskeletal injuries in rugby union players. *African Journal for Physical Health Sciences*, 23(1.2), 172–189.
- Burger, N., Lambert, M.I., Viljoen, W., Brown, J.C., Readhead, C., & Hendricks, S. (2014). Tackle-related injury rates and nature of injuries in South African Youth Week tournament rugby union players (under-13 to under-18): An observational cohort study. *BMJ Open*, 4(4), e005556.
- Burger, N., Lambert, M.I., Viljoen, W., Brown, J.C., Readhead, C., & Hendricks, S. (2016). Tackle technique and tackle-related injuries in high-level South African Rugby Union under-18 players: real-match video analysis. *British Journal of Sports Medicine*, 50, 932–938.
- Carter, A.F., & Muller, R. (2008). A survey of injury knowledge and technical needs of junior rugby union coaches in Townsville (North Queensland). *Journal of Science and Medicine in Sport*, 11(2), 167–173.
- Chalmers, D.J., Simpson, J.C., & Depree, R. (2004). Tackling rugby injury: Lessons learned from the implementation of a five-year sport injury prevention program. *Journal of Science and Medicine in Sport*, 7(1), 74–84.
- Clark, D.R., Roux, C. & Noakes, T.D. (1990). A prospective study of the incidence and nature of injuries to adult rugby players. *South African Medical Journal*, 77(11), 559–562.

- Cope, E.J., Bailey, R., & Pearce, G. (2013). Why do children take part in, and remain involved in sport? A literature review and discussion of implications for sports coaches. *International Journal of Coaching Science*, 7(1), p 55-74.
- Cross, M., Kemp, S., Smith, A., Trewartha, G. & Stokes, K. (2015). Professional rugby union players have a 60% greater risk of time loss injury after concussion: A 2-season prospective study of clinical outcomes. *British Journal of Sports Medicine*, 0, 1–6. doi:10.1136/bjsports-2015-094982
- Czaja, R. & Blair, J. (2005). Designing surveys: A guide to decisions and procedures Undergraduate research methods & statistics in the social sciences. *New York, NY: Putnam*.
- Deutsch, M.U., Kearney, G.A., & Rehrer, N.J. (2007). Time - motion analysis of professional rugby union players during match-play. *Journal of Sports Sciences*, 25(4), 461–472.
- Duthie, G., Pyne, D., & Hooper, S. (2005). Time motion analysis of 2001 and 2002 super 12 rugby. *Journal of Sports Sciences*, 23(5), 523-530.
- Dexter, T. (1999). Relationships between sport knowledge, sport performance and academic ability: empirical evidence from GCSE Physical Education. *Journal of Sports Sciences*, 17(4), 283–295.
- Eime, R., Finch, C., Sherman, C. & Garnham, A. 2002. Are squash players protecting their eyes?. *Injury Prevention : Journal of the International Society for Child and Adolescent Injury Prevention*, 8(3), 239–241.
- Eime, R., Owen, N., & Finch, C. (2004). Protective eyewear promotion: Applying principles of behaviour change in the design of a squash injury prevention programme. *Sports Medicine*, 34(10), 629–638.
- Emery, C.A., McKay, C.D., Campbell, T.S., & Peters, A.N. (2009). Examining attitudes toward body checking , levels of emotional empathy , and levels of aggression in body checking and non – body checking youth hockey leagues. *Clinical Journal of Sport Medicine*, 19(3), 207–215.
- Finch, C. (2006). A new framework for research leading to sports injury prevention. *Journal of Science and Medicine in Sport*, 9(1), 3–9.
- Finch, C., Donohue, S., & Garnham, A. (2002). Safety attitudes and beliefs of junior Australian football players. *Injury Prevention*, 8(2), 151–154.
- Finch, C.F., McCrory, P., Ewing, M.T., & Sullivan, S.J. (2013). Concussion guidelines need to move from only expert content to also include implementation

- and dissemination strategies. *British Journal of Sports Medicine*, 47(1), 12–14.
- Finch, C.F., McIntosh, A.S., & McCrory, P. (2001). What do under 15 year old schoolboy rugby union players think about protective headgear? *British Journal of Sports Medicine*, 35(2), 89–94.
- Freitag, A., Kirkwood, G., Scharer, S., Ofori-Asenso, R., & Pollock, A.M. (2015). Systematic review of rugby injuries in children and adolescents under 21 years. *British Journal of Sports Medicine*, 49(8), 511–9.
- Fuller, C., Ashton, T., Brooks, J., Cancea, R., Hall, J., & Kemp, S. (2010). Injury risks associated with tackling in rugby union. *British Journal of Sports Medicine*, 44(3), 159–167.
- Fuller, C.W., Brooks, J.H., Cancea, R.J., Hall, J., & Kemp, S.P. (2007a). Contact events in rugby union and their propensity to cause injury. *British Journal of Sports Medicine*, 41(12), 862–867.
- Fuller, C., & Drawer, S. (2004). The application of risk management in sport. *Sports Medicine*, 34(6), 349–356.
- Fuller, C.W., Molloy, M.G., Bagate, C., Bahr, R., Brooks, J.H.M., Donson, H., Kemp, S.P.T., McCrory, P., McIntosh, A.S., Meeuwisse, W.H., Quarrie, K.L., Raftery, M. & Wiley, P. (2007)b. Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *Clinical Journal of Sports Medicine*, 17, 77-181.
- Fuller, C.W, Raftery, M., Readhead, C., Targett, S.G.R., & Molloy, M.G. (2009). Impact of the International Rugby Board’s experimental law variations on the incidence and nature of match injuries in southern hemisphere professional rugby union. *South African Medical Journal*, 99(4), 232–237.
- Fuller, C.W., Sheerin, K., & Targett, S. (2013). Rugby world cup 2011: international rugby board injury surveillance study. *British Journal of Sports Medicine*, 47(18), 1184-1191.
- Fuller, C.W., Taylor, A., & Raftery, M. (2015). Epidemiology of concussion in men’s elite Rugby-7s (Sevens World Series) and Rugby-15s (Rugby World Cup, Junior World Championship and Rugby Trophy, Pacific Nations Cup and English Premiership). *British Journal of Sports Medicine*, 49(7), 478–483.
- Fuller, C.W., Taylor, A., Kemp, S.P., & Raftery, M. (2016). Rugby World Cup 2015: World Rugby injury surveillance study. *British Journal of Sports Medicine*, 51:51–57.

