Safer rugby through *BokSmart*?

Evaluation of a nationwide injury prevention programme for rugby union in South Africa

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PhD Thesis

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SAFER RUGBY THROUGH *BOKSMART*: EVALUATION OF A NATIONWIDE INJURY PREVENTION PROGRAMME FOR RUGBY UNION IN SOUTH AFRICA

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ACKNOWLEDGEMENTS

A PhD is very definitely an example of a team effort. Anyone who says otherwise is lying. Most people will not read this page, so I am not able to apologise for its length. I even had a couple of friends check through this to avoid it, but if I have managed to forgot you (and I have no doubt that I have), I truly do apologise.

First and foremost thanks to my parents for providing me with all the necessary life skills to get to the point of handing my PhD in. You guys are the ultimate example of making sure you children have everything they need in life, even if it is to your own detriment. In the same vein thanks to my sister, and at times second mother, **Kerry** for also always being supportive of me from before I can even remember.

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your altruistic attitude towards me as a student – whether you were my supervisor or not. Thanks also for your friendship.

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Speaking of Dutch friends there are also some non-VU people I need to thank. **Tania and Sean** and your family – thanks for taking me in like a surrogate son, you

guys were a lifeline when I was initially lonely overseas. **Milou, Arnoud, Hendrieke and Erik** – thanks for all the effort you made in showing me the real Amsterdam: yes, *Cool down Café* is included in that! **Annick** – thanks for looking after me from across the border in Belgium even when things were not so rosey for you. **Mieke and Pol** and family – thank for taking me in and involving me in al your fun activities – you always made me feel welcome. **Ben, Esmee, Henk and Ingrid** – man am I glad we happened to be on that same hike all those years ago in South Africa. I loved coming to visit you in Utrecht – thanks for always involving me in your parties and activities with no hassle! I know that we will be friends for a long time – I look forward to seeing you again in South Africa some time.

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DECLARATION OF AUTHOR CONTRIBUTIONS

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15th July, 2014

Dear members of the University of Cape Town Doctoral and Master Committee, Faculty of Heath Sciences

RE: Contributions to published papers included in thesis of ***Mr James Brown*** *(BRWJAM004)*

James Brown has included four published manuscripts in his PhD-thesis. This thesis will be presented to both UCT as well as VU University Amsterdam to be awarded with a double degree by both institutions, under the signed agreement between UCT and VU University on this matter. For this reason, but also for reasons of coherence and quality, I feel that the inclusion of these four manuscripts is warranted and are necessary to answer his overall thesis aims and objectives, as well as to meet the doctoral degree demands on both ends.

James Brown (JB) has been the lead author of all of these published manuscripts. The more specific contributions of himself and the other co-authors on these published manuscripts are shown in Table 1. The co-authors are:

Prof Willem Van Mechelen (WM)*, Dr Evert Verhagen (EV)*, Dr Wayne Viljoen (WV)#, Mr Clint Readhead (CR)#, Dr Sharief Hendricks (SH)**, Mr Nick Burger (NB)**, Ms Chelsea Fuller (CF)** and myself (ML)**.

**Vrije University, Amsterdam,*
 # SA Rugby,
*** UCT*

Furthermore, as Mr Nick Burger is a current PhD student at UCT (I am his supervisor), I will make special mention of the fact that this letter also certifies that Nick will not include the material of this paper (Chapter 5) in his PhD thesis. Mr Nick Burger has also read and signed this letter and confirmation of his consent.

Table 1. *Summary of relative contributions of co-authors to published manuscripts included in this thesis.*

Task	Chapter 2	Chapter 3	Chapter 4	Chapter 5
Conceptualization	**JB – 50%** ML – 10% WM – 10% EV – 15% WV – 10% CR – 5%	**JB – 50%** ML – 10% WM – 15% EV – 15% WV – 5% CR – 5%	**JB – 50%** ML – 10% WM – 15% EV – 10% WV – 10% CR – 5%	**JB – 70%** ML – 5% WV – 5% SH – 5% CR – 5% NB – 5%
Data entry	JB – 80%	JB – 70% CF – 30%	WV – 50% CR – 50%	N/A
Data analyses	**JB – 100%**	**JB – 40%** CF – 30% ML – 30%	**JB – 90%** ML – 10%	**JB – 100%**
Writing of draft	**JB - 100%**	**JB - 100%**	**JB - 100%**	**JB - 100%**
Editing of drafts	ML – 30% WM – 10% EV – 25% WV – 25% CR – 10%	ML – 10% WM – 10% EV – 35% WV – 30% CR – 10% CF – 5%	ML – 25% WM – 10% EV – 25% WV – 30% CR – 10%	ML – 25% EV – 20% WV – 30% CR – 15% NB – 10%

Yours sincerely,

Professor Mike Lambert

Signed by candidate

Mr Nick Burger Date: 2014-07-21

Signed by candidate

Witness Date: 21/07/2014

Signed by candidate

ABSTRACT

Introduction and objectives: Rugby union ('rugby') is a popular sport that has a high risk of injury. The sport has particular popularity in South Africa with about 500,000 players. Based on concerns about the number of rugby-related catastrophic injuries, the *BokSmart* nationwide injury prevention programme was launched in July 2009 by South African Rugby Union (SARU). [3] This programme educates coaches and referees on safe techniques during a Rugby Safety Workshop (RSW). To assess real-world injury prevention efforts, researchers have suggested using the six Translating Research into Injury Prevention Practice (TRIPP) stages.[4] Stage 1 and 2 investigate the incidence, severity and aetiology of injuries. Stage 2 investigates the aetiology of injuries. Stage 3 is the introduction of an intervention. Stage 4 is an investigation of the effectiveness of the intervention under ideal conditions. Stages 5 and 6 investigate the real-world implementation of the intervention. Thus, the objective of this thesis is to comprehensively evaluate the *BokSmart* programme using the TRIPP framework.

Methods: TRIPP stages 1 and 2 are investigated in Chapters 2, 3, 4 and 5. Chapter 2 investigates the incidence, severity and aetiology of injuries at four competitive youth tournaments. Chapter 3 used Chapter 2's data to investigate the economic burden of these injuries. Chapter 4 investigates the incidence and severity of catastrophic injuries. Chapter 5 investigates the risk of both general and catastrophic injury specific to the scrum phase of play using the data from Chapters 2 and 4. TRIPP stages 3 and 4 were conducted by SARU and are thus outside the scope of this thesis. TRIPP stages 5 and 6 are investigated in Chapters 6, 7 and 8. Chapter 6 evaluates the effect of *BokSmart* in on catastrophic injury rates. Chapter 7 evaluates the effect of *BokSmart* on targeted player behaviours. Chapter 8 uses qualitative methods to investigate coaches and referees' perceptions of *BokSmart*.

Results: Through TRIPP Stages 1 and 2 it was established that South Africa has comparable general and catastrophic injury rates to other countries. Senior players were at significantly ($p<0.05$) greater risk of suffering a catastrophic injury than younger players. The economic investigation indicated that injury rehabilitation was affected by whether the player had medical insurance or not – this may be unique to South Africa. Through TRIPP stages 5 and 6 *BokSmart* was associated with a reduction in catastrophic injuries in junior, but not senior players. *BokSmart* was also

associated with a significant improvement in targeted player behaviours. Coaches' perceptions of the programme varied by socioeconomic status (SES). All coaches and referees agreed that the programme was capable of reducing catastrophic injuries in players. However, high SES coaches described difficulties in changing coach and player behaviour, while low SES coaches mentioned their lack of necessary infrastructure as barriers to adoption. There was also negativity about the delivery of *BokSmart*: coaches and referees felt the course was not practical enough, was too long and should not be compulsory.

Conclusions: From *BokSmart's* perspective, the lack of effectiveness of the programme in senior players should be of concern, considering this age group's greater risk of catastrophic injury. This greater effect in juniors could be explained either by the higher number of players, or greater adoption in this age group. Future research should attempt to elucidate this reason. The barriers and suggestions described by low and high SES coaches and referees should be addressed to optimise the programme's impact. The programme should continue to be evaluated to assess the impact of these suggestions.

TABLE OF CONTENTS

1

THE INTRODUCTION OF THE *BOKSMART* NATIONWIDE INJURY PREVENTION PROGRAMME IN SOUTH AFRICA: INTRODUCTION AND BACKGROUND

BACKGROUND

Regular participation in physical exercise offers numerous benefits, including health and enjoyment to the individual.[1,2] However, participation in physical activity also has a potential risk of injury to the individual – this risk varies by the amount and type of activity. [2,3]. Rugby Union ('rugby') is currently one of the most popular sports in the world. This popularity is increasing, worldwide. [4] Of all popular team sports, rugby has a particularly high risk of injury – higher than that of soccer (non-North American football) and cricket.[3-5] The high incidence of injury in rugby is related to the nature of the game – a field-based team sport that involves multiple contact situations over the 80 minutes of play. [6-8] Since rugby's inception - speculated to have been between the start of the 1600's and the mid 1800's - the sport has always been regarded as a violent sport. [9] Indeed, the main motivations for the formation of the Rugby Football Union in 1871 were the introduction of laws to reduce the violence of the game. [9] The Laws of Rugby Union have developed exponentially in both number and complexity from these early days to present. The earliest recorded set of "laws", created at the formation of the Rugby Football Union in 1871 were put in place to ensure a fair contest of possession. [9] Even more recently, many law changes have been made to increase player safety. [10]

However, some of these law changes have been to aid rugby in its competition with other popular sports for spectator support. [9] The earliest record of a law change to improve spectator enjoyment – made in in the early 1900's was to reduce the number of players on the field from 300 to 30. [9] The result – a faster, more open, running game - is believed to have increased the injury risk due to the increased speed physical collisions. [11,12] This notion was even suggested in 1980 by the then President of the Rugby Football Union: "There is little doubt that Rugby Football at all levels...has become a more dangerous pursuit in the last ten years". [11] Despite this injury risk, law changes and the nature of the game have resulted in rugby being one of the most watched and played games in the world, currently. [4]

Therefore, the epidemiology of rugby injuries has been of interest to researchers for some time now: the earliest scientific report on this topic being published in 1954. [13] Of all sports injuries, serious or catastrophic injuries are the most life-changing: for the sufferer, as well as for their immediate family and friends. As catastrophically

injured players are often also the “bread winners” of their family, there are often both emotional and financial consequences to the injury. Furthermore, the individual requires a shift in expectations as their life of physical activity and general good health will also be affected for their rest of their lives. [14] While media reports often associate rugby with catastrophic injuries, [15] these reports may exaggerate this association. [16] The United Kingdom’s Health and Safety Executive assesses certain day-to-day activities (such as driving a car or motorcycle) and diseases or adverse events (such as cancer or drowning) in terms of risk of serious injury or death. The number of deaths are normalised by the number of people at risk for a particular situation (exposure). These risks are rated in increasing magnitude: ‘negligible’, ‘acceptable’, ‘tolerable’ and ‘unacceptable’ risk. Risk of serious injury or death due to participating in rugby was classified as either ‘acceptable’ or ‘tolerable’ risk for all countries that had available data for the study. [16] Developing cancer and driving a motorcycle were examples of events/adverse activities that carried unacceptable levels of risk, while an event such as being struck by lightning carried negligible risk. While higher than most other popular sports, Fuller [16] classified rugby’s incidence of catastrophic injuries as ‘acceptable’ in this assessment. Furthermore, rugby’s rate of catastrophic injuries was less than sports such as horse-racing, gymnastics and ice hockey. [16]

Despite the assessment of rugby-related catastrophic injuries being classified as ‘acceptable’, the consequences of catastrophic injuries are so severe that even one catastrophic injury a year is one case too many. A recent account of those suffering catastrophic injury from the Chris Burger Petro Jackson Players’ Fund (CBPJPF) in South Africa illustrates the hardships that are experienced by the players and their families post-injury. [14] The CBPJPF is a non-profit organisation that aims to financially assist players injured while playing rugby in South Africa. [14] The fund was begun in 1980 by former Springbok Captain Morne Du Plessis after his teammate and friend died a shortly after suffering a spinal cord injury during a rugby match where they were teammates. Owing to continued contributions and fund-raising activities the fund currently supports over 60 catastrophically injured rugby players.[14]

However, the most well documented example of an effort to prevent catastrophic injuries emerged from New Zealand. The sport of rugby is of "national prominence and importance" in New Zealand. [17] As a result, the country began the Rugby Injury and Performance Project (RIPP). This project's aim was to scientifically develop and evaluate a rugby injury prevention programme. The 'sequence of prevention' model [2] was chosen as a framework for this proposed intervention. (Figure 1).

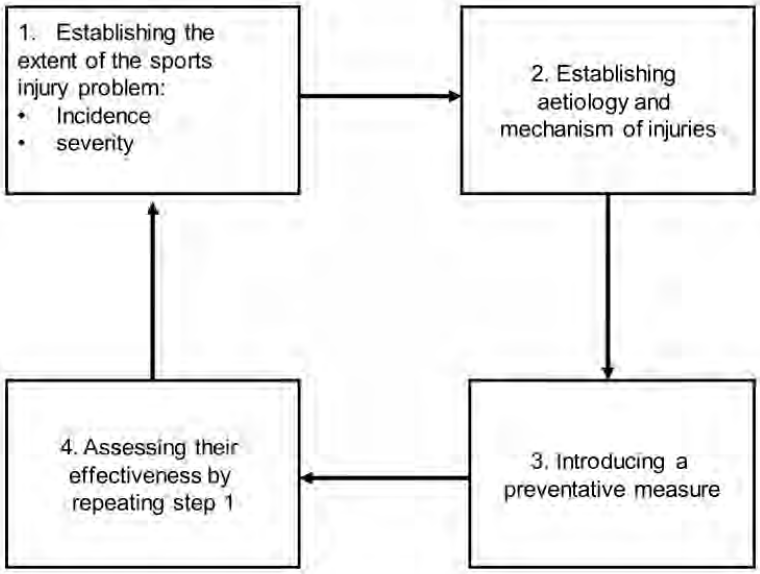

Figure 1 Four stage 'sequence of prevention' model [2]

A series of six publications [17-22] assessed Step 1 and Step 2 of the four stage model of injury prevention (Figure 1). [2] Based on this information, and the success of the original nationwide SportSmart injury prevention education programme, [23] a nationwide injury prevention programme for rugby, *RugbySmart*, was launched in New Zealand in 2001 (Step 3). The programme strategy was to educate key rugby stakeholders - coaches and referees - on 'safe' rugby coaching, game and injury management – in an attempt to improve injury rates in players. This strategy was chosen based on the importance of these role players (coaches and referees) in determining player behaviour.[24] Thus, the coaches and referees are the actual

direct target ('researcher intervention') while players are the indirect targeted "health beneficiaries" of the intervention. [25] The effectiveness of this intervention was evaluated by examining changes in injury rates and player behaviour after the launch of the programme (Steps 4). [24,26] Five years after the introduction of *RugbySmart*, there was an observed reduction in the incidence of both general [24] and catastrophic [26] injuries in players, nationwide. As targeted player behaviour (practicing of safe techniques) had improved over the concomitant time period, [24] it was assumed that the improvement in player catastrophic injury rates were a result of this improvement in their behaviour. Since this evaluation, behaviour change in the target population has been recognised as a necessary requirement for the success of injury prevention programmes. [27,28]

Similarly to New Zealand, the sport of rugby is particularly popular in South Africa with an estimated 400 000 - 500 000 players and 40 000 – 45 000 coaches nationwide.[28] Despite the high level of participation, there have only been a few well-performed prospective epidemiological studies in rugby in South Africa. This is of concern considering that the CBPJPF has received reports of an average of 22 catastrophic injuries per annum since 2001 [29] As a result, the principles of the *RugbySmart* intervention were adapted, with their permission and support, for South Africa. The South African programme was named *BokSmart*, borrowing "*Bok*" from '*Springboks'*: the popular nickname of the national rugby team. Based on the programme's success in New Zealand, the *BokSmart* manager, Dr Wayne Viljoen, predicted that *BokSmart* could reduce the incidence and severity of catastrophic head, neck and spine injuries in South Africa. [30] While the programme has other objectives, this is the main goal of the programme and will therefore be referred to as "internal goal" of the *BokSmart* programme. Although there were some preliminary discussions beforehand, the *BokSmart* injury prevention program was officially launched in South Africa in July 2009.

THE BOKSMART PROGRAMME

The *BokSmart* strategy is comprised of four 'interventions': 1. *BokSmart* rugby safety workshops (RSWs) aimed at coaches and referees, 2. *BokSmart* rugby medic programme (RMP) aimed at underprivileged communities, 3. *BokSmart* Spineline emergency number, 4. *BokSmart* website (www.boksmart.com) with freely available

resources for coaches ranging from pre-participation screening forms to physical conditioning programmes [31] These interventions are used to achieve the internal goal of the programme.

Based on the principles of *RugbySmart*, all content and legislation of *BokSmart* is evidence-based. [31] The *BokSmart* manager has contracted and still contracts relevant experts on a needs basis to conduct literature reviews on specific topics of practical importance to the programme and encourages the expert to publish the work in a high impact peer-reviewed journal. For example, the "safe techniques for rugby" [32] that are advocated to coaches and referees in the RSWs as well as a modified scrum engagement law change that occurred in South Africa in 2013 [33] were both published in international sports medicine journals. A comprehensive list of the *BokSmart* related research is available at their website (http://boksmart.sarugby.co.za/content/boksmart-research/) [29]

Intervention 1: BokSmart rugby safety workshops

The rugby safety workshops are the main focus of the *BokSmart* programme and aim to educate all rugby coaches and referees in South Africa in safe, yet effective, rugby techniques and procedures. [31] The rugby safety workshops are facilitated by a SARU-appointed trainer who takes the attendees through an educational DVD. Trainers are well-respected coaches or referees who are nominated by their local regions (called 'unions' in South Africa) to SARU for this job. After a two day training process which involves rigorous screening, training and testing of the candidates, SARU chooses it's *BokSmart* trainers. This is to ensure that all trainers are competent rugby safety workshop facilitators.

The rugby safety workshops content represents a summary and translation into everyday language for the attendees of the evidence-based articles described previously that are available on the *BokSmart* website, [29]. The topics covered in the RSW range from correct hydration and nutrition practices to serious injury management for rugby. The following topics were presented in the first rugby safety workshops in 2009:

1. *Eating and drinking right for rugby*
2. *Effective play and controlling the game*

3. Fair play and the BokSmart code of conduct
4. Management of rugby injuries
5. Physical preparation and recovery techniques
6. Pre-participation screening of players
7. Pre-season testing and physical profiling of players
8. Protective equipment in rugby
9. Safety in the playing environment
10. Serious injury protocol
11. Strength and conditioning for effective rugby

Thus, this range of topics covers both primary (i.e. preventing an injury from occurring) and secondary (i.e. adequately dealing with an injury that has occurred to promote best possible outcome) aspects of prevention. Although English is only the fourth most spoken home language in South Africa according to the latest census results, [34] the language is widely spoken in the country. Therefore, SARU decided that the rugby safety workshops would be uniformly presented in English across the country.

At the end of the rugby safety workshops, attendees are provided with their own copy of the rugby safety workshops DVD as well as an accompanying manual that contains similar information to the DVD as well as a pitch-side concussion guide (all in English). It is SARU's expectation that attendees will make use of the free resources once they return to their respective roles with players. Once attendees have sat through the entire rugby safety workshops, they are given a *BokSmart* card to certify that they have a current accreditation. This certification lasts for two years after which time the card expires and they have to redo the entire rugby safety workshop. SARU also renews the rugby safety workshop content (DVD and accompanying manual) every two years to ensure the information is current and also to incorporate relevant feedback from attendees from previous courses.

As the *BokSmart* programme is an injury prevention programme, it should address risk factors for injury. [35] The Meeuwisse model of injury causation describes the athlete on a continuum, from healthy to injured, based on the interaction of various injury risk factors (Figure 2). An athlete may become predisposed to injury through

intrinsic (internal) risk factors, which are inherent to an individual, such as age or sex. Once predisposed, the individual can become a susceptible athlete through exposure to extrinsic (external) risk factors, such as the equipment the athlete was using or the immediate playing environment. However, these two groups of risk factors alone may not necessarily result in an injury – an inciting event is a necessary extrinsic factor to cause an acute injury. [35]

Figure 2 Adapted injury causation model. [34]

To reduce the incidence of injuries in rugby, the course content of the rugby safety workshops would need to be designed to change behaviours that were risk factors for injury.[27] Therefore the content of the rugby safety workshops information book was divided into the specific intrinsic and extrinsic injury risk factors that each chapter addresses (Table 1). Due to the internal goal of the programme – to reduce the incidence and severity of catastrophic injuries, special note was made of content that had a focus on catastrophic injuries.

Table 1. BokSmart Rugby Safety Workshops chapter content and associated injury risk factors.

Chapter	Content	Injury risk factor (I - Intrinsic or E - extrinsic)
1. Eating and drinking right for rugby	Nutrition and hydration before, during and after training/match	Fatigue (I)
		Dehydration (I)
		Inadequate adaptation from training or match (I)
2.Effective play and controlling the game	Inspection of playing conditions (on- and off-field) and pre-match briefing of players	Unsafe on- or off-field conditions (E)
	Handling foul play	Foul play [C]
	Handling the tackle situation (including foul play)	Incorrect technique (I) [C]
	Coaching safe and effective techniques (scrum, tackle, being tackled, lineout, ruck and maul)	Incorrect technique (I) [C]
3.Fair play and the BokSmart Code of Conduct	Agreement to uphold fair play agreement – safe environment	Foul play [C]
4.Management of rugby injuries	Management of serious injury – safe environment and recovery from injury	Incorrect on-field injury management (E) [C] *
	Management of soft tissue injury – recovery from injury and adaptation	
	Management of concussion – safe environment and recovery from injury	Previous injury (I)
	Rehabilitation and return to play – recovery from injury	
5.Physical preparation and recovery techniques	Effective warm-up – improve range of motion, body ready for contact situation, improve visual awareness, improve mental awareness	Pre-game state (I)
	Cool-down – improve recovery from match/training	Inadequate adaptation (I)
6.Pre-participation screening of players	Identify players predisposed to injury by previous injury or familial predisposition through questionnaire	Previous injury (I) [C]
		Familial predisposition (I) [C]

I – intrinsic risk factor, E – extrinsic risk factor, [C] – targets catastrophic injuries

Table 1 continued on next page

Table 1 (continued). BokSmart Rugby Safety Workshops chapter content and associated injury risk factors.

Chapter	Content	Injury risk factor (I - Intrinsic or E - extrinsic)
7.Pre-season testing and the physical profiling of players	Awareness of players at risk by cardiorespiratory fitness or strength	Off-, pre- and in-season condition (I) [C]
	Improve cardio fitness and strength	
8.Protective equipment	Reduce impact of contact on body	Inadequate protective equipment (I)
9.Safety in the playing environment	Improve on- and off-field conditions	Unsafe on- or off-field conditions (E) [C]
10.Serious injury protocol	Dealing with a serious injury	Incorrect on- or off-field injury management (E) [C]
11.Strength and conditioning for rugby	Ensure player is physically prepared for contact and cardiorespiratory demands of game	Off-, pre- or in-season cardiorespiratory fitness or muscle strength (I) [C]
	Neck conditioning to reduce risk of serious injury	

I – intrinsic risk factor, E – extrinsic risk factor, [C] – targets catastrophic injuries

The intrinsic and extrinsic risk factors that were targeted by the content of the *BokSmart* rugby safety workshops were then applied to the Meeuwisse injury causation model in Figure 3. For the *BokSmart* programme to be effective, the content needs to be able to change behaviour associated with injuries, as well as the determinants of these behaviours, in all the key stakeholders involved in rugby in South Africa.

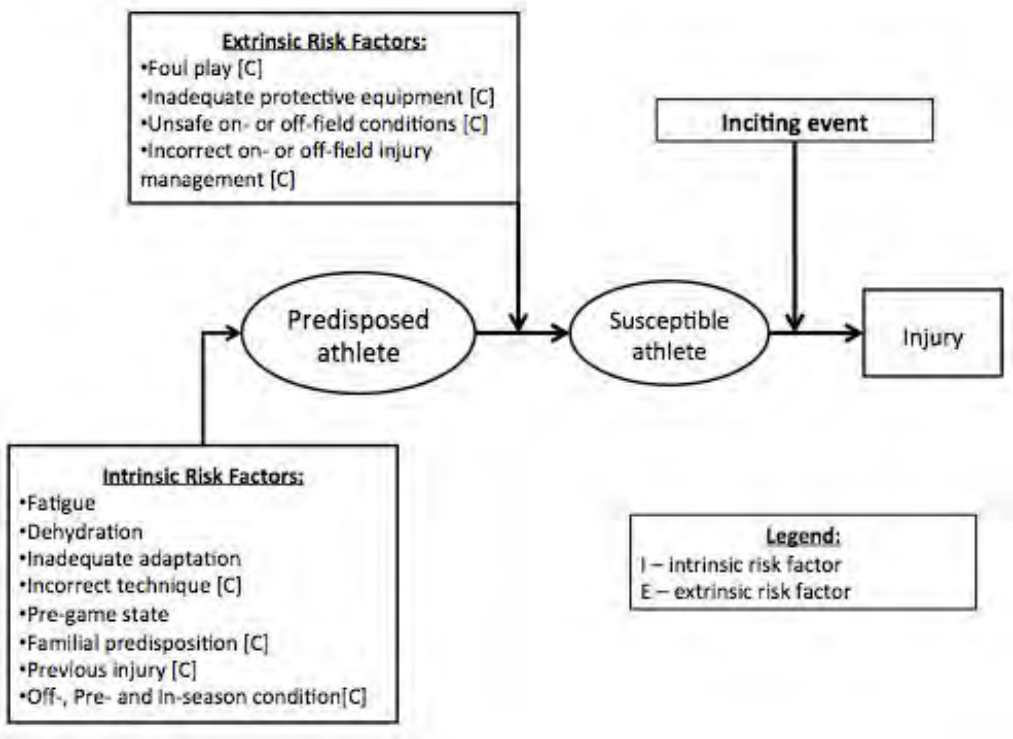

Figure 3 BokSmart content fitted to injury causation model [35]

Intervention 2: BokSmart rugby medic programme

The *BokSmart* rugby medic programme is a parallel intervention to the rugby safety workshops although it was run on a needs-basis and for underprivileged clubs and schools and run on a far smaller scale to the rugby safety workshops. The rugby medic programme is a 6-8 hour practical course that focuses on secondary prevention as part of the catastrophic injury content of the RSW course and that is performed for no charge. Due to budget constraints, the rugby medic programme was stopped in 2011. However, this intervention is described for context.

Typically in South Africa, underprivileged clubs and schools have minimal access to trained medical professionals and equipment that are implicitly requisite for rugby training and matches. The aim of the rugby medic programme is to empower individuals involved in rugby in these underprivileged communities in the prevention of catastrophic injury.

BokSmart requires a rugby medic programme course representative from the school or club before a course will be run. The identification of this rugby medic programme

course representative occurs through one of two processes. The main method is that SARU identifies leaders in known underprivileged rugby communities. Alternatively any member of a rugby community, who can prove that their club or school is underprivileged, can apply to SARU directly to be a rugby medic programme representative. Once SARU has confirmed a representative for the course, a qualified Emergency Medicine Specialist (EMS) will be sent to conduct the programme at the representative's institution. Furthermore, if the EMS notices that the school or club is without any specialist equipment for managing a catastrophic injury – such as a stretcher or spider harness – these items are delivered to the school or club by SARU at no charge.

Intervention 3: BokSmart Spineline emergency number
This is a dedicated toll-free emergency hotline for all suspected rugby-related catastrophic injuries in South Africa. The line is operated by a private emergency medical service, *ER24*, and therefore can assist with both the management and transportation of catastrophically injured players. The number (0800 678 678) is discussed with coaches and referees during the rugby safety workshops and rugby medic programme and is also advertised widely outside of the course.

Intervention 4: BokSmart website (www.boksmart.com)
The *BokSmart* website provides a variety of freely available content and resources:

1. *Description of BokSmart, including details of the rugby safety workshops, rugby medic programmes and Spineline.*
2. *Medical protocols including concussion, eating and drinking right for rugby, pre-season testing, physical conditioning programmes (with and without access to training facilities), serious injury protocols.*
3. *"Safe six" prehabilitation programme.*
4. *Legislation and regulations for South Africa*
5. *Research – BokSmart-related content published in international peer-reviewed journals,*
6. *Marketing and communications – photo galleries and press releases.*
7. *Up to date injury statistics*
8. *Coach and refereeing courses – International Rugby Board (IRB) courses and rugby safety workshops*

BOKSMART REPORTS

The *BokSmart* content evolves in two-year cycles: cycle 1 began in July 2009 (*BokSmart* launch) and cycle 2 began in July 2011. The programme is currently in its third cycle. To keep the content of *BokSmart* relevant to its environment, SARU has various internal audits and reports (either annual or biannual). For example – because the number of scrum-related catastrophic injuries was increasing, SARU began investigating safer laws for scrummaging to reduce this injury risk. [33] SARU also uses the information gleaned from these reports to optimise the enjoyment of the RSW content. Six of the most important of these reports are detailed below.

Report 1. Knowledge, Attitude and Behaviour survey (annual)

A Knowledge, Attitude and Behaviour (KAB) questionnaire was initially developed to evaluate junior and senior players' behaviour as part of the *RugbySmart* evaluation in New Zealand. [24] BokSmart has been administering a comparable version of this questionnaire (Appendix I) at the national merit Rugby tournament for schoolboys and club (senior) players since 2008. SARU uses the results of these questionnaires to: 1. Assess if player behaviour is improving over time, and 2. Compare South Africa and New Zealand player behaviours.

Report 2. BokSmart Rugby Safety Workshop (RSW)

While SARU felt that it was necessary to mandate coaches and referees attendance of *BokSmart* rugby safety workshops, they did not think it was fair to evaluate every attendee. The reasons for this were two fold: firstly, the course is already between 5-6 hours without an evaluation; secondly, with a variety of levels of attendees in both coaching expertise and socioeconomic status in the same course, SARU was concerned that some attendees would be made to feel inferior by a formal evaluation. Thus, there is no formal test or evaluation before you receive a *BokSmart* certification; only their attendance is required. However, before the course begins, attendees are required to complete a demographic information form (Appendix II). This form requires information such as the attendees' union (region) affiliation, discipline (i.e. coach, referee, administrator, etc.), coaching/referees qualification and level of involvement in rugby (e.g. national, provincial, school, club, etc.). A biannual report keeps track of the number of these various demographics, but most importantly the number of coaches and referees who have attended the course.

For payment, SARU requires that the rugby safety workshop trainers ask three attendees of each course to assess the course they have just attended. The trainers are assessed with a standardised form (Appendix III) which requires the attendee (assessor) to rate the trainer on each of the following topics: each of the chapters, the welcome and introduction, course conclusion and summary, certification and hand-out process, overall presentation, communication skills, neatness and appearance, overall organisation, knowledge and understanding and overall impression. The assessors allocate a score between 0, for poor, and 5, for excellent, for each question. The three assessor's scores are then averaged and this average presented in the report next to the initials of each trainer. This trainer assessment is not a validated method of evaluation and was not performed in *RugbySmart*. However, SARU decided to implement it as they thought it was critical to improving the accountability of the rugby safety workshop trainers.

Report 3. BokSmart Rugby Medic Programme (RMP) survey

When a rugby medic programme representative is appointed, SARU records information about the institution (club, school, etc.), location and role in rugby (coach, referee, manager, player, etc.) of the representative (Appendix IV). The representative is required by SARU to assess the EMS trainer in terms of neatness, promptness, professionalism and content they taught (Appendix IV). The RMP representatives are also asked if the students enjoyed the workshop, if the institution has its own spinal immobilization equipment, and if the institution has been issued with equipment previously (Appendix IV). Depending on the institution's catastrophic injury management equipment, SARU may allocate equipment to that institution. SARU records and reports on the details of the institution that received equipment. Owing to the termination of this intervention, this report is obviously no longer prepared.

Report 4. BokSmart *Spineline (0800 678 678) calls survey*

The emergency medicine company that runs Spineline, ER24, has a computer system that records the number of calls that are received, the time taken to answer the calls and the number of calls that were abandoned the caller stated their reason for calling to call centre professional. ER24 also records the time between answering the call and the EMS (Emergency Medical Services) arriving on the scene. Other information that ER24 records is: the type of injury (head, neck), the region where the injury occurred, the Triage classification of injury at the time of the call to the

Spineline (Red, Yellow, Green or Blue), age of the injured player, mode of transport to hospital and whether or not the injured player had health insurance. The Spineline biannual report summarises these data that are captured by ER24.

Report 5.SARU injury surveillance project

In 2008 SARU began an injury surveillance project at all of their tournaments. There are six tournaments that are surveyed: four youth tournaments and one senior (adult) tournament. The four youth tournaments are in the under-13, under-16 and under-18 (two tournaments) level. The senior tournament is for adult teams with non-professional players. All five tournaments are national merit tournaments, whereby players need to qualify for their region and be selected for the representative team to participate. An injury collection form, based on the consensus statement for injury data collection in rugby union [36] is used to collet all injury information (Appendix V).

An annual report is prepared by Professor Mike Lambert of the University of Cape Town for SARU on these five tournaments to keep track of injury rates and risk factors.

Report 6. Serious injuries report

A Serious Injury Case Manager (SICM) was appointed by SARU in March 2008 to follow-up on rugby-related catastrophic injuries that occurred in South Africa. SARU's definition of a catastrophic injury is: *"Any head, neck, spine or brain injury that is life-threatening, or has the potential to be permanently debilitating* [includes "near misses"] *and results in the emergency admission of a rugby player to a hospital or medical care center."* SARU developed a questionnaire (Appendix VI) to investigate possible risk factors that may have contributed to the injury. Recently this questionnaire has been amended to include information that the IRB (International Rugby Board) requires each rugby-playing nation to submit about these injuries. The questionnaire is either sent through to the injured player in hospital or filled in by *BokSmart*'s Serious Injury Case Manager (SICM) in consultation with the injured payer. Descriptive information on the following is captured in the questionnaire: details of the level of the game (junior or senior), field conditions, weather conditions, event causing injury and the final diagnosis of the injured player.

IMPLEMENTATION CONTEXT

There are some obvious differences between South Africa and New Zealand and that posed logistical issues to the implementers of the *BokSmart* Programme - SARU. A prominent author in the field of rugby injuries in South Africa - Professor Tim Noakes - emphasised four differences that are important in considering injury prevention efforts between these two countries: [11]

"*1. Greater number of rugby players in South Africa than New Zealand,*

2. South African players come from more diverse social backgrounds than in New Zealand, with large disparities in social classes and education,

3. Large proportion of rugby in South Africa is played outside of the control official rugby bodies,

4. Large disparities between playing facilities and level of coaching in South Africa, with an assumed greater injury risk to those players at worse facilities and coaching input."

Additionally, South Africa is made up of nine provinces with an estimated population of 49.9 million people. Within this population, there are four distinct race groups and 11 official languages. [34] English, the language in which the rugby safety workshops are taught, is only the fourth most spoken home-language of the country. [34] Administratively, rugby is divided into 14 regions or 'unions', which fall under the overarching governance of the South African Rugby Union (SARU).