- Gabbett, T.J. (2003). Incidence of injury in semi-professional rugby league players. *British Journal of Sports Medicine*, 37(1), 36-44.
- Gabbett, T., & Kelly, J. (2007). Does defensive line speed influence tackling proficiency in collision sport athletes? *International Journal of Sports science & Coaching*, 2(4), 467-472.
- Gabbett, T., & Ryan, P. (2009). Tackling technique, injury risk, and playing performance in high-performance collision sport athletes. *International Journal of Sports Science and Coaching*, 4(4), 521-533.
- Gallimore, R., Ermeling, B.A., Saunders, W.M., & Goldenberg, C. (2009). Moving the learning of teaching closer to practice: Teacher education implications of school-based inquiry teams. *The Elementary School Journal*, 109(5), 537-553.
- Garraway, W.M., Lee, A.J., & Hutton, S.J., Russell, E.B.A.W., & Macleod, D.A.D. (2000). Impact of professionalism on injuries in rugby union. *British Journal of Sports Medicine*, 34(5), 348-351.
- Garraway, W.M., Lee, A.J., Macleod, D.A., Telfer, J.W., Deary, I.J., & Murray, G.D. (1999). Factors influencing tackle injuries in rugby union football. *British Journal of Sports Medicine*, 33(1), 37-41.
- Garraway, W.M., and Macleod, D.A.D. (1995). Epidemiology of rugby football injuries. *The Lancet*, 345(8963), 1485-1487.
- Gerrard, D.F., Waller A.E., & Bird, Y.N. (1994). The New Zealand Rugby Injury and Performance Project : II . Previous injury experience of a rugby-playing cohort. *British Journal of Sports Medicine*, 28(4), 229-233..
- Gianotti, S., Hume, P.A., Hopkins, W.G., Harawira, J., & Truman, R. (2008). Interim evaluation of the effect of a new scrum law on neck and back injuries in rugby union. *British Journal of Sports Medicine*, 42(6), 427-430.
- Gianotti, S.M, Quarrie, K.L., & Hume, P.A. (2009). Evaluation of RugbySmart: A rugby union community injury prevention programme. *Journal of Science and Medicine in Sport*, 12(3), 371-375.
- Gilbert, W., Gallimore, R., & Trudel, P. (2009). A learning community approach to coach development in youth sport. *Journal of Coaching Education*, 2(2), 3-23.
- Greenlees, I.A., Nunn, R.L., Graydon, J.K., & Maynard, I.W. (1999). The relationship between collective efficacy and precompetitive affect in rugby players: Testing Bandura's model of collective efficacy. *Perceptual & Motor Skills*, 89(2), 431-440.

- Gwadry-Sridhar, F., Guyatt, G.H., Arnold, J.M.O, Massel, D., Brown, J., Nadeau, L., & Lawrence, S. (2003). Instruments to measure acceptability of information and acquisition of knowledge in patients with heart failure. *European Journal of Heart Failure*, 5(6), 783–791.
- Haseler, C.M., Carmont, M.R., & England, M. (2010). The epidemiology of injuries in English youth community rugby union. *British Journal of Sports Medicine*, 44(15), 1093-1099.
- Hendricks, S., Den Hollander, S., Tam, N., Brown, J., & Lambert, M. (2015). The relationships between rugby players' tackle training attitudes and behaviour and their match tackle attitudes and behaviour. *BMJ Open Sports and Exercise Medicine*, 1(1), e000046, 1–7.
- Hendricks, S., Jordaan, E., & Lambert, M. (2012). Attitude and behaviour of junior rugby union players towards tackling during training and match play. *Safety Science*, 50(2), 266–284.
- Hendricks, S., & Lambert, M. (2010). Tackling in rugby: Coaching strategies for effective technique and injury prevention. *International Journal of Sports Science and Coaching*, 5(1), 117–136.
- Hendricks, S., Lambert, M.I., Brown, J.C., Readhead, C., & Viljoen, W. (2014a). An evidence- driven approach to scrum law modifications in amateur rugby played in South Africa. *British Journal of Sports Medicine*, 48(14):1115–1119.
- Hendricks, S., Matthews, B., Roode, B., & Lambert, M., (2014b). Tackler characteristics associated with tackle performance in rugby union. *European Journal of Sport Science*, 14(8), 753-762.
- Hendricks, S., & Sarembock, M. (2013). Attitudes and behaviours of top-level junior rugby union coaches towards the coaching of proper contact technique in the tackle – a pilot study. *South African Journal of Sports Medicine*, 25(1), 8–11.
- Hermanus, F.J., Draper, C.E., & Noakes, T.D. (2010). Spinal cord injuries in South African Rugby Union (1980–2007). *South African Medical Journal*; 100(4):230–234.
- Hicks, C. M. (1999). Research methods for clinical therapists: Applied project design and analysis. 297 ed. Edinburgh, London, New York: Churchill Livingstone.
- Hodges, N. J., & Franks, I. M. (2002). Modelling coaching practice: the role of instruction and demonstration. *Journal of Sports Sciences*, 20(10), 793-811.
- Hoffman, M. (2001). Quality of Measurement. Introduction to Epidemiology:

Department of Public Health, UCT.