Another difference between the two countries is the absence of a nationwide injury-recording database in South Africa. New Zealand's comprehensive medical insurer, the Accident Compensation Corporation (ACC), records details of an injury that occurs within New Zealand borders. In this way, the researchers of *RugbySmart* were aware of the number and severity of injuries caused by rugby. Furthermore, through extensive registries, the New Zealand Rugby Union (NZRU) has accurate information on the number of coaches, referees and players in the country – this is not available in South Africa. Without an accurate idea of the number of players and a comprehensive injury registry, the *BokSmart* programme's effectiveness cannot be assessed by comparing injury rates over time, as was performed in the *RugbySmart* evaluation. [24,26]

OBJECTIVES

Although the *RugbySmart* evaluation was an exemplary injury prevention evaluation at the time, [36] the knowledge and experience associated with implementing strategies to prevent or reduce injuries has advanced rapidly since 2008. [38] For instance, the Van Mechelen's 'sequence of prevention' model has now been built upon and included into the Translating Research into Injury Prevention Practice (TRIPP) model (Figure 3). [39]

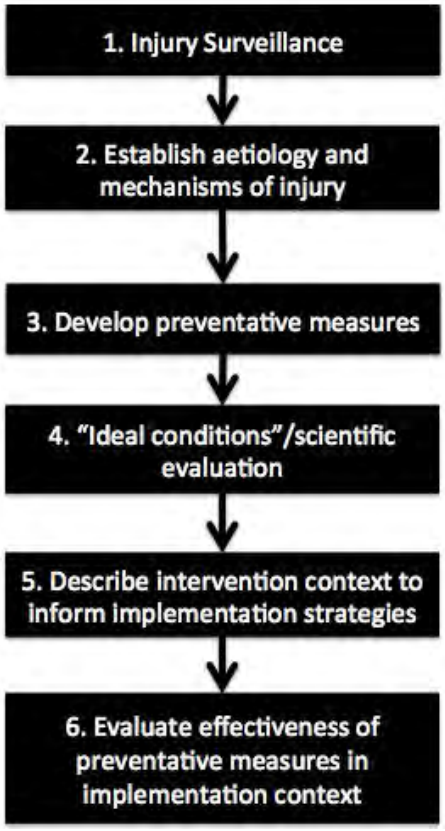

Figure 3. The TRIPP framework stages: 1 – 6 [38]

The TRIPP framework adds stages 5 and 6 to the established 'sequence of prevention' model as these stages focus on the actual intervention developed in Step 4 of the original Van Mechelen model. [2] Stage 5 seeks to understand the motivators/barriers to uptake of particular safety behaviours in the intervention target, while stage 6 seeks to understand how effective the intervention is in a real-world context.

In order to understand the motivators/barriers (TRIPP Stage 5), a public health evaluation framework such as RE-AIM, has been suggested for use in injury

prevention implementation studies. [38] RE-AIM is an acronym for five components of evaluation: **R**each, **E**ffectiveness, **A**doption, **I**mplementation and **M**aintenance. Obviously the Effectiveness component of RE-AIM also serves as Stage 6 of the TRIPP model and thus would be assessed in Stage 5 if the RE-AIM model were used. Besides using RE-AIM, there has also been a call by prominent authors for greater clarity in defining the intervention and the intervention's target(s) [25] – this is provided in Table 2.

Table 2. BokSmart intervention and intervention target(s) definition

Evaluation question	Planned evaluation
Who is the intervention target?	Intervention target: coaches and referees
	Health beneficiaries: players
What is the intervention?	Researcher intervention: SARU trainers deliver RSW to coaches and referees
	Injury prevention intervention: players
Who delivered the intervention	Coaches and referees: not under SARU or researcher control

RSW – rugby safety workshop

Having defined the *BokSmart* intervention (Table 2), it is obvious that this injury prevention programme has two targets: (1) Coaches and referees ("researcher intervention") and, (2) Players ("injury prevention intervention").[25] Thus, the *BokSmart*-specific definitions for the RE-AIM framework (TRIPP stage 5) have separate definitions for these two different targets in Table 3.

Table 3. BokSmart RE-AIM definitions (TRIPP Stage 5)

RE-AIM component	Researcher intervention: coaches and referees	Injury prevention intervention: players
Reach	All 40,000-50,000 coaches and referees attend RSW	N/A
Effectiveness	Acquire RSW knowledge	Reduction in catastrophic injury rates **(SARU Internal goal)**
Adoption	Employ RSW methods/regulations	Adopt RSW behaviour
Implementation	Positive about the RSW format and content	N/A
Maintenance	Make use of RSW material after the RSW	Employ RSW behaviours after initial teaching

RSW – rugby safety workshop

THESIS OUTLINE

Seven research questions are proposed to answer the overall thesis question: "Evaluation of the effectiveness of *BokSmart* – a nationwide injury prevention programme for rugby union". These research questions were necessary to satisfy each stage of the Translating Research into Injury Prevention Practice (TRIPP) framework (Table 4).

Chapters 2, 3, 4 and 5 address both stages 1 and 2 of TRIPP: the incidence and severity of injuries; as well as the aetiology of these injuries. Chapter 2 investigates the incidence, severity and aetiology of injuries at four competitive youth tournaments. This study used data from the SARU injury surveillance project described under the "*BokSmart* reports" heading. Chapter 3 uses the same data that were used in Chapter 1 to investigate and often understudied injury severity measure: the economic burden of injuries. The data for these two chapters are described under the "SARU injury surveillance" heading in this chapter ("*BokSmart* reports" general heading). Chapter 4 investigates the incidence and severity of all catastrophic injuries in South Africa. The details of these injuries are recorded by the *BokSmart* serious injury case manager and this data collection process is described in detail under "Report 6" ("BokSmart reports" general heading) in this chapter. Chapter 5 investigates in more detail the risk of both general and catastrophic injury specific to the scrum phase of play (TRIPP stage 2), using the data from Chapters 2 and 4.

Chapters 6, 7 and 8 assess TRIPP stage five (which includes TRIPP stage six). Chapter 6 investigates the internal goal of SARU for the *BokSmart* programme: the effectiveness of the programme in reducing the catastrophic injury rates in South Africa. This investigation is performed using the data from the Serious injury report ("Report 6" under "BokSmart reports" general heading) in this chapter. Chapter 7 investigates player behaviour to see if it changed over the time that *BokSmart* had been implemented. This study was performed using data collected for the Knowledge Attitude and Behaviour survey, described in detail under "BokSmart reports" in this chapter. Chapter 8 is a qualitative study to investigate coaches and referees' perceptions of *BokSmart* ("researcher intervention").

Table 4. Thesis research questions

Chapter	Research Question	TRIPP* stage
2	*What is the injury incidence and severity of rugby injuries in competitive youth players?*	1 + 2
3	*What is the economic burden of rugby related injuries in competitive youth players*	1 + 2
4	*What is the incidence and severity rugby-related catastrophic injuries in South Africa?*	1 + 2
5	*Are we underestimating the risk of scrum-related injuries to front-row players?*	2
6	*BokSmart evaluation I: Has the launch of the programme been associated with changes in catastrophic injury rates?*	5 + 6
7	*BokSmart evaluation II: Has the programme been associated with changes in player's injury-preventing behaviours?*	5 + 6
8	*BokSmart evaluation III: What are coaches and referees (research intervention) perceptions of the programme?*	5 + 6

*TRIPP – Translating Research into Injury Prevention Practice [39]

Thus, the *BokSmart* programme will be investigated for SARU's internal goal of reducing catastrophic injuries in players as part of these six TRIPP stages. Irrespective of whether SARU achieved its goal of reducing catastrophic injuries, the rest of the TRIPP stages will help the authors to establish *why* the intervention is/isn't working. Once this is known, suggestions can be made to improve the intervention. By documenting this process, barriers and facilitators to programme success may be established, thereby assisting the development of similar injury prevention programmes in future.

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2

INCIDENCE AND SEVERITY OF INJURIES TO SOUTH AFRICAN RUGBY UNION (SARU) YOUTH WEEK TOURNAMENT PLAYERS

PUBLISHED AS:

James C Brown, Evert Verhagen, Wayne Viljoen, Clint Readhead, Sharief Hendricks, Willem Van Mechelen, Mike Lambert. **The incidence and severity of injuries at the 2011 South African Rugby Union (SARU) Youth Week Tournaments**. *South African Journal of Sports Medicine* 2012; 24 (2); 49-54.

ABSTRACT

Introduction and objectives: To determine the injury incidence densities (IIDs) and severity of SARU Youth Week tournament injuries, if the IID increases with age, and the types of injuries at the different age group levels, in 2011.

Methods: All match-related injuries presenting to the Tournament Doctor during these tournaments were recorded and classified for severity and type, using the injury collection Consensus Statement for Rugby. Injury incidence per 1 000 match hours and 95% confidence intervals were calculated using overall player exposure time.

Results: Match-related IIDs for 'all' (combined: 47.9 injuries/1 000 match hours) and time-loss injuries (combined: 23.1 injuries/1 000 match hours) were not significantly different by age group, despite a strong tendency to indicate differences. The absolute number of injuries per match increased with age. In general, there was a higher proportion of concussions at the GK16, AW18, and CW18 compared with the CW13 tournament(s).

Conclusions: Time-loss IIDs at SARU Youth Weeks are similar to other elite junior rugby data. The absolute number and type/classification of injuries per match may be more informative than IIDs alone for medical planning purposes.

INTRODUCTION

The participation by children and adolescents in organised sport is increasing globally for various reasons, including enjoyment, social interaction and health. [1] However, there is a risk of injury associated with participation in the activity, which varies depending on the type of activity. [2] During organised events involving physical activity an accurate quantification of the risk associated with a particular activity is important to both the participant, the medical support associated with the event, and to injury epidemiologists attempting to provide guidelines to reduce this risk.

Of all popular team sports, Rugby Union (henceforth referred to as 'Rugby') presents an above-average overall risk of injury (69 injuries per 1 000 hours exposure) to the player – greater than that of cricket (2 injuries per 1 000 hours exposure), soccer (28 injuries per 1 000 hours exposure) or even ice hockey (53 injuries per 1 000 hours exposure).[3] The high incidence of injury in Rugby is related to the nature of the game – a field-based team sport, with the match lasting 80 minutes (at senior levels), and characterised by short, intermittent bouts of high-intensity exercise with the 30 players having multiple contact situations throughout the game. [4] Risk of injury may increase with age and level/grade, which could be explained by greater speed, [5,6] increased competitiveness/aggression, [7,8] increased height and weight [9] and increased foul play [8] at higher levels of play. In Rugby League, a faster, but comparable version of Rugby, the incidence of injury may also increase with age, which has been attributed to a higher intensity of play at higher levels. [10] Rugby is popular globally, with an estimated 96 countries currently participating worldwide, [4,11] and enjoys particular popularity in South Africa with an estimated 400 000 - 500 000 players nationwide. [12] The annual South African Rugby Union (SARU) youth tournaments, which began in 1964, are a showcase of the country's elite schoolboy rugby players at the under-13, under-16 and under-18 (two tournaments) age groups. The best 22 players from each of the country's 14 Rugby unions (as well as other invited teams, including neighbouring countries Namibia and Zimbabwe), compete for the title of unofficial winner of each tournament. For the under-18 Academy Week and Craven Week (AW18 and CW18) tournaments, there is an additional incentive to be selected for national representative teams. Given the

prestige associated with provincial union or national representation in South Africa, these tournaments are played at a high level that is thought to be associated with a high injury incidence, based on the aforementioned literature. Despite this, no accurate injury data have been collected at these tournaments since their inception in 1964.

Therefore, the aim of this study was to investigate the incidence and severity of the 2011 SARU Youth Week tournament injuries, to determine differences, if any, with increasing age. A secondary aim was to explore associated factors in injured players. Through the results of this investigation, it was hoped that injury prevention strategies may be enhanced at these age groups to prevent any unnecessary injuries at future tournaments.

METHODS

Written informed consent to analyse the recorded information was provided by the player, or by the player's parent or guardian if the the player was younger than 18 years of age. If, in the former case, the player was unable to sign the form owing to the nature of the injury, verbal consent was received after explaining the nature of the study. All of the injured players' information was recorded on a SARU database and the authors were subsequently granted access to this database for analysis in 2011 by SARU and the UCT Human Research Ethics Committee.

Injury surveillance was conducted on the 1 804 players (82 teams with 22 squad members) at the four SARU Youth Week tournaments: Craven Week under-13 (CW13), Grant Khomo Week under-16 (GK16), Academy Week under-18 (AW18) and Craven Week under-18 (CW18), which took place during June and July 2011. A SARU-appointed tournament doctor (TD) was available at each tournament to assess any injury complaint that a player may have had. All injuries that happened before the official tournament matches were not included in the analyses.

Because of the compact schedule of these tournaments, the non-match training hours contributed relatively little to overall tournament exposure and non-match injuries were therefore not recorded. An injury collection form (Appendix V) was designed based on the Consensus Statement for injury surveillance. [13]

Demographic information of each injured player, such as the player's team, body height, body weight, age, whether or not the player had medical aid (insurance), and protective gear at the time of the injury, was also collected. Unfortunately, this information was not available for players who were not injured. Exposure time was calculated based on the injury collection consensus statement for Rugby:[13]

$$N_M \times P_M \times D_M$$

(*where is N_M is the number of matches, P_M is the number of players per match, and D_M is the duration of the match in hours*).

Owing to the fact that the injury surveillance was conducted on all the teams in the tournament, P_M was calculated as 30 (15 players per team) for each match. It was also assumed that there were 30 players for the entire match, thereby ignoring the effects of yellow and red cards on match exposure. [13]

Injury definition

The injury definitions, described in the Rugby injury consensus statement,[13] were adapted to the following to suit the needs of these tournaments: '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 and required attention from the SARU Tournament Doctor (TD), irrespective of who decided this'.

Injury severity

Highly qualified paramedics and/or nursing staff were available at all tournament matches and therefore, for a player to consult with a TD, the injury would have to be one that the paramedics/nurses could not deal with. A time-loss injury was an injury (based on the aforementioned definition) that resulted in being absent more than one match in a tournament, or more than one day of normal/planned recreational activities after the tournament.

Injury type

The 'type' of injury categories were collapsed from the original definition for the SARU tournaments so that each injury was classified, according to the TD, as relating to one of the following: concussion, spinal cord, broken bone/fracture,

joint/ligament/tendon, muscle, bruise, laceration (including skin abrasion), other, unsure.

Match days (Ms)

Match days (Ms) are defined as days on which all teams played an official tournament match on the same day. For CW18, when only half the teams played in an alternating fashion for the first four days, one M would span two days to include all the team matches. However, for the purpose of comparing the daily load on the tournament medical staff, a tournament match day (TM) is defined as any day in which official rugby matches were played. A TM could also be a M. These terms should be contrasted to 'rest days' (Rs), on which teams were able to do what they wanted. Exposure was only calculated from Ms, and not Rs.

The recording of information was performed at all tournaments by either JB or SH to reduce internal inconsistencies. Owing to the short duration of these tournaments (4 - 5 days), only a small number of players were injured a second time (n=4) and therefore these second injuries were analysed with the first injuries. It has been suggested that only injuries severe enough to be considered time-loss injuries (see 'Injury definitions') should be reported for uniformity of injury comparisons. [13] However, because of the relatively short duration and corresponding low absolute injury numbers at these tournaments, which would make further analyses and interpretation difficult, 'Medical attention' and 'Unsure' injuries were also reported for this study. Suspected time-loss injuries were followed up either at the tournament or at weekly intervals after the conclusion of the tournament to confirm the severity of injury: when the player was able to return to normal sporting activities or stopped all treatment.

Statistical analyses

Exposure was calculated as the total number of team matches played (varied by tournament, Table 1) multiplied by the number of players per match (30 in each case) multiplied by the match duration in hours (varied by tournament, Table 1). [13] For clarity: when two teams were competing against each other, as occurred for every tournament match, this was considered one team match. Injury incidence densities (IIDs) and corresponding 95% confidence intervals (95% CIs) were calculated for the number of injuries (regardless of whether one person was injured more than once) per 1 000 hours of match play. [14] Incidences, including their 95%

CIs, which did not overlap were considered to be significantly different from each other.

RESULTS

Key tournament descriptive information for the four Youth Week tournaments is provided in Table 1. The match duration increased with age, from two 20-minute halves (total match duration = 40 minutes) at under-13 to two 35-minute halves (total match duration = 70 minutes) at under-18 level. Although CW18 was the only five-day tournament, this tournament structure was unique in that only half of the teams (10 teams, five matches) played per day, in an alternating fashion, until the final match day in which all 20 teams competed (10 matches). The other three tournaments (CW13, GK16 and AW18) had each team play every day, with a rest day before the final day of the tournament, in which all teams played. Therefore, CW13 had the greatest number of Ms (n=4), while the other tournaments had three. The number of teams at each tournament was also greatest at the under-18 tournaments, although, owing to CW13 having four Ms as opposed to the three in the other tournaments, the youngest age-group tournament also had the second highest number of overall matches. The under-18 tournaments had a greater overall exposure time because of the longer duration of their matches.

Table 1. Descriptive details of the four South African Rugby Union (SARU) Youth Week tournaments, 2011

Tourna-ment	Teams (n)	Duration (min)	Matches (n)	Exposure (hours)	Structure	IID (95% CI)	Time-loss IID (95% CI)
CW13	18	40	36	720	M,M,R,M, M	43.1 (27.9 - 58.2)	15.3 (6.2 - 24.3)
GK16	18	60	27	810	M,M,R,M	45.7 (31.0 - 60.4)	9.8 (10.1 - 29.4)
AW18	26	70	39	1 365	M,M,R,M	50.5 (38.6 - 62.5)	24.9 (16.5 - 33.3)
CW18	20	70	30	1 050	TM,TM,TM, TM,R,M*	49.5 (36.1 - 63.0)	28.6 (18.3 - 38.8)

CW13 – Craven Week under-13; GK16 – Grant Khomo under-16; AW18 – Academy Week under-18; CW18 – Craven Week under-18; M – match day; TM – tournament match day; R – rest day; IID – injury incidence density (injuries/1 000 hours exposure).

In total, there were 1 804 players at risk for 3 945 hours of match injury exposure (exposure based on consensus statement calculations [13]) for all of the SARU Youth Week tournaments (Figure 1). Of these players, 185 sustained an injury during a tournament match-related incident and were attended to by the TD. Four players suffered two injuries during the tournaments. Based on the TD's estimation, 91 injuries were considered severe enough to be classified as time-loss injuries. The remaining 98 injuries comprised 87 medical attention injuries and 11 injuries for which the TD was unsure of the diagnoses and the players could not be followed up. The majority (81%) of the 91 estimated time-loss injuries were confirmed telephonically one week after each tournament.

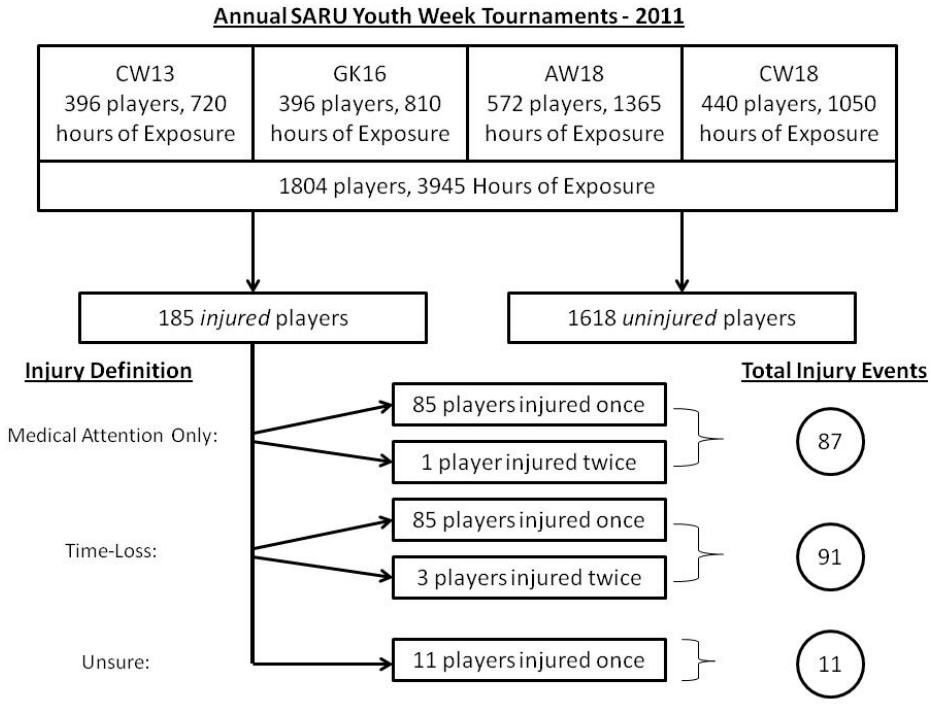

Figure 1. Flow diagram indicating the number of players injured at the 2011 SARU Youth Weeks according to the injury definitions. The severity of injury was estimated by the tournament doctor (TD) in each case; these were subsequently confirmed telephonically.

The combined IID of time-loss injuries was 23.1 injuries per 1 000 match hours (95% CIs: 18.3 - 27.8) across all the tournaments, while the overall IID was 47.9 injuries per 1 000 exposure hours (95% CI: 41.1 - 54.7). CW13 had the lowest IID of time-loss injuries (15.3 injuries per 1 000 exposure hours; 95% CI: 6.2 - 24.3), whereas CW18 had the highest IID of time-loss injuries (28.6 injuries per 1 000 exposure hours; 95% CI: 18.3 - 38.8) (Figure 2).

The overall IID (all injuries), and the IID of time-loss injuries, tended to increase with age, although there were no statistically significant differences between tournaments for either overall or time-loss IIDs (Figure 2).

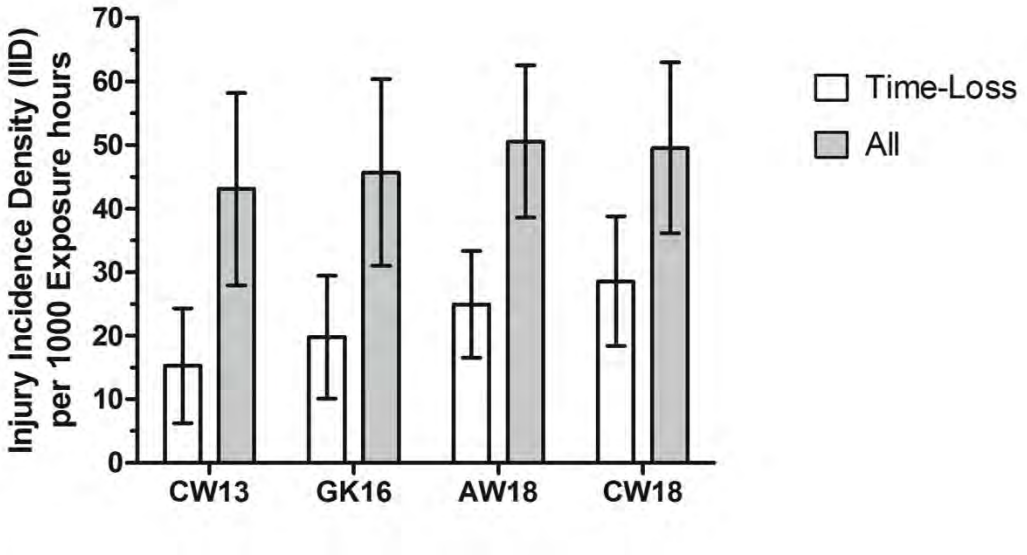

Figure 2. Incidence (+/- 95% CIs) of time loss (white bars) and all (time loss are included in all) injuries at each South African Rugby Union (SARU) tournament in 2011. CW13 – Craven Week under-13; GK16 – Grant Khomo under-16; AW18 – Academy Week under-18, CW18 – Craven Week under-18.

Injuries per match, injury severity and type

The oldest age-group tournaments (AW18 and CW18) had the highest absolute number of injuries per match (Table 2). These two tournaments also had the highest absolute number of time-loss injuries per match. Among the youngest age group (CW13), muscle injuries accounted for the greatest proportion of injuries, while joint/ligament/tendon injuries were consistently over-represented at the three older age tournaments (GK16, AW18 and CW18). There was a relatively high proportion

of lacerations/skin abrasions that led to time loss; two injuries to a mouth (one tongue laceration and one case of multiple tooth loss), three eye-lid lacerations and two deep head wounds.

Medical insurance and protective equipment use

Twenty-four per cent (*n*=41) of the 174 injured players who answered the question had no medical insurance for their injuries. Of the players who suffered a time-loss injury, 22% (*n*=19) reported having no medical insurance. Only 57% (*n*=107) of all injured players were wearing a mouth guard at the time of their injury. Similarly, of the players who suffered a time-loss injury, only 51% (*n*=46) were wearing a mouth guard at the time of their injury.

Table 2. Number of injuries per match in South African Rugby Union (SARU) Youth tournaments, 2011. (The number of matches per day is indicated in parentheses after the tournament title. Time-loss (TL) injuries are reported separately and as part of the 'all' injuries category. The proportions of the different types of injuries, as diagnosed by the TD, are shown below the number of injuries per match.)

	CW13 (*n*=9)		**GK16 (*n*=9)**		**AW18 (*n*=13)**		**CW18 (*n*=5 or 10)**	
Injury severity	**TL**	**All**	**TL**	**All**	**TL**	**All**	**TL**	**All**
Injuries per match (*n*)	0.3	0.9	0.6	1.4	0.9	1.8	1.0	1.7
Type of injury (%)								
Concussion	18	10	38	17	38	19	13	8
Contusion	9	26	6	3	6	13	10	21
Fracture	18	6	6	3	12	6	3	2
Joint/lig./ten.	18	19	44	31	29	32	47	37
Lacerations †	9	3	0	14	3	9	17	25
Muscle	27	29	6	14	6	16	0	0
Unsure/other	0	6	0	19	6	6	10	8

CW13 – Craven Week under-13; GK16 – Grant Khomo under-16; AW18 – Academy Week under-18; CW18 –Craven Week under-18; All – all injuries; TL – time-loss; Lig. – ligament; ten. – tendon.

† Includes skin abrasions.

DISCUSSION

The main finding of this paper was that the IIDs of injuries (overall and time loss) during the SARU Youth Week tournaments did not differ significantly by age in 2011, rejecting our initial hypothesis. However, there was a strong tendency for the absolute number and relative proportion of time-loss injuries to increase with

increasing age group (proportion of time loss to all injuries: CW13 - 36%; GK16 - 43%; AW18 - 49%; CW18 - 58%). Haseler *et al*. [15] reported similar time-loss injury incidences in age groups that were comparable with those investigated in the current study and lower than those at elite under-20 level. [9] Overall, muscle and joint/ligament/tendon injuries were the most common types of injuries, which is comparable with the elite under-20 level previously studied [9] and junior Rugby League, [10] but not community-level junior rugby. [15]

This lack of significant differences between age group IIDs, particularly those of the time-loss injuries, are in contrast to findings consistently reported in the literature. These conflicting reports are from early [5-8] and more contemporary literature, [9,15] collected and reported on using the Consensus Statement for injury surveillance in rugby. [13] Both contemporary studies [9,15] took place over a longer time period (former = three-week tournament; latter = nine-month season) than this study.

Despite the fact that the wearing of mouth guards was highly recommended in the team manager's handbook, only 51% of players who suffered a time-loss injury were wearing a mouth guard at time of their injury. This phenomenon does not appear unique to South Africa as similarly low compliance has been reported in Northern Italy.[16] Although the literature on mouth guard effectiveness in injury prevention is equivocal about concussion, [17] there is evidence to suggest that dental claims can be reduced with improved compliance of mouth guard wearing.[18]

Because of the relatively small number of time-loss injuries in this study, further comparisons between tournaments for positions or phases of play (scrum, ruck, tackle) could not be facilitated, as Knowles *et al*. [14] stated that CIs become inaccurate and therefore of little use to the researcher when calculated on raw data of five or less. However, the proportion of concussions of all time-loss injuries at the tournaments of older groups (GK16, AW18 and CW18) was high and should be focused on in future years.

These youth tournament formats (Table 1) may not be unique internationally and, therefore, raise the question of whether the Consensus Statement, [13] suggested

for all rugby injury surveillance studies, should consider broadening the definition of injury that should be reported, particularly for short-format tournaments such as the ones presented in this study. Furthermore, injury incidence densities alone may not have as much practical relevance for prospective medical professionals involved in providing medical support and infrastructure at these type of rugby tournaments. Importantly, this study reports only one year of data collection and therefore may not be a true reflection of these tournaments, emphasising the importance of continued injury surveillance at future SARU tournaments.

Of concern is that 22% of the players who suffered time-loss injuries, had no medical aid cover for the on-going treatment of their injuries. Although financial situations vary by Rugby, all competing teams should attempt to ensure that all their players are covered by medical aid or have some financial support structure in place for their participating players in case of a medical emergency, prior to competing in future tournaments.

A limitation of our study was the large reliance on the TD's clinical judgement for diagnosing severity and type of injury at each tournament; this could potentially compromise the level of comparability between tournaments. While all time-loss and 'unsure' injuries were followed up telephonically after the tournament, medical attention injuries were assumed to be accurately defined by the TD. Inaccurate diagnoses could have resulted in under-reporting of time-loss injuries. Secondly, although it would be in direct contrast to SARU's player safety mandate, some teams may have 'hidden' injuries from the TD owing to the short nature of the tournaments. Also, players were less likely to report injuries to the TD on the final day of the tournament as they may have preferred to see their family physician (families on medical aid would not need to pay for these services). Thirdly, the lack of quantification of training time and injuries before and during the tournament was a further limitation, but was logistically difficult to measure.

Practical implications

The current article could be used as a reference for prospective TDs and support personnel involved in the medical planning and management of future SARU Youth Week tournaments, or any other tournaments with similar, compact structures. IIDs, in isolation, may be misleading for prospective TDs for planning purposes. For

example, with reference to Figure 3A, which displays IIDs, prospective TDs could interpret the medical management loads of the two under-18 tournaments to be comparable. However, Figure 3B accurately illustrates the greater TM medical burden placed on the AW18 compared with the CW18 TD, despite both teams having the same number of Ms (*n*=3) according to the definition. Despite the same number of Ms and a similar number of injuries per match (Table 2), the CW18 tournament structure is less compacted, has fewer overall teams and therefore less matches than AW18. As the first four days of CW18 only has half the teams participating, this adds to the reduced medical load on the TD. The data presented in the suggested consensus format alone do not accurately guide the infrastructure and personnel requirements for these tournaments. This could have huge practical implications regarding effective planning around budget spend, and medical staffing and infrastructure requirements for these tournaments. Therefore, for medical planning purposes, it is suggested that the data in Tables 1 (daily tournament format) and 2 (injuries per match) are used in combination to determine and cater appropriately for the estimated number, severity and types of injuries per day at each tournament.

The tournament should be planned based on the known absolute number of injuries per match (Table 2), with particular reference to time-loss injuries that tend to require longer treatment and diagnostic times. For example, the recommended assessment and treatment of a concussion using the Sports Concussion Assessment Tool (SCAT2) card[21] takes approximately 30 minutes for the TD to administer properly. With two, or three, concurrent matches being played at the under-18 age groups, the TD would become overwhelmed and would potentially compromise optimal treatment. A simple practical guide for future planning of these tournaments would be to allocate one TD per time-loss injury per match. Therefore, the under-18 tournaments would require one TD per match, while the TDs of the under-13 and under-16 age groups could cope with one TD, with two matches being played concurrently.

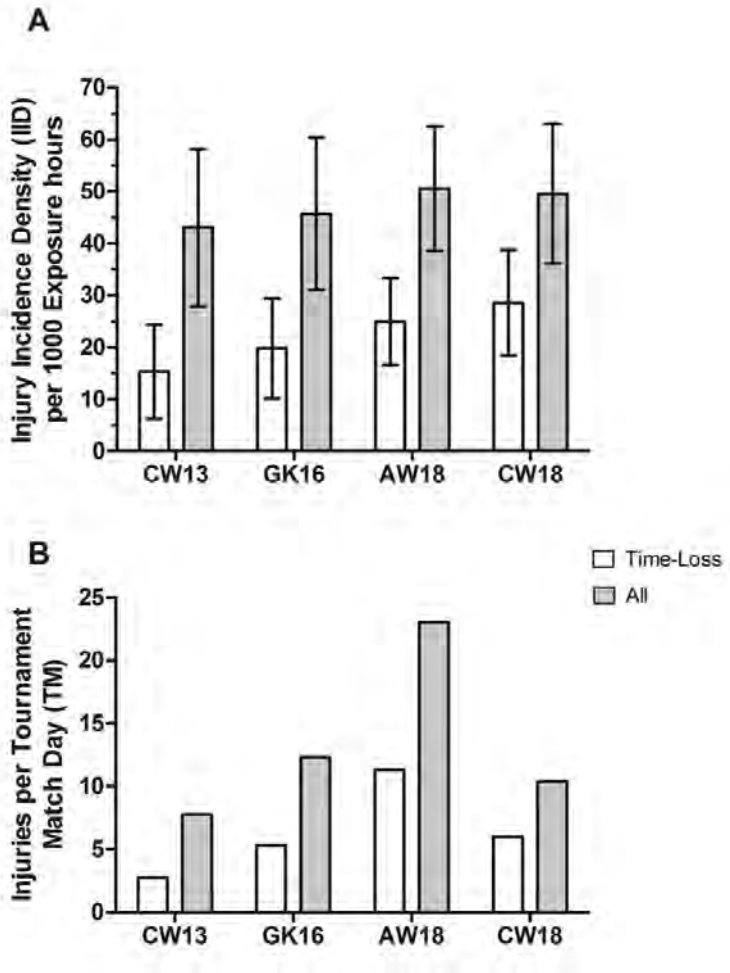

Figure 3. (A) Injury incidence density (IID) (+/- 95% CIs); and (B): Injuries per match day (M) of all injuries (medical attention, time-loss and unsure) and time-loss injuries only (white area) at each South African Rugby Union (SARU) tournament in 2011. (CW13 – Craven Week under-13; GK16 – Grant Khomo under-16; AW18 – Academy Week under-18; CW18 – Craven Week under-18. Tournament match days - CW13: 4; GK16: 3; AW18: 3; CW18: 5. Note that CW18 has three M, but five actual tournament match days (TM).)

CONCLUSION

The injury incidences of both all and time-loss injuries were not significantly different between age groups at the 2011 SARU tournaments. This finding is contrary to contemporary literature and our initial hypothesis, but is probably explained by the short duration of the SARU tournaments. However, the SARU tournament structures/formats may not be unique, and therefore the consensus statement for injury collection should be adapted to include reporting of a broader definition of injuries. Furthermore, while injury incidences of time-loss injuries may be

scientifically comparable, in isolation they may be misleading from a medical planning or evaluation perspective. Presenting absolute numbers of injuries (both time-loss and medical attention) per match, in conjunction with injury incidences, [13] may satisfy more stakeholders in gaining practical application from injury surveillance reports.

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3

THE ECONOMIC BURDEN OF TIME-LOSS INJURIES TO YOUTH PLAYERS PARTICIPATING IN WEEK-LONG RUGBY UNION TOURNAMENTS

PUBLISHED AS:

James C Brown, Wayne Viljoen, Mike I Lambert, Clint Readhead, Chelsea Fuller, Willem Van Mechelen, Evert Verhagen. **The economic burden of time-loss injuries to youth players participating in week-long rugby union tournaments**. Accepted by *J Sci Med Sport*. DOI: 10.1016/j.jsams.2014.06.015

ABSTRACT

Introduction and objectives: Rugby Union ("rugby") is a popular sport with high injury risk. Burden of injury is described by the incidence and severity of injury. However reports have ignored the monetary cost of injuries. Therefore the aim of this study was to describe the monetary cost associated with youth rugby injuries.

Methods: This descriptive study quantified medical treatments of injured players at the South African Rugby Union Youth tournaments in 2011/2012 and the days of work parents missed as a result of the injuries. A health insurer used these data to calculate associated costs. Legal guardians of the 421 injured players were contacted telephonically on a weekly basis until they returned to play. Treatments costs were estimated in South African Rands based on 2013 insurance rates and converted to US$ using purchasing power parities.

Results: Of the 3652 players, 2% (n=71) sought medical care after the tournament. For these players, average treatment costs were high (US$731 per player, 95% CI: US$425 – US$1096), with fractures being the most expensive type of injury. Players with medical insurance had higher costs (US$937, 95% CI: US$486 – US$1500) than those without (US$220, 95% CI: US$145 – US$302).