- Holtzhausen, L.J., Schwellnus, M.P., Jakoet, I., & Pretorius, A.L. (2006). The incidence and nature of injuries in South African rugby players in the rugby Super 12 competition. *South African Medical Journal*, 96(12), 1260–1265.
- International Rugby Board, (2012). Junior World Championship 2012: South Africa, Game Analysis Statistical Report.1-29.
- International Rugby Board, (2013). Six Nations 2013: Statistical Analysis and Match Review, IRB Game Analysis. 1-31.
- Jakoet, I., & Noakes, T.D. (1998). A high rate of injury during the 1995 Rugby World Cup. *South African Medical Journal*. 88(1): 45-47.
- Junge, A., Cheung, K., Edwards, T., & Dvorak, J. (2004). Injuries in youth amateur soccer and rugby players--comparison of incidence and characteristics. *British Journal of Sports Medicine*, 38(2), 168–172. <http://doi.org/10.1136/bjism.2002.003020>.
- Kemp, S.P., Hudson, Z., Brooks, J.H., & Fuller, C.W. (2008). The epidemiology of head injuries in English professional rugby union. *Clinical Journal of Sports Medicine*, 18(3) 227-234.
- Kerr, H.A., Ledet, E.H., Ata, A., Newitt, J.L., Santa Barbara M., Kahanda, M., & Sperry Schlueter, E. (2017). Does instructional video footage improve tackle technique? *International Journal of Sports Science & Coaching*; 13(1),3-15.
- Kok, G., & Bouter, L.M. (1990). On the importance of planned health education. Prevention of ski injury as an example. *American Journal of Sports Medicine*; 18(6),600–605.
- Koester, M.C. (2000). Youth sports: A pediatrician's perspective on coaching and injury prevention. *Journal of Athletic Training*, 35(4), 466–470.
- Lee, A.J., & Garraway, W.M. (1996). Epidemiological comparison of injuries in school and senior club rugby. *British Journal of Sports Medicine*, 30(3), 213-217.
- Lee, A.J., Garraway, W.M., & Arneil, D.W. (2001). Influence of preseason training, fitness, and existing injury on subsequent rugby injury. *British Journal of Sports Medicine*, 35(6), 412–417.
- Lund, J., & Aarø, L.E. (2004). Accident prevention. Presentation of a model placing emphasis on human, structural and cultural factors. *Safety Science*, 42(4), 271-324.

- Maffulli, N., Longo, U.G., Gougoulas, N., Caine, D., & Denaro, V. (2011). Sport injuries: A review of outcomes. *British Medical Bulletin*, 97(1), 47–80.
- Maffulli, N., Longo, U., Spiezia, F., & Denaro, V. (2010). Sports injuries in young athletes: long-term outcome and prevention strategies. *The Physician and Sportsmedicine*, 38(2), 29–34.
- McCroory, P., Johnston, K., Meeuwisse, W., Aubry, M., Cantu, R., Dvorak, J., Graf-Baumann, T., Kelly, J., Lovell, M., & Schamasch, P. (2005). Summary and agreement statement of the Second International Conference on Concussion in Sport, Prague 2004. *British Journal of Sports Medicine*, 39(suppl1), i78-i86. doi: 10.1136/bjism.2005.018614.
- McCroory, P., Meeuwisse, W., Dvorak, J., Aubry, M., Bailes, J., Broglio, S., ... & Vos, P. (2017). Consensus statement on concussion in sport—the 5th International Conference on Concussion in Sport held in Berlin, October 2016. *British Journal of Sports Medicine*, 51:838–847.
- McCroory, P., Meeuwisse, W. H., Aubry, M., Cantu, R. C., Dvorák, J., Echemendia, R. J.,... & Turner, M. (2013). Consensus statement on concussion in sport - The 4th International Conference on Concussion in Sport Held in Zurich, November 2012. *Journal of Science and Medicine in Sport*, 16, 178–189.
- McCroory, P., Meeuwisse W., Johnston, K., Dvorak, J., Aubry, M., Molloy, M. & Cantu, R. (2009). Consensus statement on concussion in sport—the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *South African Journal of Sport Medicine*, 21(2), 36–46.
- McFie, S., Brown, J., Hendricks, S., Posthumus, M., Readhead, C., Lambert, M., ... & Viljoen, W. (2016). Incidence and factors associated with concussion injuries at the 2011 to 2014 South African Rugby Union Youth Week Tournaments. *Clinical Journal of Sports Medicine*, 26(5), 398–404.
- McIntosh, A. S. (2005). Risk compensation, motivation, injuries, and biomechanics in competitive sport. *British Journal of Sports Medicine*, 39(1), 2-3.
- McIntosh, A.S., McCroory, P., Finch, C.F., & Wolfe, R. (2010)a. Head, face and neck injury in youth rugby: Incidence and risk factors. *British Journal of Sports Medicine*, 44,188-193 doi:10.1136/bjism.2007.041400
- McIntosh, A.S., Savage, T.N., McCroory, P., Fréchéde, B.O., & Wolfe, R. (2010)b. Tackle characteristics and injury in a cross section of rugby union football. *Medicine & Science in Sports and Exercise*, 42(5), 977–984.

- McKay, G.D., Goldie, P.A., Payne, W.R., & Oakes, B.W. (2001). Ankle injuries in basketball: Injury rate and risk factors. *British Journal of Sports Medicine*, 35(2), 103–108. <http://doi.org/10.1136/bjism.35.2.103>
- Meeuwisse, W.H. (1994). Assessing causation in sport injury: A multifactoral model. *Clinical Journal of Sport Medicine*, 4, 166-170
- Merkel, D.L. (2013). Youth sport: Positive and negative impact on young athletes. *Open Access Journal of Sports Medicine*, 4,151.
- Milburn, P.D (1993). Biomechanics of rugby union scrummaging. *Sports Medicine*, 16(3), 168–179.
- Moore, I.S., Ranson, C., & Mathema, P. (2015). Injury risk in international rugby union: Three-year injury surveillance of the Welsh national team. *Orthopaedic journal of sports medicine*, 3(7), 1-9.
- Mountjoy, M., Costa, A., Budgett, R., Dvorak, J., Engebretsen, L., Miller, S., Moran, J., Foster, J., & Carr, J. (2018). Health promotion through sport: international sport federations’ priorities, actions and opportunities. *British Journal of Sports Medicine*, 52:54-60.
- Murphy, D.F., Connolly, D.A.J., & Beynnon, B.D. (2003). Risk factors for lower extremity injury: A review of the literature. *British Journal of Sports Medicine*, 37(1), 13-29.
- Murray, A.D., Murray, I.R. & Robson, J. (2014). Rugby union: faster, higher, stronger: Keeping an evolving sport safe. *British Journal of Sports Medicine*, 48(2), 73–74
- Nash, C.S., Sproule, J., & Horton, P. (2008). Sport coaches’ perceived role frames and philosophies. *International Journal of Sports Science & Coaching*, 3(4), 539–555.
- Nathan, M., Goedeke, R., Noakes, T.D. (1983). The incidence and nature of rugby injuries experienced at one school during the 1982 rugby school season. *South African Medical Journal*, 64(4),132–137.
- Nicol, A., Pollock, A., Kirkwood, G., Parekh, N., & Robson, J. (2010) Rugby union injuries in Scottish schools. *Journal of Public Health*, 33(2), 256–261.
- Noakes, T.D., & Draper, C.E. (2007). Preventing spinal cord injuries in rugby union. *British Journal of Sports Medicine*, 334(7604), 1122–1123.
- Orchard, J.W., Leeder, S.R., Moorhead, G.E., Coates, J.J., & Brukner, P.D. (2007). Australia urgently needs a federal government body dedicated to monitoring and

- preventing sports injuries. *Medical Journal of Australia*, 187(9), 505–506.
- Osberg, J.S., & Stiles, S.C. (2000). Safety behavior of in-line skaters. *Injury Prevention*, 6(3), 229–231.
- Palmer-Green, D.S., Stokes, K.A., Fuller, C.W., England, M., Kemp, S.P., & Trewartha, G. (2015). Training activities and injuries in English youth academy and schools rugby union. *The American Journal of Sports Medicine*, 43(2), 475–481.
- Palmer-Green, D.S., Stokes, K.A., Fuller, C.W., England, M., Kemp, S.P., & Trewartha, G. (2013). Match injuries in English youth academy and schools rugby union: an epidemiological study. *American Journal of Sports Medicine*, 41(4), 749–755.
- Patricios, J.S. (2014). Rugby contact and collisions--clinical challenges of a global game. *Current Sports Medicine Reports*, 13(5), 326–333.
- Pettersen, J.A. (2002). Does rugby headgear prevent concussion? Attitudes of Canadian players and coaches. *British Journal of Sports Medicine*, 36(1), 19–22.
- Posthumus, M., & Viljoen, W. (2008). BokSmart : Safe and effective techniques in rugby union. *South African Journal of Sport Medicine*, 20(3), 64–70.
- Quarrie, K.L., Cantu, R.C., & Chalmers, D.J. (2002). Rugby union injuries to the cervical spine and spinal cord. *Sports Medicine*, 32(10), 633–653.
- Quarrie, K.L., Gianotti, S.M., Hopkins, W.G., & Hume, P.A. (2007). Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: ecological study. *BMJ*, 334(7604), 1150–1150.
- Quarrie, K.L., & Hopkins, W.G. (2008). Tackle injuries in professional rugby union. *The American Journal of Sports Medicine*, 36(9), 1705–1716.
- Quarrie, K.L., Raftery, M., Blackie, J., Cook, C.J., Fuller, C.W., Gabbett, T.J., ... Tucker, R. (2017). Managing player load in professional rugby union: A review of current knowledge and practices. *British Journal of Sports Medicine*, 51, 421–427.
- Roberts, S.P., Trewartha, G., Higgitt, R.J., El-Abd, J., & Stokes, K.A. (2008). The physical demands of elite English rugby union. *Journal of Sports Sciences*; 26(8), 825–833.
- Roberts, S.P., Trewartha, G., England, M., & Stokes, K.A. (2015). Collapsed scrums and collision tackles: What is the injury risk? *British Journal of Sports Medicine*, 49(8), 536–540.

- Roux, C., Goedeke, R., Visser, G., Van Zyl, W., & Noakes, T.D. (1987). The epidemiology of school boy rugby injuries. *South African Medical Journal*, 71(5), 307–313.
- Saunders, N., Otago, L., Romiti, M., Donaldson, A., White, P., & Finch, C.F. (2010). Coaches' perspectives on implementing an evidence-informed injury prevention programme in junior community netball. *British Journal of Sports Medicine*, 44(15), 1128–1132.
- Scher, A.T. (1991) Catastrophic rugby injuries or the spinal cord: changing patterns or injury. *British Journal of Sports Medicine*, 25(1), 57-60.
- Schick, D.M., Molloy, M.G., & Wiley, J.P. (2008). Injuries during the Women's Rugby World Cup. *British Journal of Sports Medicine*, 42(6), 447-451.
- Schmidt, R. A., & Wrisberg, C. A. (2008). *Motor learning and performance: A situation-based learning approach*. Human Kinetics.
- Schwellnus, M. P., Thomson, A., Derman, W., Jordaan, E., Readhead, C., Collins, R., ... & Williams, A. (2014). More than 50% of players sustained a time-loss injury (>1 day of lost training or playing time) during the 2012 Super Rugby Union Tournament: A prospective cohort study of 17 340 player-hours. *British Journal of Sports Medicine*, 48(17), 1306–15.
- Sedeaud, A., Marc, A., Schipman, J., Tafflet, M., Hager, J., & Toussaint, J. (2012). How they won Rugby World Cup through height, mass and collective experience. *British Journal of Sports Medicine*, 46(8), 580–584. <http://doi.org/10.1136/bjsports-2011-090506>.
- Sewry, N., Verhagen, E., Lambert, M., van Mechelen, W., Marsh, J., Readhead, C., Viljoen, W., & Brown, J. (2018). Trends in time-loss injuries during the 2011-2016 South African Rugby Youth Weeks. *Scand J Med Sci Sports*. 00:1–8.
- Shelly, M. J., Butler, J. S., Timlin, M., Walsh, M. G., Poynton, A. R., & O'Byrne, J. M. (2006). Spinal injuries in Irish rugby: A ten-year review. *Journal of Bone and Joint Surgery*, 88(6), 771–775. <http://doi.org/10.1302/0301-620X.88B6.17388>.
- Smart, D.J., Gill, N.D., Beaven, C.M., Cook, C.J., & Blazevich, A.J. (2008). The relationship between changes in interstitial creatine kinase and game-related impacts in rugby union. *British Journal of Sports Medicine*, 42(3), 198-201.
- Taylor, A.E., Fuller, C.W., & Molloy, M.G. (2011). Injury surveillance during the 2010 IRB Women's Rugby World Cup. *British Journal of Sports Medicine*, 45(15), 1243–1245.