Conclusions: Although a minority of players sought follow-up treatment after the tournaments, the cost of these injuries was high. Players without medical insurance having lower costs may indicate that these players didn't receive adequate treatment for their injuries. Injury prevention efforts should consider injuries with high costs and the treatment of players without medical insurance.

INTRODUCTION

Participation in physical activity has numerous health benefits for children. [1] However, physical activity can also pose the risk of health detriments, such as injury, the likelihood of which may vary depending on the mode of physical activity. [2] This potential burden of injury may discourage participation in a particular sport, unless preventative measures are introduced effectively. [2] Of all international sports, Rugby union ("rugby") is arguably amongst the most popular, for all age groups, including youth. [3]

To better understand the injury problem, both the incidence and severity of a particular sport-related injury need to be accurately quantified. [2] The incidence of injury can be described by calculating the number of new injuries that occur taking into account the participation levels of that sport. [4] "Severity" could be described using six criteria: (i) nature of sports injury, (ii) duration and nature of treatment, (iii) sporting time lost, (iv) working time lost (of the injured individual or injured individual's parent/legal guardian), (v) permanent damage and (vi) monetary cost. [4] In general, rugby carries a higher incidence and severity of injury to the participant, [5] in comparison to other popular sports. [6] Although other sports, [7-9] including rugby league, [10-12] have reported on injury-related monetary costs, this analysis is yet to be performed in rugby union.

Besides being an important descriptor of severity, the monetary cost of injury provides valuable information to drive and evaluate the effectiveness of preventative measures. [8] In South Africa, the BokSmart programme is responsible for implementing injury prevention strategies in rugby union [13] and information on the costs of injuries is therefore essential for guiding future policies emanating from this nationwide programme. Therefore, the aim of this study is to describe the monetary cost of rugby-related injuries in a youth cohort.

METHODS

The population studied included the combined attendees of the South African Rugby Union (SARU) Youth Weeks in 2011 and 2012, and, depending on the tournament,

players ranged between the ages of 12 and 18 years old. These tournaments showcase the most talented players in each age group, and have been described in more detail elsewhere. [14] Written informed consent was provided by the player or by the player's parent/legal guardian if the player was younger than 18 years of age. All information was recorded on a SARU database to which the authors were granted access by SARU and the UCT Human Research Ethics Committee.

In total, 3652 players attended the four elite national Youth tournaments: Craven week under-13, Grant Khomo under-16, Academy Week under-18 and Craven Week under-18 in 2011 and 2012 (Figure 1). Although preliminary analyses indicated no differences in injury rates, the tournaments were analysed separately by age group for the purposes of this study: "under-13" (Craven Week under-13 tournament), "under-16" (Grant Khomo under-16 tournament) and "under-18" (combination of Craven Week and Academy Week under-18 tournaments). Of these players, 12% (421 players) received medical attention from the SARU tournament Doctor and accounted for a total of 436 injury events. Of the 421 injured players, 17% (n = 71 players) sought further treatment after the tournament.

The data collection process has been discussed previously. [14] Briefly, SARU collected data on all 421 injured players that were attended to by the tournament medical doctors in 2011 and 2012. The injury definitions, including that of what constituted a "time-loss" (TL) injury were consistent with the consensus statement for injury surveillance in rugby union [15] with slight adjustments for these tournaments. The injury definition was:

"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 and required attention from the SARU Tournament Doctor, irrespective of who decided this".

Therefore, a time-loss (TL) injury was an injury that resulted in the player being absent from more than one match in a tournament, or more than one day of normal/planned recreational activities after the tournament. After the tournament ended and the injured players returned home, the responsibility of the treatment and

rehabilitation of their injuries resided with the players' parents/legal guardians. Players that were confirmed or suspected by the tournament medical doctors to have suffered a TL injury at the tournaments were followed up telephonically (Figure 1). Costs were estimated from the perspective of the medical insurer in South Africa.

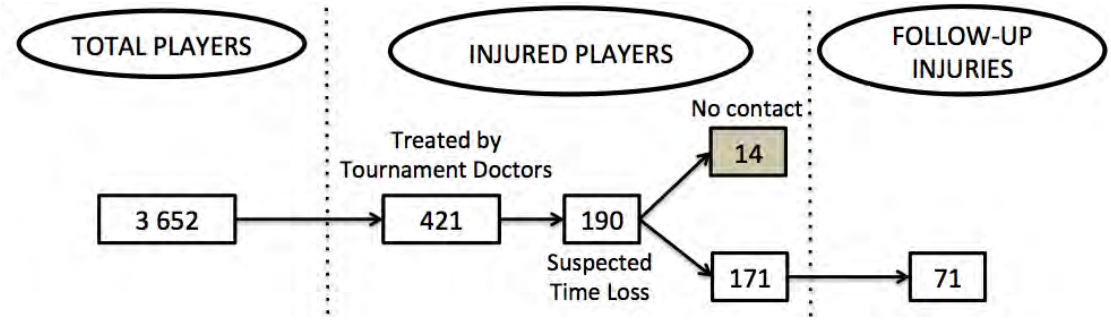

Figure 1. A flow diagram illustrating the number of players that were considered for this study. Although there were 3652 players at these tournaments, only 2% (n = 71) sought follow-up treatment after the tournament conclusion.

An "old" injury was one in which the player answered "yes" to the following question, asked by the tournament Doctor, or data capturer, or both: "Have you ever had this injury before?". If the player answered "no" to the question, the injury was classified as "new".

The consensus statement severity of injury categories[15] of slight, minimal and mild, were grouped together as "mild", and compared to "moderate" and "severe" categories due to a lack of statistical power.

The parents/legal guardians of all players with confirmed and suspected time-loss (including "unsure" diagnoses) injuries (n = 190) were contacted a week after the completion of the tournament (Figure 1). Of these 190 injured players, 7% (n = 14 of 190) could not be followed up due to incorrect contact details or no response to these follow-up calls ("no contact" in Figure 1) and 3% (n = 5 of 190) were re-classified as medical attention injuries, leaving 171 time-loss injuries. [14] Of the 171 injured players that were contacted, 42% (n = 71) sought follow-up treatment after the tournament ("follow-up injuries"). Only the medical treatments that were sought after the tournament (i.e. excluding the Tournament Doctor's treatment) were included in these analyses.

Medical treatments/services and the time that the injured player's parent/legal guardian were away from work were quantified using a cost diary used previously, [8] and which was adapted for use in South Africa. The South African version was adapted from the original version to provide a semi-structured guide for the telephonic interviewer to capture total quantity and type of medical service sought (Appendix VII).

Direct costs (medical care quantification) were initially estimated in South African Rand (R) for all medical treatments. Indirect costs could not be calculated due to the wide range in average salaries in South Africa. Thereafter, costs were converted to US dollars (US$) based on purchasing power parities (PPP's), as suggested for economic evaluations. [16] To convert R to US$, the R value should be divided by a factor of 5.48: this factor was obtained from the most recent World Bank estimates, which were last provided in 2012. [17]

Discovery Health Insurance, one of the largest private medical insurance companies in South Africa, provided cost estimates for medical consultations. This approach was adopted due to South Africa not having any national standard medical care costs available at the time of the study. Inferred costs were calculated based on the medical insurance company's 2013 data even though the actual treatments occurred in 2011 and 2012.

Discovery Health based their care cost estimates on historical data of the medical insurance company for a given region within a specific diagnosis-related group. These rates were based on 2006 national rates (the last time standard rates were available) and included inflation adjustments, time factors, difficulty in receiving treatment, and thousands of claims factored into the estimation. Medical care costs may vary depending on the type of injury and initial consultations sometimes differ in price from the follow-up treatments (rehabilitation).

Surgeries were assumed to be conditions without major complications – e.g. basic shoulder/clavicle injury with basic reduction and repair. Therapy (Physiotherapy, Occupational Therapy, Biokinetics) costs were based on the most likely modalities related to the particular injury type (e.g. muscle strain or ligament tear). For

radiology costs, the x-rays and scans were assumed to be uncontrasted (i.e. basic evaluations). Dental cases were considered to be basic examinations as not enough information was available.

Total costs were calculated based on the initial rate for a particular medical service and medical service provider and multiplied by the frequency of these visits. The parents' missed work could not be converted into a financial cost due to the large rates of unemployment and variance in average wages in South Africa.

As costs were not normally distributed, mean differences in costs and associated 95% Confidence Intervals were obtained by bias corrected and accelerated bootstrapping (2000 replications). All analyses were performed with IBM SPSS statistical software (Version 21). Differences in costs were compared between categories using 95% confidence intervals. [15]

RESULTS

The overall injury rates (Table 1) were not significantly different between the various age groups (under-13 to under-18), with a combined rate of 54.6 injuries per 1 000 hours (95% CIs: 49.5 – 59.8 injuries per 1 000 hours) of tournament play resulting from 436 injury events in 7 945 exposure hours. Of the 436 injury events, the most common injury was a joint/ligament/tendon injury which accounted for 31% of all injuries. The joint/ligament/tendon injuries were the most common at all age groups except for under-13 where bruises/contusions were the most common type of injury (31%). Of the 421 players who received medical attention and agreed to answer the question (n = 388), 25% (n = 97) did not have medical insurance.

The overall confirmed time-loss injury rate was 21.4 injuries per 1 000 hours (95% CIs: 18.2 – 24.6). Similarly to all injuries, joint/ligament/tendon injuries accounted for the highest proportion (36%) of all TL injuries, overall. This was consistent for all the age groups.

Of the 71 players that sought and received treatment once returning home (Table 1), the largest proportion was from the under-18 age group (n = 48; 68%). Overall, 26%

(n = 18 of 69; 2 did not answer) of these players did not have medical insurance. The highest proportions of these injured players with no medical insurance were at the under-18 age group (61%, n = 11 of 18).

Table 1. The injury rate (per 1 000 hours of tournament play), type of injury and proportion of injured players with medical insurance for the 2011 and 2012 tournaments (n = 3652).

	Under-13	**Under-16**	**Under-18**	***Combined***
ALL INJURIES (n = 436)	64.6	54.4	52.1	*54.6*
Injury rate (95% CIs)	(51.5 – 77.7)	(43.3 – 65.4)	(45.7 – 58.6)	*(49.5 – 59.8)*
Injury type - % (n = 436)				
Concussion	9% (n=8)	13% (n=12)	11% (n=27)	*11% (n=47)*
Bruise/contusion	31% (n=29)	13% (n=12)	18% (n=45)	*20% (n=86)*
Broken bone/fracture	8% (n=7)	2% (n=2)	4% (n=9)	*4% (n=18)*
Joint/Lig./Ten.	22% (n=20)	32% (n=30)	33% (n=83)	*31% (n=133)*
Laceration/abrasion	4% (n=4)	15% (n=14)	12% (n=31)	*11% (n=49)*
Muscle strain/cramp	19% (n=18)	12% (n=11)	14% (n=36)	*15% (n=65)*
Unsure/other	8% (n=7)	13% (n=12)	8% (n=19)	*9% (n=38)*
	Under-13	**Under-16**	**Under-18**	***Combined***
TL INJURIES (n = 171)	22.2	22.2	21.1	*21.4*
Injury rate (95% CIs)	(14.5 – 29.9)	(15.2 – 29.3)	(17.0 – 25.2)	*(18.2 – 24.6)*
Injury type - % (n = 171)				
Concussion	19% (n=6)	29% (n=11)	27% (n=27)	*26% (n=44)*
Bruise/contusion	19% (n=6)	11% (n=4)	6% (n=6)	*9% (n=16)*
Broken bone/fracture	22% (n=7)	5% (n=2)	8% (n=8)	*10% (n=7)*
Joint/Lig./Ten.	22% (n=7)	39% (n=15)	40% (n=40)	*36% (n=62)*
Laceration/abrasion	3% (n=1)	5% (n=2)	6% (n=6)	*5% (n=9)*
Muscle strain/cramp	16% (n=5)	5% (n=2)	8% (n=8)	*9% (n=15)*
Unsure/other	0% (n=0)	5% (n=2)	6% (n=6)	*5% (n=8)*

Under-13 – Craven week under-13, Under-16 – Grant Khomo under-16, Under-18 - Academy Week under-18 + CW18 – Craven Week under-18 combined, CIs – confidence intervals, IID – injury incidence densities, TL – Time-Loss, Med. – medical, Lig. – ligament, Ten. – tendon

The most expensive unit costs of medical treatment (Supplemental table – at end of Chapter) were the hospital/surgery costs which ranged from US$1 066 (per day) for

the Intensive Care Unit (ICU) to US$8 421 for surgery to the lower extremities. Other large costs included MRI/CT scans of various joints (range US$393 – US$1 038).
In total, there were 390 treatments that amounted to an estimated total cost of US$80 228. Of the 390 medical treatments (Supplemental Table), the most common category of treatment was "consultations and rehabilitations" (87%, n = 340 of 390), of which General Practitioner consultations accounted for the largest proportion (18%, n = 60). Despite accounting for the largest proportion of treatments (87%), this category of "consultations and rehabilitations" only accounted for 26% of the total costs of all treatments. In contrast, the "hospital/surgery" category only accounted for 3% (n = 11 of 390) of all treatments sought, yet accounted for 66% of the total treatment costs (US$52 787 of US$80 228).

Follow-up injuries cost the 71 players, on average, US$731 per follow-up injury (95% CIs: US$425 – US$1 096) (Table 2). These follow-up costs would be, on average, US$ 123 per injured player or US$ 14 per tournament player (Table 2). While the younger under-13 and under-16 age group had a tendency to be more expensive than the under-18 age group, these average costs were not significantly different from one another (Table 2). Injuries of "mild" severity (US$217, 95% CIs: US$122 - US$ 321), cost on average, significantly less than injuries with a "severe" severity (US$ 1 551, 95% CIs: US$655 - US$2 696). Injuries to the lower extremities (US$ 278, 95% CIs: US$217 - US$342) cost significantly less than those to the upper extremities (US$1 242, 95% CIs: US$446 - US$2 269), on average, and injuries to the head/face (US$822, 95% CIs: US$168 - US$1 825) and to the neck/cervical/back regions (US$480, CIs could not be calculated) fell between the costs to the lower and upper extremities. On average, fractures (US$2 609, 95% CIs: US$864 - US$4 605) were the most expensive type of injury to treat. This treatment cost was significantly greater than the cost of treating muscle injuries (US$261, 95% CIs: US$134 - US$426), on average. Also, players with medical insurance had significantly greater treatment costs (US$937, 95% CIs: US$486 - US$ 1 500) than those players without medical insurance (US$220, 95% CIs: US$145 - US$302).

In total, n = 13 parents/guardians reported missing work to ensure their child received follow-up treatment. In total, these parents missed 26 work days (8 hour

work day) at a median of 0.5 days (Minimum: 0.1 day – Maximum: 9 days) per parent.

DISCUSSION

The main finding of this paper was that the monetary cost to players seeking follow-up treatment was, on average US$731 (95% CIs: US$425 – US$1 096). These high costs were incurred by a relative minority of players: 17% (n = 71 of 421) of injured players and 2% (n = 71 of 3 652) of the total tournament players. If these costs were divided by all the tournament players (n = 3 652) instead of just those that sought follow-up treatment, the costs would be less of a burden (US$14 instead of US$731, on average). Furthermore, the highest costs were for injuries of "severe" nature (based on time-loss definition), upper extremity injuries, fractures and for players who had medical insurance (in comparison to those that did not).

The average cost per tournament player of the present study (US$14) is, as expected, far less than the annual medical costs reported for a high school population of athletes in 1999 (US$187 per registered athlete). [7] However, only players with time-loss injuries who actively sought medical treatment above and beyond what was already provided at the rugby tournament were included in the present study, so this finding was not surprising. Also, the average cost per follow-up injury in the present study (US$731) was about ten times less than moderate to serious injuries reported for rugby league between 1999 and 2007 (US$7 100), [18] although the rugby league study included players of all ages, not just youth.

The finding that the injuries with the longest periods of recovery (more than 28 days = "severe") were also the most expensive was expected and is consistent with findings in a population of high school sports participants in the United States. [7] Severe injuries in the present study (US$1 551) also cost much less than in the study of high school sports (US$35 336). [7] The very different study designs could explain the discrepancies between the two studies. Nonetheless, the findings of the present study indicate an additional burden of injury that has not been identified in a youth rugby union cohort before, i.e. the economic burden of injury of player's that seek follow-up treatment. For player's seeking follow-up treatment this was, on

average, US$731 and a median of 0.5 missed work days per injury for the parent/legal guardian.

The higher average costs of upper extremity injuries in comparison to lower extremity injuries was unexpected and in contrast to what has been found in rugby league players of all ages, [18] but was not dissimilar to general physical activity and sport injuries in children aged 10-12 years. [8] The costs for both of these sites (upper and lower extremity) were greater in the present study than in that of rugby league players that involved all ages and both sexes. However, injury *sites* were not corrected for the possible confounding effect of injury *type* – therefore we cannot exclude the possibility that the significantly higher average cost of fractures (Table 2) could have influenced the mean cost of injury *sites* in the present study. The finding of higher average costs of fractures, in comparison to other injury sites in the present study was also in contrast with a rugby league report of all ages [18] and study on knee injuries in Swiss youth sports. [19] The average cost of fractures in the present study (US$2 609) was also over 5 times greater than in the rugby league study (US$469). [18]

The relatively low average cost of head/neck injuries and, specifically, concussions in the present study (US$358) (Table 2) is surprising and in less than 70 times the cost in the rugby league study of all ages in New Zealand (US$25 347). [18] Rugby league has comparable rates of concussion to rugby union and thus this difference could not be explained by injury rates between the two sports (Table 1). [20] Of concern is that the low treatment costs associated with concussions in the present study could indicate that players did not consult a medical doctor or follow the correct return-to-play guidelines, which are considered “best-practice” [21] and are strongly advocated by *BokSmart*/SARU for players with concussion. [13] In fact, only 14% of all concussions (n = 7 of 50) received *any* form of follow-up treatment. Another explanation could be that the first-line medical professionals involved in assessing the concussed players both with medical aid, and especially those concussed players without medical aid, might also not be appropriately versed in the current scientific literature and medical protocols for correctly identifying, suspecting, diagnosing, treating and managing concussed players for safe return to play. [22]

This potential phenomenon of inadequate medical care could partially explain the finding that players with medical insurance had, on average, higher treatment costs than those players without medical aid: it is possible that those players without medical insurance did not receive optimal care for their injuries. In South Africa, access to medical insurance is linked to socioeconomic status and determines how one deals with a manageable disease such as hypertension. [23] It is also possible that players with medical insurance could have received more treatment than was necessary for a particular injury. Thus, it is further possible that the absence or presence of medical insurance could have affected follow-up treatment-seeking behaviour.