- Taylor, A.E., Kemp, S., Trewartha, G., & Stokes, K.A. (2014). Scrum injury risk in English professional rugby union. *British Journal of Sports Medicine*, 48, 1066–1068.
- Taimela, S., Kujala, U.M., Osterman, K. (1990). Intrinsic risk factors and athletic injuries. *Sports Medicine*, 9(4), 205–215.
- Timpka, T., Ekstrand, J., & Svanström, L. (2006). From sports injury prevention to safety promotion in sports. *Sports Medicine*, 36(9), 733-745.
- Twomey, D., Finch, C., Roediger, E. & Lloyd, D.G. (2009). Preventing lower limb injuries: Is the latest evidence being translated into the football field? *Journal of Science and Medicine in Sport*, 12(4), 452–456.
- Usman, J., & McIntosh, A.S. (2013). Upper limb injury in rugby union football: Results of a cohort study. *British Journal of Sports Medicine*, 47(6), 374–379.
- Van Mechelen, W., Hlobil, H., & Kemper, H.C. (1992). Incidence, severity, aetiology and prevention of sports injuries: A review of the concepts. *Sports Medicine*, 14(2), 82–99.
- Van Tiggelen, D., Wickes, S., Stevens, V., Roosen, P., & Witvrouw, E. (2008). Effective prevention of sports injuries: A model integrating efficacy, efficiency, compliance and risk-taking behaviour. *British Journal of Sports Medicine*, 42(8), 648–652.
- Verhagen, E.A., van Stralen, M.M., & Van Mechelen, W. (2010). Behaviour, the key factor for sports injury prevention. *Sports Medicine*, 40(11), 899–906.
- Viljoen, W., & Patricios, J. (2012). BokSmart - implementing a national rugby safety programme. *British Journal of Sports Medicine*, 46(10), 692–693.
- West, D.J., Finn, C.V., Cunningham, D.J., Shearer, D.A., Jones, M.R., Harrington, B.J., ... & Kilduff, L.P. (2014). Neuromuscular function, hormonal, and mood responses to a professional rugby union match. *Journal of Strength and Conditioning Research*, 28(1), 194–200.
- Wheeler, K., & Sayers, M. (2009). Contact skills predicting tackle-breaks in rugby union. *Journal of Sports Science and Coaching*, 4(4), 535-544.
- White, P.E., Otago, L., Saunders, N., Romiti, M., Donaldson, A., Ullah, S., & Finch, C.F. (2013). Ensuring implementation success: How should coach injury prevention education be improved if we want coaches to deliver safety programmes during training sessions? *British Journal of Sports Medicine*, 48(5), 402–403.

- Williams, S., Trewartha, G., Kemp, S.P., Brooks, J.H., Fuller, C.W., Taylor, A.E., Cross, M.J. & Stokes, K.A., (2015). Time loss injuries compromise team success in Elite Rugby Union: a 7-year prospective study. *British Journal of Sports Medicine*, pp.bjsports-2015
- Williams, S., Trewartha, G., Kemp, S. & Stokes, K. (2013). A meta-analysis of injuries in senior men's professional rugby union. *Sports Medicine*, 43(10), 1043–1055.
- Wilson, B.D., Quarrie, K.L., Milburn, P.D., & Chalmers, D. (1999). The nature and circumstances of tackle injuries in rugby union. *Journal of Science and Medicine in Sport*, 2(2), 153–162. [http://doi.org/10.1016/S1440-2440\(99\)80195-9](http://doi.org/10.1016/S1440-2440(99)80195-9)
- World Rugby. 2016. *Global rugby participation*, viewed July 29, 2017, from <http://www.worldrugby.org/development/player-numbers?lang=en>
- World Rugby n.d. *Tournament General Information*, viewed January 23, 2018 from <https://www.rugbyworldcup.com/tournament-overview?lang=en>
- World Rugby. 2018. *Laws of the Game: Rugby Union. Incorporating the Players' Charter*, viewed 25 April, 2018 from http://www.laws.worldrugby.org/downloads/World_Rugby_Laws_2018_EN.pdf

Appendix A

Research Instrument – Questionnaire from Hendricks et al. (2012)

No:



Department of Human Biology

UCT/MRC RESEARCH UNIT FOR EXERCISE SCIENCE & SPORTS MEDICINE
 Faculty of Health Sciences, University of Cape Town
 Private Bag, Rondebosch 7700, South Africa
 Tel: + 27-21-650-4569 Fax: + 27-21-686-7530

Investigation into Tackling Technique from the Perspective of Junior Rugby Players

Tackling in rugby is a fundamental component of the game. The ability to execute an effective tackle could be the difference between winning and losing, and more importantly getting injured or not. The purpose of this questionnaire is to gain insight into the:

- I. Knowledge and opinions of South African rugby players around the tackle in training and match situations
- II. Training and match behavior around the tackle situation among South African rugby players

This information will prove invaluable in our understanding and development of a safe and effective tackle which will allow for a more exciting and safe game of rugby for all.

Player Information		Date: yyyy /mm/ dd																
Surname																		
First Names																		
Club/School Name																		
Province																		
Date of Birth	y y y y	m m d d																
Height (cm)																		
Weight (kg)																		
Position (Indicate by marking an X on the position you mostly play)	<table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td> </tr> </table>		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
What is the highest level you have played?	Team (e.g. 1 st XV, 2 nd XV, under 20A, under 19 etc)	Competition (e.g Provincial, Varsity Cup, Super A/B, school etc)																
What is the current level you playing (i.e this season)?	Team (e.g. 1 st XV, 2 nd XV, under 20A, under 19 etc)	Competition (e.g Provincial, Varsity Cup, Super A/B, school etc)																
What was your age when you started playing rugby?	<table border="1"> <tr> <td><5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>>20</td> </tr> </table>		<5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>20
<5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>20			



The University of Cape Town is committed to policies of equal opportunity and affirmative action which are essential to its mission of promoting critical inquiry and scholarship



Instructions:

All questions should be answered based on your current or most recent season's training and matches unless stated otherwise.

The questionnaire is divided into 2 sections: A. Training Questions
B. Match Questions

The questions are set out so that you may answer on a rating scale of 1 to 5 (except for Questions 1 were an exact amount is needed). The meaning of each of the numbers will be given on top of the answer table unless stated otherwise.

A "not familiar (NF)" option in certain questions will also be provided if you do not know what we are talking about.

To indicate your answers make an X in the desired block.

Example:

E.g Which type of tackle do you focus on during training? To indicate your answers make an X in the desired block						
	Not Familiar (NF)	Never	Rarely	Sometimes	Frequently	Always
Front-On Tackle	NF	1	X	3	4	5

A. Training Questions

1. How often do you train per week (includes gym, running, field sessions) during the different periods in the last season? To indicate your answers make an X on the number of sessions you train per week.										
Off-Season (Sep-Jan)	1	2	3	4	5	6	7	8	9	10 or more
Pre-Season (Jan-April)	1	2	3	4	5	6	7	8	9	10 or more
In-Season (April-Sep)	1	2	3	4	5	6	7	8	9	10 or more

2. How important is proper technique to you for the following? To indicate your answers make an X in the desired block					
	Not all important	Not too important	Undecided	Somewhat important	Very important
Injury prevention <i>(lowering the risk of getting injured during the tackle)</i>	1	2	3	4	5
Improved tackling performance <i>(Preventing the ball-carrier from gaining territory and the ball-carriers team from retaining the ball)</i>	1	2	3	4	5

3. How important is training tackling to you for the following? To indicate your answers make an X in the desired block					
	Not all important	Not too important	Undecided	Somewhat important	Very important
Injury prevention <i>(lowering the risk of getting injured during the tackle)</i>	1	2	3	4	5
Improved tackling performance <i>(Preventing the ball-carrier from gaining territory and the ball-carrier's team from retaining the ball)</i>	1	2	3	4	5

4. When having a team/squad field training session, how often did your team/squad train tackling technique in different periods of the last season? To indicate your answers make an X in the desired block					
	Never	Rarely	Sometimes	Frequently	Always
Off-Season (Sep-Jan)	1	2	3	4	5
Pre-Season (Jan-April)	1	2	3	4	5
In-Season (April-Sep)	1	2	3	4	5

5. When having a team/squad field training session, how often do you train the following different types tackles? To indicate your answers make an X in the desired block						
	Not Familiar (NF)	Never	Rarely	Sometimes	Frequently	Always
Front-On Tackle	NF	1	2	3	4	5
Side-On Tackle	NF	1	2	3	4	5
Smother Tackle	NF	1	2	3	4	5
Tackling from behind	NF	1	2	3	4	5
Double Tackle	NF	1	2	3	4	5

6. Coaches use various drills to train tackling and may spend more time on different aspects of the tackle. Please rate what method of coaching is important to you for a) Injury prevention (*lowering the risk of getting injured during the tackle*) and b) Improving tackle performance (*preventing the ball-carrier from gaining territory and the ball-carriers team from retaining the ball*)

To indicate your answers make an X in the desired block

a) Injury Prevention	Not Familiar (NF)	Not all important	Not too important	Undecided	Somewhat important	Very important
Live tackling in a 1 player vs. 1 player grid	NF	1	2	3	4	5
Using tackling bag	NF	1	2	3	4	5
Given verbal instruction	NF	1	2	3	4	5
Using shield	NF	1	2	3	4	5
Using a body armour	NF	1	2	3	4	5
A full contact practice match	NF	1	2	3	4	5
Demonstration	NF	1	2	3	4	5
Tackling Drill combined with ball skill exercise	NF	1	2	3	4	5
Tackling Drill combined with a vision exercise	NF	1	2	3	4	5
Tackling Drill combined with reaction exercise	NF	1	2	3	4	5
Tackling Drill combined with fitness conditioning	NF	1	2	3	4	5
b) Improving Tackle Performance						
Live tackling in a 1 player vs. 1 player grid	NF	1	2	3	4	5
Using tackling bag	NF	1	2	3	4	5
Given verbal instruction	NF	1	2	3	4	5
Using shield	NF	1	2	3	4	5
Using a body armour	NF	1	2	3	4	5
A full contact practice match	NF	1	2	3	4	5
Demonstration	NF	1	2	3	4	5
Tackling Drill combined with ball skill exercise	NF	1	2	3	4	5
Tackling Drill combined with a vision exercise	NF	1	2	3	4	5
Tackling Drill combined with reaction exercise	NF	1	2	3	4	5
Tackling Drill combined with fitness conditioning	NF	1	2	3	4	5

7. Continuing from the previous question (Question 6), what method have you been coached in the last season?

To indicate your answers make an X in the desired block

	Not Familiar (NF)	Never	Rarely	Sometimes	Frequently	Always
Live tackling in a 1 player vs. 1 player grid	NF	1	2	3	4	5
Using tackling bag	NF	1	2	3	4	5
Given verbal instruction	NF	1	2	3	4	5
Using shield	NF	1	2	3	4	5
Using a body armour	NF	1	2	3	4	5
A full contact practice match	NF	1	2	3	4	5
Demonstration	NF	1	2	3	4	5
Tackling Drill combined with ball skill exercise	NF	1	2	3	4	5
Tackling Drill combined with a vision exercise	NF	1	2	3	4	5
Tackling Drill combined with reaction exercise	NF	1	2	3	4	5
Tackling Drill combined with fitness conditioning	NF	1	2	3	4	5

8. When training 1 vs. 1 live tackling, coaches commonly use a small grid (less than 10x10m) or a larger grid (more than 10x10m) to simulate match conditions. Also, some coaches may prefer to control the conditions in the grid by letting the tackler know what the ball-carrier is going to do or some coaches may prefer to have a less controllable grid where the tackler does not know what the ball-carrier is going to do. What 1vs 1 live tackling grid have you been training most frequently in the last season?