Although there were no significant differences in mean costs sustained in the different age groups (Table 2), this was expected due to the similar injury rates of the three age groups (Table 1). These findings support a study of high school sports participants in North Carolina, where age was also not considered a risk factor for the cost of injury albeit that age was categorised differently to that of the present study which based it's categorisation on tournaments. [7] Similarly, there was no significant difference in mean costs for players who did, or did not, mention having previously had the injury they were treated for - this phenomenon was also observed in the North Carolina High School study. [7] However, comparable costs indicate that the costs for the present study might be greater than that of the North Carolina high school study in general. For example, the average medical cost of football-related injuries was $577 in the North Carolina high school study, while the comparable cost per injury for the present study was $731.

A possible limitation of the present study was that only the 190 players who suffered what the tournament doctor predicted to be a "time-loss" injury were followed-up. This decision was made for logistical reasons as it would have been difficult to accurately follow-up all medical attention injuries telephonically. However, it is unlikely that many medical attention injuries required follow-up treatment. The cost estimations were based on numerous assumptions by the medical insurance company due to the unique situation in South Africa in which there is no prescribed standard rate for medical treatment costs. Thus, although the present method is subject to potential inaccuracies as a result of these assumptions, the authors

contend that any method of calculating costs in South Africa would require many assumptions. This approach of using an insurer to estimate costs also meant that the raw data were not available for conducting sensitivity analyses, which may limit the comparability of these findings to other countries although the unit cost and frequency of care (Supplementary Table 1 – at end of chapter) should provide some allowance for comparison. Owing to the large discrepancy in average wage in South Africa, the authors were unable to estimate an indirect cost for the loss of the working time of the parents who had to take time off work to accompany their children to the health care practitioner. The classification of "old" or previous injury was also highly subjective, although it was difficult to implement a repeatable objective assessment in the circumstances in which these data were collected. Mean injury costs should have been corrected for different proportions of types of injuries (e.g. fractures, strains, etc.) in the different tournaments, but the study was statistically underpowered to be able to perform these analyses. Finally, comparisons between the present findings and other studies were limited due to a paucity of economic studies that investigated male youth athletes.

CONCLUSION

Although the estimation of costs associated with the medical treatments described in the present study involved many assumptions due to the circumstances in which they were collected, this study is the first to quantify and compare monetary cost as an indication of injury burden in youth rugby union. In particular *BokSmart*, the national injury prevention programme in South Africa, [13] should consider the high monetary costs of fractures and upper extremity injuries, in addition to injuries of large severity which have previously been identified. [14] Furthermore, this study indicated the potential to significantly reduce the direct burden of injury to injured players, by dividing predicted injury costs amongst all players attending these tournaments, instead of just the relative minority who suffered an injury requiring follow-up treatment. This proposed model could potentially alleviate and offset individual injury costs at these types of tournaments, regardless of medical insurance status.

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Table 2. Mean costs for the 71 players seeking treatment after the four tournaments; divided according to age group, injury sites, injury types, injury severity, injury nature and medical insurance status (n = 71).

	N	Mean cost	95% confidence interval	
		(US$*)	Lower	Upper
Costs per population				
Costs per player [a]	3 652	14	8	22
Costs per injury [a]	421	123	66	195
Costs per follow-up injury [a]	71	731	425	1 096
Age group				
Under-13	14	1 743	298	3 519
Under-16	9	774	186	1 517
Under-18	48	428	232	736
Injury Severity				
“Mild” [b]	14	217	122	321
“Moderate"	34	296	188	421
"Severe" [b]	21	1 551	655	2 696
Injury site				
Lower extremity [c]	26	278	217	342
Upper extremity [c]	24	1 242	446	2 269
Head/face	14	822	168	1 825
Neck/cervical/back	7	480	-	-

[a] Costs per player, costs per injury and costs per follow-up injury were all significantly different from each other.

[b] “Mild” severity significantly different to “severe” severity category.

[c] Lower extremity injuries significantly different to upper extremity injuries.

[d] Fracture injuries significantly different to muscle injuries

[e] Injured players without medical insurance (“No”) significantly different to players with medical insurance (“Yes”).

*Conversion: local currency (ZAR)/5.48 to obtain US$ at purchasing power parity (PPP) rate: obtained from World Bank in March 2014 [17]

Table 2 continues on next page

Table 2 (continued). Mean costs for the 71 players seeking treatment after the four tournaments; divided according to age group, injury sites, injury types, injury severity, injury nature and medical insurance status (n = 71).

	N	Mean cost	95% confidence interval	
		(US$*)	Lower	Upper
Injury type				
Concussion	7	358	-	-
Contusion	3	240	-	-
Fracture [d]	11	2 609	864	4 605
Joint/ligament/tendon	29	522	232	962
Laceration	5	65	-	-
Muscle strain [d]	9	261	134	426
Unsure/Other	7	311	-	-
Injury nature				
New injury	51	786	372	1 307
Old injury	19	608	214	1 235
Medical Insurance				
Yes [e]	51	937	486	1 500
No [e]	18	220	145	302

[a] Costs per player, costs per injury and costs per follow-up injury were all significantly different from each other.

[b] "Mild" severity significantly different to "severe" severity category.

[c] Lower extremity injuries significantly different to upper extremity injuries.

[d] Fracture injuries significantly different to muscle injuries

[e] Injured players without medical insurance ("No") significantly different to players with medical insurance ("Yes").

*Conversion: local currency (ZAR)/5.48 to obtain US$ at purchasing power parity (PPP) rate: obtained from World Bank in March 2014 [17]

Supplemental Table 1. Unit costs, frequency and total costs of medical services sought for the 71 injured players in both years (2011 and 2012). The services are categorised into four types: "consultations and rehabilitation", "chemist/pharmacy", "radiology" and "hospital/surgery" costs.

Medical service provider and type	Unit Cost (US$*)	Fre-quency	Total Cost (US$*)
Consultations and rehabilitation		340 (87%)	**21 023**
General practitioner			
Consultation/Check-up	53	60 (18%)	3 199
Physiotherapist			
Consultation for muscle strain/tendon injuries	77	17 (5%)	1 309
Consultation for ligament strains/joints	78	25 (7.%)	1 949
Rehabilitation for muscle strain/tendon injuries	57	61 (18%)	3 456
Rehabilitation for ligament strains/joints)	58	87 (26%)	5 012
Dentist – general visit	102	4 (1%)	409
Orthodontist – general visit	125	5 (2%)	622
Ophthalmologist – general visit	55	6 (2%)	332
Sports physician – consultation	79	5 (2%)	398
Orthopaedic surgeon – consultation	55	41 (12%)	2 269
Occupational therapist			
Consultation	91	1 (0%)	91
Rehabilitation	59	2 (1%)	118
Neurosurgeon – consultation	79	2 (1%)	159
Biokineticist			
Consultation	93	7 (2%)	652
Rehabilitation	62	17 (5%)	1 047
Chemist/pharmacy		10 (3%)	**871**
Moonboot for foot fractures	324	2 (20%)	649
Elbow crutches – adjustable	71	1 (10%)	71
Compression socks **–** below knee	43	1 (10%)	43
Transact patches (for inflammation)	33	1 (10%)	33
Anti-inflammatories (e.g. Cataflam/Voltaren)	12	1 (10%)	12
Painkillers (e.g. Mybulen/Mypaid/Myprodol) – 30 pills	16	4 (40%)	64
Radiology		29 (7%)	**5 547**
X-rays			
X-ray ankle (per unit)	63	3 (10%)	189
X-ray foot (per unit)	53	1 (4%)	53
X-ray shoulder region (per unit)	60	6 (21%)	357
X-ray complete cervical (per unit)	144	2 (7%)	287
X-ray lumbar (per unit)	143	1 (4%)	143
X-ray hand (per unit)	58	2 (7%)	117
X-ray ribs (per unit)	91	1 (4%)	91
X-ray sternum (per unit)	80	1 (4%)	80
X-ray hip (per unit)	60	1 (4%)	60
X-ray lower leg (per unit)	56	1 (4%)	56
X-ray knee (per unit)	63	2 (7%)	126

*Conversion at local currency (ZAR)/5.48 to obtain US$ at purchasing power parity (PPP) rate - obtained from World Bank in March 2014 [17]

Supplemental Table 1 (continued). Unit costs, frequency and total costs of medical services sought for the 71 injured players in both years (2011 and 2012). The services are categorised into four types: "consultations and rehabilitation", "chemist/pharmacy", "radiology" and "hospital/surgery" costs.

Medical service provider and type	Unit Cost (US$*)	Fre-quency	Total Cost (US$*)
MRI			
MRI shoulder scan (per unit)	1 038	1 (4%)	1 038
MRI cervical/neck scan (per unit)	713	3 (10%)	2 138
CT scan			
CT scan ankle (per unit)	393	1 (4%)	393
Ultrasound			
Ultrasound upper limb/shoulder (per unit)	140	2 (7%)	280
Sonar			
Sonar/US scan	140	1 (4%)	140
Hospital/Surgery		11 (3%)	**52 787**
Intensive Care Unit (per day)	1 066	2 (18%)	2 132
Knee Procedures	5 790	1 (9%)	5 790
Shoulder/Elbow/Forearm	4 972	3 (27%)	14 914
Hand/Wrist	3 413	1 (9%)	3 413
Lower Extremity & Humerus (excl. hip/knee/foot/femur)	8 421	2 (18%)	16 843
Facial bone procedures (excl. major head/neck)	7 703	1 (9%)	7 703
Injuries and other eye disorders	1 992	1 (9%)	1 992

*Conversion at local currency (ZAR)/5.48 to obtain US$ at purchasing power parity (PPP) rate - obtained from World Bank in March 2014 [17]

4

INCIDENCE OF RUGBY-RELATED CATASTROPHIC INJURIES (INCLUDING CARDIAC EVENTS) IN SOUTH AFRICA: 2008 – 2011

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ABSTRACT

Introduction and objectives: To establish an accurate and comprehensive injury incidence registry of all catastrophic events that occurred in rugby union ('rugby') in South Africa between 2008-2011. An additional aim was to investigate correlates associated with these injuries.

Methods: Rugby related catastrophic injury data have been recorded since 2008 in South Africa at all levels of play (amateur and professional). There are an estimated 529 483 junior and 121 663 senior players (population at risk). Injuries were categorised by type: cardiac events, traumatic brain and acute spinal cord injuries; and outcome: full recoveries - fatalities. Position and event (phase of play) were also assessed.

Results: The average annual incidence of Acute Spinal Cord Injuries (ASCIs) and Traumatic Brain Injuries (TBIs) combined was 2.00 per 100 000 players (95% CI: 0.91 – 3.08) from 2008-2011. The incidence of ASCIs with permanent outcomes was significantly higher at senior (4.52 per 100 000 players, 95% CI: 0.74 – 8.30) than junior (0.24 per 100 000 players, 95% CI: 0 – 0.65) level during this period. The hooker position was associated with 46% (n = 12 of 26) of all *permanent* ASCI outcomes, the majority of which (83%) occurred during the scrum phase of play.

Conclusions: The incidence of rugby-related catastrophic injuries in South Africa between 2008-2011 is comparable to that of other countries and to most other collision sports. The higher incidence rate of permanent ASCIs at the senior level could be related to different law variations or characteristics (e.g. more regular training) compared to junior level. The hooker and scrum were associated with high proportions of permanent ASCIs. The *BokSmart* injury prevention programme should focus efforts on these areas (senior level, hooker and scrum) and use this study as a reference point for the evaluation of the effectiveness of the programme.

INTRODUCTION

While catastrophic events rarely occur in sport [1] the long-term consequences and implicit severity of these events make them the most devastating of all injuries to the player, their family and friends.[2] Up until the third decade of life, sport is associated with a large proportion of all catastrophic spinal injuries. Of all sports, collision games such as American Football, Ice Hockey and Rugby account for a large proportion of these sport-related catastrophic events.[3-5] Furthermore, Rugby Union (henceforth "Rugby") is currently the most popular collision sport worldwide [6] and has an enormous participant base with 118 active international Unions (www.irb.com).

Despite these participation levels, a recent review concluded that the level of risk of suffering a catastrophic injury while playing Rugby in the United Kingdom was "acceptable" (0.8 per 100 000 participants). Furthermore, this annual incidence was not higher than that of other collision sports such as Rugby League (1.9 per 100 000 participants), Ice Hockey (4.1 per 100 000 participants) or American Football (1.0 per 100 000 participants). [1] For South Africa in 2007, the average annual incidence of rugby-related permanently disabling spinal cord injury was estimated to be lower (0.6 per 100 000 participants) than other rugby-playing nations such as New Zealand, Ireland and Australia.[1,7] Despite these "endorsements" of the relatively low risk of catastrophic injury associated with rugby, an early South African study [8] concluded that 56% of all rugby-related spinal cord injuries reported, could potentially have been prevented. It is these *predictable and preventable* catastrophic injuries that are the priority focus for injury prevention strategies.[5,9]

As a result, New Zealand's *RugbySmart* programme (http://www.nzrugby.co.nz/the_game/safety/rugbysmart) was developed and proved successful in reducing catastrophic injuries.[1,9-11] Based on this success, the South African Rugby Union (SARU) developed their own programme, *BokSmart* (www.boksmart.com) [12,13] modelling it on a comparable intervention approach to New Zealand with additional components to suit the South African rugby landscape, making it an example of a National Sports Organization intervention.[14] Other catastrophic injury prevention strategies for rugby include *Rugbyready* (IRB), *Smartplay* (Australia) and Tackling Safety (England).[1] To evaluate the

effectiveness of the *BokSmart* programme, one first needs to establish the incidence and severity of catastrophic events.[15]

Therefore, the primary aim of this paper was to establish an accurate and comprehensive injury incidence registry of all rugby union-related catastrophic events in South Africa between 2008-2011. An additional aim was to investigate correlates associated with these injuries.

METHODS

Data for this study were collected through the *BokSmart* program, which is a joint initiative between the South African Rugby Union (SARU) (www.sarugby.co.za) and the Chris Burger/Petro Jackson Player's Fund (CBPJPF) (www.playersfund.org.za). The CBPJPF is a non-profit public benefit organization (PBO), developed to aid players who have been permanently disabled while playing rugby in South Africa.[16] Permission to analyse the data was obtained, with SARU's and the CBPJPF's permission, by the UCT Human Research Ethics Committee. This is a descriptive study in which injury incidences are described from data that were collected prospectively. Risk factors between players that suffered catastrophic events and those that did suffer these events were *not* investigated. The following definitions were adopted for this manuscript (a more detailed description of the game of rugby union is available elsewhere [17]):

Catastrophic injury

BokSmart and the CBPJPF use the following definition for recording catastrophic injuries:

"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."

An event that satisfied the above definition, but was established to be a cardiac-related injury (not head, neck, spine or brain) was also recorded and classified as a "cardiac event". Injuries (includes cardiac events) represented both amateur and professional levels. Catastrophic injuries were classified into three different groups: 1. Acute Spinal Cord Injury (ASCI), 2. Traumatic Brain Injury (TBI) and 3. Cardiac

events. ASCIs were further grouped into outcomes, listed in order of increasing severity: Near miss (full recovery expected, ambulant), Neurological deficit (some deficit remains, may walk with or without the requirement of assistive devices), Quadriplegic, and Fatal. TBI outcomes were divided into, with increasing severity: fully recovered, disability (remaining neurological deficit), and fatal. ASCIs and TBIs were further grouped into "non-permanent" (near misses/fully recovered) and "permanent" (residual disability, including fatalities). Non-fatal Permanent injuries - Neurological deficit (ASCI), Quadriplegia (ASCI), residual disability (TBI) – would be classified as morbidities and all Fatalities would be classified as mortalities.

The outcomes presented are the hospital-confirmed diagnoses within one month after the initial injury date as this time frame was thought to be able to provide a more accurate diagnosis.

Incidence
The numerator was calculated as the number of catastrophic injuries and the denominator was the population at risk (total number of rugby players in South Africa). These player numbers were obtained from the International Rugby Board's (IRB's) website (www.irb.com/unions/index.html). Incidences were presented as an annual average (over the four years) per 100 000 players.

Age group
This term distinguished between juniors and seniors. "junior", which is synonymous with "schoolboy" in the South African context (under-7 to under-19), and included "pre-teen" and "teen" males and females (as per IRB website). "senior", was comprised of anyone who was not in the definition for "junior" for males and females (older than under-19) and also included both amateurs and professionals. This term was used to describe the age group of match where the injury event occurred, regardless of whether the player was legitimately participating in that age group at the time.

Event
This term described the phase of play where the injury occurred and included scrum, ruck, tackle (this included both ball-carriers and tacklers) and collisions (an unintentional or intentional clash - which is distinct from a "tackle").

Positional grouping

Owing to small sample sizes, the fifteen general positions were grouped into nine positional groupings as per Durandt et al.:[18] prop (loose-head and tight head prop; = 2 positions), hooker (= 1 position), lock (left and right lock; = 2 positions), loose-forward (open-side flank, blind-side flank and eighth man; = 3 positions), scrumhalf (= 1 position), flyhalf (= 1 position), center (inside and outside center, = 2 positions), wing (left and right wing; = 2 positions), and fullback (= 1 position).

Statistics

Incidences with 95% confidence intervals were calculated using standard formulae [19] suggested for rugby union injury studies.[20] Incidences were considered significantly different if the 95% confidence intervals (CIs) did not overlap. Any negative lower 95% confidence limits were presented as "0". To confirm these comparisons using 95% CIs, p-values were also calculated for comparisons of junior and senior groups using VRP injury statistics software [8,21]. If a P-value was less than 0.05, the difference between groups was considered significantly different, even if overlap existed between 95% CIs.[22] All presented proportions were calculated after excluding missing data (if present) for a particular section - the denominator is always indicated to remove ambiguity.