To indicate your answers make an X in the desired block

	Not Familiar (NF)	Never	Rarely	Sometimes	Frequently	Always
Small grid (less than 10x10m) + controlled conditions	NF	1	2	3	4	5
Small grid (less than 10x10m) + less controlled conditions	NF	1	2	3	4	5
Large grid (more than 10x10m) + controlled conditions	NF	1	2	3	4	5
Large grid (more than 10x10m) + less controlled conditions	NF	1	2	3	4	5

Further Comment (Any additional information regarding this question):

Appendix

9. When doing a tackle drill during a team/squad field session, how much time is spent on the following? Answer according to the last season.

To indicate your answers make an X in the desired block

	Not at all	A little	A fair amount	Much	Very Much
Emphasising proper technique to prevent injuries (<i>lowering the risk of getting injured during the tackle</i>)	1	2	3	4	5
Emphasising proper technique to improve tackle performance (<i>Preventing the ball-carrier from gaining territory and the ball-carriers team from retaining the ball</i>)	1	2	3	4	5

Further Comment (Any additional information regarding this question):

10. How much influence have the following factors had on your tackle technique to prevent you from injuries (*i.e lowering the risk of getting injured during the tackle*) and improve your tackling performance (*i.e preventing the ball-carrier from gaining territory and the ball-carriers team from retaining the ball*) in the last season.

To indicate your answers make an X in the desired block

Your coach from last season	Not at all	A little	A fair amount	Much	Very Much
Individual one-one verbal instruction from the coach	1	2	3	4	5
Verbal instruction to the entire team	1	2	3	4	5
Individual one-one demonstration	1	2	3	4	5
Demonstration to the entire team	1	2	3	4	5
Identifying a problem in your tackle technique and fixing it	1	2	3	4	5
Identifying a team problem in tackle technique and fixing it	1	2	3	4	5
Media and books					
Newspapers	1	2	3	4	5
Rugby Magazines	1	2	3	4	5
Internet	1	2	3	4	5
Televised rugby matches	1	2	3	4	5
Sport/Rugby shows on TV	1	2	3	4	5
Rugby training videos	1	2	3	4	5
Rugby training books	1	2	3	4	5
Other					
Relatives	1	2	3	4	5
Friends	1	2	3	4	5
Teammates	1	2	3	4	5
Experience	1	2	3	4	5
Attending live rugby matches	1	2	3	4	5
Coaching clinics	1	2	3	4	5
Your rugby icon	1	2	3	4	5

11. How much did you learn about tackling technique in the different age categories?

To indicate your answers make an X in the desired block

Age Category	Not at all	A little	A fair amount	Much	Very Much
Under 10	1	2	3	4	5
Under 13	1	2	3	4	5
Under 15	1	2	3	4	5
Under 19	1	2	3	4	5
Seniors	1	2	3	4	5

12. During a front-on tackle drill in the last season, how much emphasis was placed on the following pointers? To indicate your answers make an X in the desired block						
Pointers before the tackle	Not Familiar (NF)	Never	Rarely	Sometimes	Frequently	Always
Approach	NF	1	2	3	4	5
Body position before the tackle	NF	1	2	3	4	5
Where your eyes should focus	NF	1	2	3	4	5
Position of the arms	NF	1	2	3	4	5
Lowering your centre of gravity	NF	1	2	3	4	5
Footwork before the tackle	NF	1	2	3	4	5
Aim for the legs	NF	1	2	3	4	5
Aim for the waist	NF	1	2	3	4	5
Aim for the upper body	NF	1	2	3	4	5
Aim for the ball only	NF	1	2	3	4	5
No target —just bring the opposition player down	NF	1	2	3	4	5
Pointers for contact in the tackle						
Importance of safety	NF	1	2	3	4	5
Head placement	NF	1	2	3	4	5
Eyes being open	NF	1	2	3	4	5
Position of your neck and spine	NF	1	2	3	4	5
Direction from which to enter contact in the tackle	NF	1	2	3	4	5
Shoulder and chest placement	NF	1	2	3	4	5
Arm placement	NF	1	2	3	4	5
Staying on feet	NF	1	2	3	4	5
Accelerate into contact with the same shoulder as the front leg	NF	1	2	3	4	5
Accelerate into contact with the opposite shoulder to the front leg	NF	1	2	3	4	5
Diving into the tackle	NF	1	2	3	4	5
Using the legs to drive the tackle	NF	1	2	3	4	5
Lifting the opposition player	NF	1	2	3	4	5
Using your own bodyweight to bring the opposition player down	NF	1	2	3	4	5
Pointers for after contact						
Following through with the tackle	NF	1	2	3	4	5
Staying on feet	NF	1	2	3	4	5
Lift off and dive through the tackle	NF	1	2	3	4	5
Use your bodyweight to bring the opponent down	NF	1	2	3	4	5
Prepare body position for going to ground after the tackle	NF	1	2	3	4	5

B. Match Questions

1. In the last season of matches you played (friendlies and league) from which direction do you think you tackled the most? To indicate your answers make an X in the desired block					
	Not at all	A little	A fair amount	Much	Very Much
Front-On Tackle	1	2	3	4	5
Side-On Tackle	1	2	3	4	5
Smother Tackle	1	2	3	4	5
Tackling from behind	1	2	3	4	5
Double tackle	1	2	3	4	5

2. What is important to you when making a tackle during a match? To indicate your answers make an X in the desired block					
	Not all important	Not too important	Undecided	Somewhat important	Very important
Doing what you practiced	1	2	3	4	5
Proper technique	1	2	3	4	5
Bringing down the ball-carrier at all costs	1	2	3	4	5
Your own safety (lowering the risk of getting injured)	1	2	3	4	5
Safety of the ball-carrier (lowering the risk of injuring the ball-carrier)	1	2	3	4	5
Safety of both you and the ball-carrier	1	2	3	4	5
Putting in a 'Big Hit'	1	2	3	4	5
Going for the ball only	1	2	3	4	5
Staying on your feet	1	2	3	4	5
Preventing the ball-carrier from retaining position	1	2	3	4	5
Preventing the ball-carriers team from retaining the ball	1	2	3	4	5
Further Comment (Any additional information regarding this question):					