RESULTS

Since 2008, there have been 54 catastrophic injuries (24 in juniors and 30 in seniors) recorded in total in South Africa (Table 1), the majority of which (n = 45) were Acute Spinal Cord Injuries (ASCIs). In juniors, the highest number of injuries occurred in 2009 (n = 8), while for Seniors the highest number (n = 9) occurred in both 2009 and 2010. Owing to small changes in numbers per year, incidences were calculated on the annual average of injuries over the four-year period (Table 1).

With an estimated 651 146 players at both levels (junior: n = 529 483; senior: n = 121 663) in South Africa, the average annual incidence for all catastrophic injuries (TBI, Cardiac events and ASCIs) was 2.07 per 100 000 players (95% CI: 0.97 - 3.18). Senior players had a significantly higher incidence of these events (6.16, 95% CI: 1.75 – 10.58) than junior players (1.13, 95% CI: 0.23 – 2.04) (P = 0.03). The average annual incidence for all TBIs and ASCIs combined (excluding cardiac events) was also significantly higher at senior (5.96, 95% CI: 1.62 – 10.30) than junior (1.09, 95% CI: 0.20 – 1.97) level (P = 0.03) (Combined = 2.00 per 100 000

players, 95% CIs: 0.91 – 3.08) between 2008 and 2011. In combination, *permanent* TBIs and ASCIs occurred significantly more often at the senior (5.14 per 100 000 players, 95% CIs 1.11 – 9.16) than at the junior level (0.33 per 100 000 players, 95% CIs: 0 – 0.82) (P = 0.02) between 2008 and 2011 (combined: 1.23 per 100 000 players; 95% CIs: 0.38 – 2.08).

The incidence of TBIs was 0.19 per 100 000 junior players (95% CI: 0 – 0.56) and 0.62 per 100 000 senior players (95% CIs: 0 – 2.01). The incidence of cardiac events was 0.05 per 100 000 junior players (95% CIs: 0 – 0.23) and 0.21 per 100 000 senior players (95% CI: 0 to 1.01). The point estimates calculated for TBIs and cardiac events should be interpreted with caution due to low number of these events (Table 1). Half of the TBIs in junior players (50%, n = 2 of 4) had full recoveries, while all outcomes in senior players (100%, n = 3) were fatal. Both cardiac events to date (n = 2) had fatal outcomes. Owing to the low numbers of cardiac and TBI outcomes (n = 9), subsequent analyses only focus on ASCIs.

Correlates of Acute Spinal Cord injuries (TBIs and cardiac events excluded): 2008-2011

All of the ASCIs occurred to males. Seven % of the ASCIs (n=3 of 42) were fatal, 26% (n=11 of 42) resulted in Quadriplegia, 31% (n=13 of 42) resulted in neurological deficit and the remaining 36% (n=15 of 42) were classified as “Near Misses” (outcome not provided in n = 3 cases) (Table 1). Henceforth for further comparison, outcomes of ASCI were also grouped as either “Permanent” (Neurological Deficit, Quadriplegia, Fatal) or Non-Permanent (Near Miss).

The senior level accounted for 58% (n = 26 of 45) of all ASCIs. Considering the population at risk numbers, the average annual incidence of all ASCIs (including “not provided” outcomes) was significantly higher at the senior (5.34 per 100 000 players, 95% CI: 1.24 – 9.45) compared to junior level (0.90 per 100 000 players, 95% CI: 0.09 – 1.70) (P = 0.04) between 2008 and 2011 (Table 2).

Table 1: Absolute numbers of serious/catastrophic injuries in junior and senior rugby levels in South Africa by year, between 2008 and 2011 (4 years, inclusive).

Type of injury	2008		2009		2010		2011		TOTAL		Annual Average*	
Acute Spinal Cord Injury (ASCI) [n = 45]	Junior	Senior	Junior	Senior	Junior	Senior	Junior	Senior	Junior	Senior	Junior	Senior
"Near miss" (full recovery/ ambulant)	2	1	4	0	3	1	3	1	12	3	3.00	0.75
Neurological deficit	1	1	0	2	0	4	2	3	3	10	0.75	2.5
Quadriplegics	1	1	0	3	0	2	1	3	2	9	0.50	2.25
Fatal	0	0	0	1	0	1	0	1	0	3	0	0.75
Not Provided	*1*	*0*	*0*	*1*	*1*	*0*	*0*	*0*	*2*	*1*	*0.50*	*0.25*
Traumatic Brain Injury (TBI) [n = 7]												
Fully recovered	0	0	2	0	0	0	0	0	2	0	0.50	0
Disability	1	0	0	0	0	0	0	0	1	0	0.25	0
Fatal	0	1	1	1	0	1	0	0	1	3	0.25	0.75
Cardiac events [n = 2]												
Fatal	0	0	1	1	0	0	0	0	1	1	0.25	0.75
TOTAL	**6**	**4**	**8**	**9**	**4**	**9**	**6**	**8**	**24**	**30**	**6.00**	**7.50**

*Average is calculated for the four years that data has been collected.

Table 2: Average annual incidences (based on IRB estimated numbers) of acute spinal cord injury (ASCI) from 2008 – 2011 in South Africa (4 years, inclusive). Incidences include 95% confidence intervals (CI). Acute Spinal Cord injuries (ASCI's) are divided into outcomes

	Junior	**Senior**	**Combined**
ASCI outcome	Incidence (95% CI)	Incidence (95% CI)	Incidence (95% CI)
Permanent (ND + Quad. + Fatal)	0.24 (0 – 0.65)	**4.52 (0.74 – 8.30)**	1.04 (0.25 – 1.82)
Neurological deficit (ND)	0.14 (0 – 0.46)	2.05 (0 – 4.60)	0.50 (0 – 1.04)
Quadriplegics (Quad.)	0.09 (0 – 0.36)	1.85 (0 – 4.27)	0.42 (0 – 0.92)
Fatal	0 (–)	0.62 (0 – 2.01)	0.12 (0 – 0.38)
Non-permanent ("Near miss")	0.57 (0 – 1.21)	0.62 (0 – 2.01)	0.58 (0 – 1.16)
*Not Provided**	0.09 (0 – 0.36)	0.21 (0 – 1.01)	0.12 (0 – 0.38)
Total ASCI's	0.90 (0.09 – 1.70)	5.34 (1.24 – 9.45)	1.73 (0.72 – 2.74)

*Specific diagnosis not available/supplied, but confirmed as ASCI
ASCI – Acute Spinal Cord Injury
Bold text indicates value is significantly different from junior level

In senior players, 85% (n = 22 of 26) of all ASCIs had *permanent* outcomes (neurological deficit, quadriplegia or fatal) in comparison to 26% (n = 5 of 19) in junior players. When considering the different numbers for the populations at risk, *permanent* ASCIs occurred significantly more often in senior (4.52 per 100 000 players; 0.74 – 8.30) than junior players (0.24 per 100 000 players; 0 – 0.65) (P = 0.04) (combined: 1.04 per 100 000 players, 95% CI: 0.25 – 1.82) between 2008 and 2011 (Table 2).

Matches, as opposed to training, were associated with 88% (n = 38 of 43) of all ASCIs (information not available for n = 2 cases). The training injuries occurred either in a scrum (n=2), tackle (n=2) or ruck (n=1). Owing to the low numbers of training injuries and the fact that their mechanisms were similar to those that occurred in matches, these injuries were combined with match injuries for further analyses (Figures 1 and 2).

The scrum was involved in 42% (n=19 of 45) of all ASCIs. Sixty-three % (n=12 of 19) of scrum-related ASCIs occurred to senior players, which equates to an incidence of 2.47 injuries per 100 000 senior players (95% CI: 0 - 5.26) between 2008 and 2011. Together, the scrum and tackle accounted for 80% (n=36 of 45) of all ASCIs for both levels combined (junior and senior) (Figure 1A). Eighty-two % (n=14 of 17; outcome “not provided” for n=2) of scrum related injuries had *permanent* outcomes compared to 50% of tackle injuries (n=8 of 16; outcome “not provided” for n=1) (Table 1B). The 14 scrum-related permanent ASCI outcomes equated to an average annual incidence of 0.54 *permanent* scrum ASCIs per 100 000 players (95% CI: 0 – 1.10) between 2008 and 2011.

The senior age group accounted for 79% (n=11 of 14) of the *permanent* scrum injuries and 88% (n=7 of 8) of the *permanent* tackle injuries. Of all the scrum injuries, scrum engagement and a collapsed scrum contributed to 56% and 39% of cases, respectively (n=10 and 7 of 18, respectively; n=1 case was attributed to *popping out*, and information was not provided for n=1 case). The tackle events were evenly split between tackler and ball-carrier (n=8 for each).

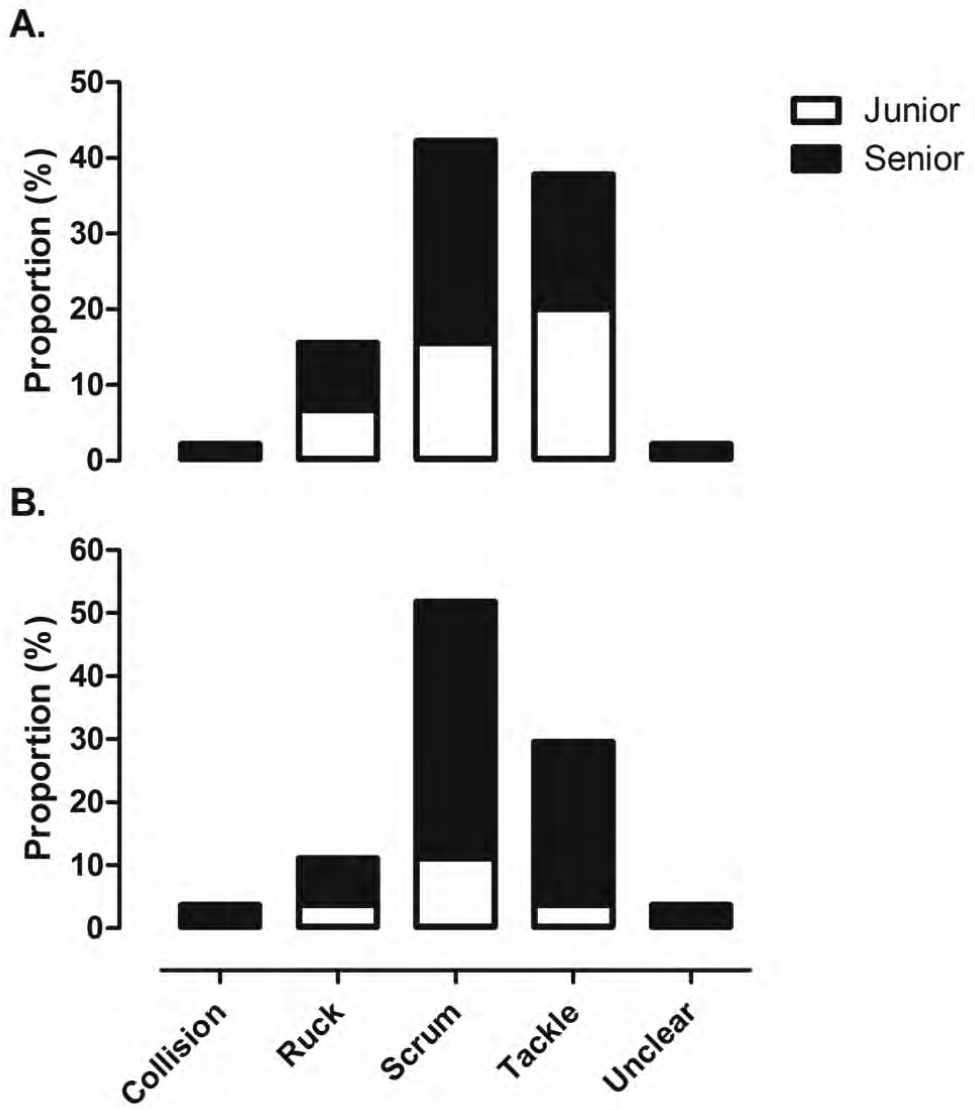

Figure 1. [A] The phase of play (Collision, Ruck, Scrum or Tackle) that accounted for all ASCI (n = 45) and [B] permanent ASCI outcomes at junior and senior level. Segments add up to 100%.

For further analyses, only n=40 cases were considered because four cases occurred in positional groupings that are not conventional 15-a-side rugby (n=3 “seven-a-side”, n=1 mini-rugby) and the event responsible was “unclear” for one case.

The hooker and loose-forward positional groupings were associated with 38% (n = 15 of 40) and 25% (n=10 of 40) of all ASCIs (Figure 2A). Eighty % of all ASCIs to the hooker position were permanent injury outcomes (n=12 of 15). Together, the hooker, prop, and lock positional grouping (tight five) accounted for all the scrum injuries. The tackle injuries were shared between all positional groupings except prop and scrumhalf.

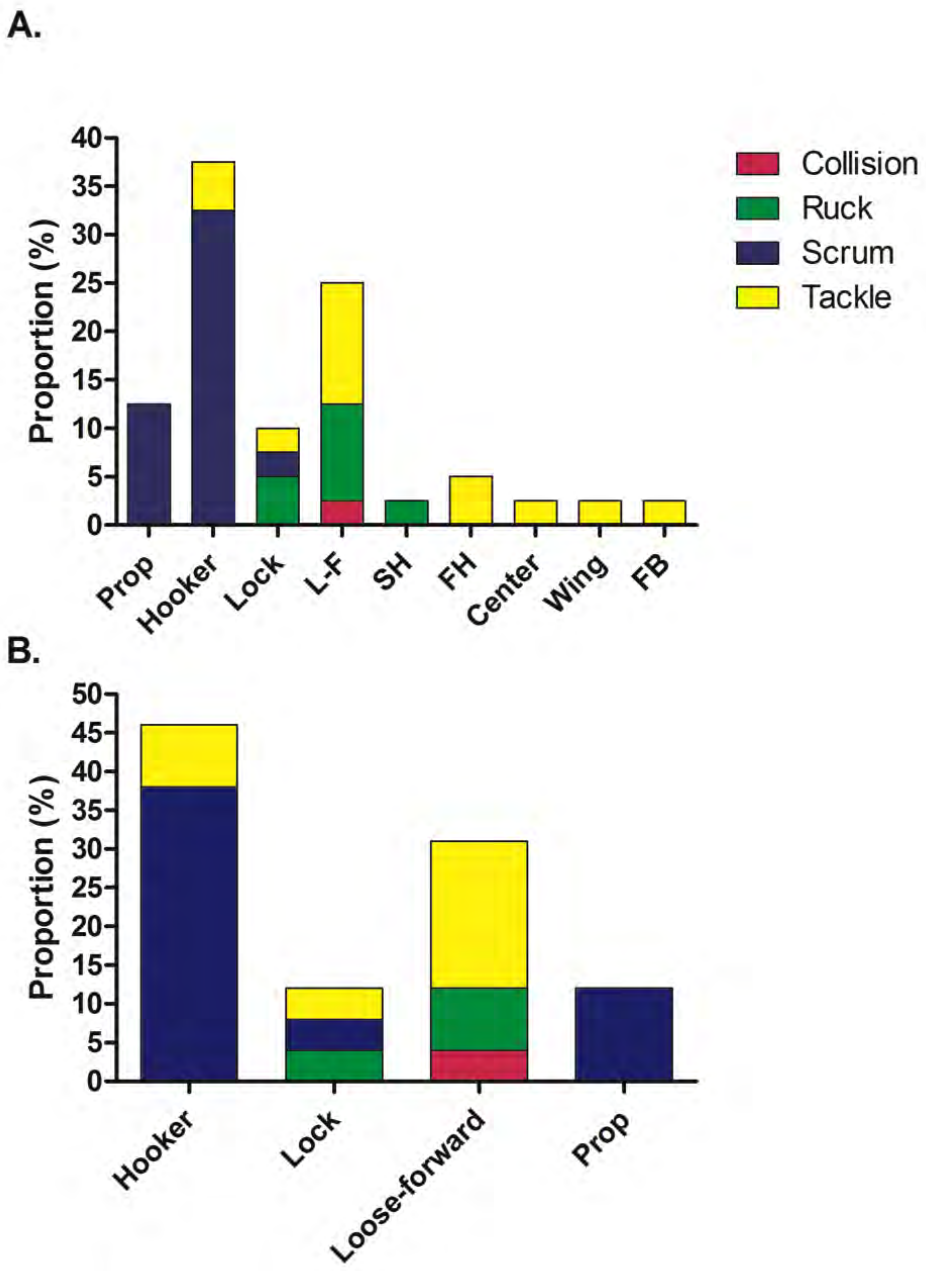

Figure 2. [A] The positional grouping, and the phase of play (tackle, scrum, ruck or collision) that accounted for all ASCI (n = 40) and [B] permanent ASCI (n=27) outcomes. All segments, in combination, add up to 100%.

****L-F = Loose-Forward; SH = Scrumhalf, FH = Flyhalf***

When examining *permanent* ASCIs in isolation (Figure 2B), only the forwards positional groupings were represented (prop, hooker, lock and loose-forward). Of these permanent outcomes, the hooker alone accounted for 46% (n=12 of 26) of all injuries, 83% of which (n=10 of 12) were as a result of the scrum. The loose-forward positional grouping accounted for 31% (n = 8 of 26) of all permanent outcomes, 63% (n = 5 of 8) of which came from the tackle.