3. Does your answer to question 2 change according... To indicate your answers make an X in the desired block					
As the match progresses	Never	Rarely	Sometimes	Frequently	Always
First 20 min of the 1 st half	1	2	3	4	5
Second 20 min of the 1 st half	1	2	3	4	5
First 20 min of the 2 nd half	1	2	3	4	5
Second 20 min of the 2 nd half	1	2	3	4	5
As the score changes					
In your team's favour	1	2	3	4	5
In the opposition's favour	1	2	3	4	5
A small score margin (less than 10 points)	1	2	3	4	5
A large score margin (more than 10 points)	1	2	3	4	5
Position on the field					
Defending on your try-line	1	2	3	4	5
Defending within your 22-M (from your try-line to your 22-M line)	1	2	3	4	5
Defending within the mid-section of the field (from your 22-M line to the opposition 22-M line)	1	2	3	4	5
Defending within the opposition 22-M (from the opposition 22-M line to the opposition try-line)	1	2	3	4	5
Position relative to ruck/maul/scrum/lineout					
If you are close (within 5m) to the ruck/maul/scrum/lineout	1	2	3	4	5
If you are not close (more than 5m away) to the ruck/maul/scrum/lineout	1	2	3	4	5
If you are on the blind-side	1	2	3	4	5
If you are on the open side	1	2	3	4	5
Importance of the game					
Playing for promotion or relegation	1	2	3	4	5
Playing a final	1	2	3	4	5
Playing a local derby	1	2	3	4	5
Further Comment (Any additional information regarding this question):					

4. What do you think may help you improve your tackle performance (preventing the ball-carrier from gaining territory and the ball-carriers team from retaining the ball) and lowering your risk of injury in a tackle during a rugby match?

To indicate your answers make an X in the desired block

	Not at all	A little	A fair amount	Much	Very Much
Knowledge of proper technique	1	2	3	4	5
Training proper technique regularly	1	2	3	4	5
Attitude	1	2	3	4	5
Reaction time	1	2	3	4	5
Vision	1	2	3	4	5
Defensive structures	1	2	3	4	5
Motivation	1	2	3	4	5
Determination	1	2	3	4	5
Weather conditions	1	2	3	4	5
The crowd	1	2	3	4	5
Confidence	1	2	3	4	5
Match day preparations	1	2	3	4	5
Personal fitness conditioning (strength, speed, stamina)	1	2	3	4	5
Rest prior to the game	1	2	3	4	5
Stretching prior to the game	1	2	3	4	5
General flexibility	1	2	3	4	5
Using protective gear (shoulder pads, scrumcap)	1	2	3	4	5

Further Comment (Any additional information regarding this question):

Appendix B

Parent Informed Consent

No:



Department of Human Biology
 UCT/MRC RESEARCH UNIT FOR EXERCISE SCIENCE & SPORTS MEDICINE
 Faculty of Health Sciences, University of Cape Town
 Private Bag, Rondebosch 7700, South Africa
 Tel: + 27-21-650-4569 Fax: + 27-21-686-7530

Investigation into Tackling Technique from the Perspective of Junior Rugby Players

Parent/Guardian Informed Consent

Tackling in rugby is a fundamental component of the game. The ability to execute an effective tackle could be the difference between winning and losing, and more importantly getting injured or not. The purpose of this questionnaire is to gain insight into the:

- I. Knowledge and opinions of South African rugby players around the tackle in training and match situations
- II. Training and match behavior around the tackle situation among South African rugby players

The information collected from this questionnaire will be used to further our understanding of the tackle. Filling out the questionnaire is completely voluntary and the information will be treated confidential and remain anonymous.

I, _____ the parent/guardian of _____ declare that I have understood the above information and agree to allow my child to complete the questionnaire, and that the information my child provides in this questionnaire can be used for research by the University of Cape Town.

Parent/Guardian Signature:

Contact Details:	Phone No	Email
Principle Investigator: Sharief Hendricks	021 650 4569	sharief.hendricks@uct.ac.za
Supervisor: Mike Lambert	021 650 4558	mike.lambert@uct.ac.za
Research Ethics Committee	021 406 6492	mark.blockman@uct.ac.za



The University of Cape Town is committed to policies of equal opportunity and affirmative action which are essential to its mission of promoting critical inquiry and scholarship



Appendix C

Player Informed Assent



No: _____
Department of Human Biology
UCT/MRC RESEARCH UNIT FOR EXERCISE SCIENCE & SPORTS MEDICINE
Faculty of Health Sciences, University of Cape Town
Private Bag, Rondebosch 7700, South Africa
Tel: + 27-21-650-4569 Fax: + 27-21-686-7530

Investigation into Tackling Technique from the Perspective of Junior Rugby Players

Player Informed Assent

Tackling in rugby is a fundamental component of the game. The ability to execute an effective tackle could be the difference between winning and losing, and more importantly getting injured or not. The purpose of this questionnaire is to gain insight into the:

- I. Knowledge and opinions of South African rugby players around the tackle in training and match situations
- II. Training and match behavior around the tackle situation among South African rugby players

The information collected from this questionnaire will be used to further our understanding of the tackle. Filling out the questionnaire is completely voluntary and this information will be treated confidential and remain anonymous.

I, _____ declare that I have understood the above information and agree to voluntarily fill out the questionnaire, and that the information I provide in this questionnaire can be used for research by the University of Cape Town.

Signature:

Contact Details:	Phone No	Email
Principle Investigator: Sharief Hendricks	021 650 4569	sharief.hendricks@uct.ac.za
Supervisor: Mike Lambert	021 650 4558	mike.lambert@uct.ac.za
Research Ethics Committee	021 406 6492	mark.blockman@uct.ac.za



The University of Cape Town is committed to policies of equal opportunity and affirmative action which are essential to its mission of promoting critical inquiry and scholarship