DISCUSSION

In South Africa, we found that the average annual incidence of all rugby-related catastrophic outcomes (excluding cardiac events) was 2.00 per 100 000 players (95% CI: 0.91 – 3.08) between 2008 and 2011. This is comparable to the rate reported for Argentina (1.90 per 100 000 players) [23], between 1977 and 1997 and Ireland (0.89 per 100 000 players) [5] between 1995 and 2004. These are the only rugby-related catastrophic injury papers that included "near miss" outcomes and the incidences were only subsequently estimated by a recent review article [1]. While the current consensus statement for rugby injury data collection recognizes the importance of calculating incidences for comparability across playing nations [20], it still does not include "near miss" outcomes in the definition of catastrophic injury. The small difference between non-permanent and permanent outcomes and therefore the epidemiological importance of including these outcomes has been stated by various authors in the past [3,24] and was clearly illustrated in a recent UK study of spinal injuries in junior players [25].

For comparative purposes, the average annual incidence of permanent ASCIs and TBIs was 1.23 per 100 000 players (95% CI: 0.38 - 2.08) between 2008 and 2011. On a Health and Safety Executive scale [1] which categorises risk in ascending order, from "negligible" (0.001 – 0.1 cases/100 000 population) to "acceptable" (0.1 – 2.0 cases per 100 000 population); "tolerable" (2.0 – 100.0 cases per 100 000 population); and "unacceptable" (> 100 cases per 100 000 population), this incidence would be classified as "acceptable". This average incidence is also comparable to the rates reported in a review of rugby-related permanently disabling head and spinal injuries [1] in the UK (0.48 – 1.50 per 100 000 players), but was on the lower end of rates reported for other countries (0.89 – 13.00 per 100 000 players) in the same review. However, although this aforementioned review [1]

intended to include both permanent TBIs *and* ASCIs, the majority of studies that were included only investigated the latter type of injury.

Therefore, the average annual incidence of permanent ASCIs in the present study (1.04 per 100 000 players, 95% CI: 0.25 – 1.82) is the more comparable incidence to those presented in the review [1]. The incidence of permanent ASCIs in the present study is also similar to that reported for comparable outcomes in Australia between 1997 and 2002 (3.2 per 100 000 players) [26] and New Zealand before (between 1.6 and 3.9, per 100 000 players, per year) and after the introduction of *RugbySmart* (between 0.8 and 1.7, per 100 000 players, per year) [10]. The incidence data of New Zealand is particularly believable and accurate due to their comprehensive no-fault insurance system [27]. The annual average incidence of the present study is also greater than the estimated incidence of permanent spinal cord injuries for South Africa between 2001 and 2005 (0.6 per 100 000 players) [7], although the earlier study had a different method of data collection to that of the present.

For further comparison, the annual average incidence of non-fatal permanent ASCIs (excluding near misses and fatalities), for the present study was 0.92 per 100 000 players (95% CI: 0.18 – 1.66) which is significantly lower than the rate reported for comparable outcomes (ASIA scale A – D, excluding fatalities) in Australia between 1995 and 2003 (6.8 per 100 000 players, 95% CI 4.0 – 10.7) [28], but comparable to France before (2.1 per 100 000 players, per year) and after the introduction of modified Laws and guidelines for the scrum (1.4 per 100 000 players, per year).

The main finding of the present study was the higher incidence of catastrophic injuries at the senior, in comparison to the junior level. This associated factor, along with other relevant factors are described in the following section.

Senior (as opposed to junior) level

The novel conclusion of the present study is that the annual average incidence of all (including “near misses”) and *permanent* ASCI outcomes between 2008 and 2011 was significantly higher at the senior than junior level. Although incidences at senior level have previously not been statistically compared with those at junior level, preceding literature in Australia [26] and France [29] have indeed also reported

higher incidences in senior compared to Junior age groups. The best comparison to the present study was an American Football study [30] that investigated a comparable range of all ASCI outcomes per 100 000 players: fatal to serious, with full recovery outcomes (equivalent to "near miss" in the present study). This American Football study had similar annual average incidences per 100 000 high school and college players respectively to the present study: 1.10 (present study: 0.90 per 100 000 players, 95% CI: 0.09 – 1.70) and 4.72 (present study: 5.34 per 100 000 players, 95% CI: 1.24 – 9.45). It was interesting to note that this study presents the first documented incidence of catastrophic injury in mini rugby [1], although this injury had a "near miss" outcome.

The reason for higher incidence rates at senior level may, in part, be related to more stringent law variations, in particular with respect to the scrum, at Junior levels [31]. Under 19 law variations, for the scrum, include, but are not limited to: not being able to push a scrum more than 1.5 metres and not being allowed to wheel a scrum [32]. These law changes decreased numbers of spinal cord injuries in New Zealand [33]. However, the consistent finding that *all* (non-catastrophic as well as catastrophic) injury incidences rates are higher at senior than junior level [34-36] suggest that this finding is not unexpected. Studies investigating general injuries have suggested that increased speed [36] and increased competitiveness and aggression [34,35] may be responsible for the differences in incidences at these levels. Other factors such as "weekend warriors" (adults only playing sport on the weekend, without sufficient training, coaching and conditioning) and the low numbers of players at the senior level which could force players to play in unfamiliar positions, are potential contributing factors, although these require further investigation.

Hooker positional grouping

While the many positional groupings of rugby does not allow for statistical comparisons, the hooker positional grouping accounted for the highest *proportion* of all ASCIs (38%) in the present study, which is alarming considering the small proportion (7%, n = 1 of 15) that this position represents in a traditional 15-man starting line-up. Furthermore, this finding and comparison has been made in previous research in South Africa [7] and other countries [2]. Moreover, this position also accounted for the majority of all *permanent* ASCIs (46%) in the present study, regardless of age group, and 83% of these (n = 10 of 12) were in the scrum. While

the findings could not be investigated statistically, common-sense would argue that the large proportion of ASCIs attributed to this one specific playing position represents an alarming and concerning finding.

The Hooker's role and position in the scrum could place this player at more risk of suffering a scrum-related ASCI than any other positional groupings. During engagement, the hooker has each arms bound around a prop, and is driven into the gap between the opposition hooker and prop by his/her team-mates. During this period, and the subsequent shove, there are a number of forces experienced by the front-row including lateral, vertical and compressive. Depending on the level, the compressive forces can be between 8.7 and 16.5 kiloNewtons [37]. At these large impulsive forces, and with the hooker unable to adjust his/her position due to the scrum structure, a slight miscalculation or deliberate foul play could result in a catastrophic event to this player.

Scrum (as opposed to any other phase of play)
The scrum alone accounted for a rate of 0.73 ASCIs per 100 000 players and for 42% of all ASCIs. The high proportion of scrum-related catastrophic injuries has previously been shown in South Africa [7] and other countries [2] [1]. Additionally, there was a higher proportion of scrum-related catastrophic injuries in the present study (42%) in comparison to other studies which also included "near misses", e.g. in Ireland (17%, 2 of 12) [5].

However, studies that only investigated permanent outcomes found that the scrum accounted for 37% (68 of 183) of all cases in South Africa, 51% (19 of 37) of all cases in France, and 61% of all cases in Argentina [23], which were comparable in proportion to that of the present study (52%). Independently, a higher proportion of scrum- compared to tackle-related ASCIs resulted in permanent outcomes (82% vs. 50%). Considering that scrums occur relatively infrequently in comparison to tackles and rucks [38], these findings are noticeably understated.

While, the hooker, prop, and lock positional grouping (tight five) accounted for all the scrum-related permanent ASCIs, the tackle-related injuries were shared between all positional groupings except prop and scrumhalf, which represents the more generalised risk in the latter phase of play. While the incidence was not significantly

different between age groups, 79% of all permanent scrum-related ASCIs occurred at the senior rather than the junior level. The engagement sequence accounted for the largest proportion of scrum-related injuries (56%) in the present study, which is consistent with previous findings [2,39] and has been attributed to the high forces experienced by the front row during this phase of the scrum [29] [40]. The high forces (and thus acceleration) during engagement would exacerbate any predisposing risk factor.

The premature degeneration of the cervical spine, particularly in front row players [10,41], mismatches in size between front-row players [2,12], and high impact forces [40,42] have been mentioned as potential factors for the relative overrepresentation of scrum-related injuries in previous literature, but other factors such as refereeing experience, coaching experience, scrum laws, technical preparation, appropriate player selection and specific conditioning of players should also be scrutinized more carefully. While the four phase “crouch, touch, pause, engage” (CTPE) refereeing sequence has been shown to have some positive effect on injury incidences [39], the results of the present study warrants considering further Law changes with potentially greater effect, especially for the amateur game. The modification of scrum laws/regulations in amateur rugby in France: removal of the high impact on engagement, and linking the two packs together before the scrum commences, and a “rugby passport” license to certify capacity of front-row players, significantly reduced scrum-related catastrophic cervical spine injuries, including those to the front-row and hooker positions [29]. Furthermore, the exemplary nationwide injury prevention program of New Zealand, *RugbySmart*, had a significant reduction in scrum-related spinal injuries [10] and it is hypothesized that the *BokSmart* program can produce a similar effect over time [12]. This paper serves as a reference point for the *BokSmart* program going forward.

Although all ASCIs occurred to males in the present study, this may simply be an artefact of disproportionate participation levels: there are only 17 917 females in comparison to 633 229 males (www.irb.com/unions/index.html). The average annual incidence of cardiac death rates in the present study in junior players (0.05 per 100 000 players) is less than rates published previously for competitive athletes younger

than 18 years of age [42]. There were no prospective incidences available for adult/senior populations.

Limitations

Player numbers were assumed to remain constant over the four years of investigation. While they may have fluctuated between years, it is unlikely that numbers have declined appreciably, thereby ensuring that incidences were not under-estimated. The estimation of player numbers (population at risk) may also be open to error. However, due to the fact that these rare events are shown as an incidence per 100 000 players, the inaccuracy would have to be enormous to affect the results presented in the current study. Furthermore, errors in numbers would probably be consistent at both levels (junior and senior) and should not drastically affect between-level comparisons.

It is plausible to suggest that some catastrophic events might not be reported to *BokSmart* and the CBPJPF. However, the Serious Injury Protocol, and the potential benefit of financial assistance that is associated with reporting injuries in South Africa would make this possibility very small. Information dissemination via social media and other more formal communication channels regarding catastrophic rugby injuries would generally pick up any shortfall potentially missed.

CONCLUSION

In conclusion, the rates of all (including near-miss) and permanent (excluding near-miss) rugby-related ASCIs in South Africa from 2008 to 2011 are comparable to that of most other countries and to rates in other collision sports such as American Football. Despite this finding, three factors were strongly associated with catastrophic injury and warrant further attention for prevention strategies: Senior players, hooker playing position and the scrum phase of play. This four year registry will serve as reference point for the evaluation of the *BokSmart* injury prevention program going forward.

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5

ARE WE CURRENTLY UNDERESTIMATING THE RISK OF SCRUM-RELATED NECK INJURIES IN RUGBY UNION FRONT-ROW PLAYERS?

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ABSTRACT

Introduction and objectives: Of all rugby-related injuries, those to the head and neck carry the most concern for medical professionals. Each rugby team of 15 is comprised of eight 'forwards' and seven 'backs' – each of which have position-specific roles in the team. The phase of play that is most well-regulated by the referee is the scrum, yet this phase has a high propensity to result in injury. Injury rates are typically calculated by dividing the number of injuries by the total exposure. Depending on the study design, this exposure can either be the total number (catastrophic injuries generally) or amount of time (non-catastrophic injuries generally) of participants potentially at risk of suffering a particular injury. In rugby epidemiology, exposure for scrum-related injuries is conventionally calculated based on the eight forwards as they are the only players involved in this activity. However, injuries in all injury epidemiology it is generally only the three front-row forwards (hooker and two props) that are at risk of suffering a scrum-related neck injury. Thus, the authors intend to show through re-calculating previous data, that the scrum-related neck injury rate to front-row forwards has been underestimated.

Methods: The data from two publications was re-calculated with only the front-row forwards in the exposure calculation. One publication which examined catastrophic injury rates used total number of players in the exposure. The other publication, which used total amount of time as the exposure, was an investigation of general (all) injuries. Injury point estimates and 95% confidence intervals were re-calculated using on the injuries and exposure for the front-row positions and these values were compared to the previous calculations.

Results: For catastrophic injuries, the rate can be up to five-fold higher than has been reported previously when all eight forwards were considered to be exposed to scrum-related injury risk. Similarly for general injuries, the scrum-related injury rate was significantly greater in the three front-row forwards than the other eight forwards

Conclusions: These finding of this study have implications for risk communication to administrators, medical personnel, coaches, referees, parents and most importantly players. Depending on the research question, future studies should consider the calculations adopted in this article or at least consider the players at risk of suffering scrum-related neck injuries in their calculation only.

INTRODUCTION

To understand the risk of incurring a particular rugby injury, and to identify risk factors related to this injury, it is necessary to know both the injury counts and the time that the players are exposed to the risk of sustaining that injury.[1] The latter poses an interesting debate with respect to the scrum as there are various ways in which the exposure can be expressed. While not the only two methods, "exposure" in sports injury epidemiology has often been calculated as either: the "Athlete at risk" and the "Athlete participation" method:[2]

"Athlete at risk" = number of athletes involved in a game X number of games X average duration of game.
"Athlete participation" = total number of athletes who could possibly have been at risk for a particular injury.

The "athlete participation" method is sometimes the only way to calculate injury incidence rates for certain investigations, such as for catastrophic injury risk,[3] in which data are mainly collected retrospectively. However, this method typically underestimates injury rates as the exact time at risk is not quantified.[2] Where match time is recorded, the current consensus statement for the surveillance of injuries in rugby union,[4] provides a formula for the calculation of match exposure. This consensus statement, which defines terms and preferred methodology, has significantly advanced the quality of research on injuries associated with rugby union by offering guidelines for a standardised approach, enabling universal comparison of injury risk and risk factors.[5] For the majority of rugby union epidemiological studies, it is assumed that within one team (*Team A*) 15 players (the number of players per team on the field at one time) are at risk for *Y* minutes (80 minutes for senior level) over *Z* number of matches during a season/tournament.[1,4]

This exposure calculation assumes that all 15 players of the team are at equal risk of injury during this time: *Y* (minutes of match) x *Z* (number of matches). However, the 15 players are comprised of two broad positional groupings: eight forwards and seven backs. Rugby union involves activities, such as scrummaging, that are position specific, and therefore do not involve all 15 players.[6] Furthermore, players

are not at risk for the full match time as the ball is typically in play for far less time than the full 80 minutes. [6] Outside of this "ball in play" time there is no injury risk to players. Also, certain activities, such as scrummaging, occur for a small percentage of the total match time: at international level, players only physically scrum for 1 minute and 16 seconds per match, on average. [6] Thus, the calculated incidence rate, based on the assumed exposure of 15 players at risk for the full match time (80 minutes, in most cases), would be a gross underestimation of the actual incidence rate of activity-related injuries when measured against the incidence rate calculated using the time of "ball in play". Reporting incidence rates separately for forwards and backs[1] may reduce some, but not all of the inaccuracies of this calculation. For example, if only the three front-row positions (loose-head prop, hooker and tight-head prop) are mainly at risk of injury during the scrum, the current exposure calculation is overestimated, and the incidence rate is underestimated by the order of five players that are not at risk of injury. This point is even more pertinent for catastrophic scrum injuries which occur almost exclusively to the front row.[3,7-8]

Scrummaging is not the only event that may have an underestimated injury risk because of its specificity during a match. Other examples of events that are more related to certain playing positions than others due to the position-specific nature of the game are lineouts, kicking, ball carries, tackles, mauls and rucks. However, scrums are a well-structured and controlled event, governed by numerous safety Laws which referees have to enforce. Thus, the authors felt this specific aspect of play, was the most suited to practically demonstrate the underestimated injury risk per event, in this case for scrum-related injuries in the front row playing positions.

METHODS

Two worked examples, based on data from previously published manuscripts, [7,9] are presented to illustrate this potential underestimation in the calculation of non-catastrophic (Worked example A) and catastrophic (Worked example B) injury rates. Incidences with 95% confidence intervals were calculated using formulae[10] frequently used in rugby union injury studies:[1,5] incidence rates were considered significantly different from each other if their respective 95% confidence intervals (CIs) did not overlap at all.

RESULTS

Worked Example A: evaluation of non-catastrophic injury rates using "athlete at risk" method

Teams followed across two rugby seasons (with 15 players per team) participating in a total of 420 matches that are each 80 minutes in length, have an overall exposure time of 8400 player hours. There are 91 scrum-related neck injuries to the front-row players (various severities, including medical attention injuries) during these 420 matches. Depending on the number of players that one considers to be "at risk" during the scrum, there are typically three methods to calculate risk exposure, each of these exposure calculations produces notably different incidence rates:

(i) Consider all 15 players (Figure 1 – all players); (91 ÷ 8400) × 1000 = an incidence rate of 10.8 scrum-related injuries per 1 000 player hours (95% confidence intervals: 8.6 to 13.1). As mentioned previously, this is highly inaccurate since not all 15 players participate in a scrum.

(ii) Consider only the eight forwards (Figure 1 – forwards only); [91 ÷ (8400 x $^{8}/_{15}$)] × 1000 = an incidence rate of 20.3 scrum-related injuries per 1 000 forward hours (95% confidence intervals: 16.1 to 24.5), which is significantly greater than the incidence rate for all 15 players. This method has been suggested by Brooks and Fuller [1] and Gianotti et al. [12] previously, but does not feature in the current consensus statement [4] and is not applied ubiquitously.

(iii) Consider only the three front row players who are at risk of suffering a scrum-related injury (Figure 1 – front-row only); [91 ÷ (8400 x $^{3}/_{15}$)] × 1000 = an incidence rate of 54.2 scrum-related injuries per 1 000 front-row hours (95% CIs: 43.0 to 65.3), which is significantly greater than both the incidence rates for all 15 players (i) and for all eight forwards only (ii). Given previously recorded scrum injuries, this calculation, may be closer to a true reflection of the injury incidence rate during the scrum.

Moreover, scrummaging accounts for a small amount of total activity: it only accounts for 2% of total match time (1 minute 16 seconds of 80 minutes) [6] and 6%

of total events/activities (1447 of 22842 events).[11] Thus, points (ii) and (iii), which assume that the exposure to scrum injury risk is for the entire 80 minutes of a senior match, also overestimate the exposure, and underestimate the risk. However, quantifying the amount of time spent scrummaging and ball-in-play time, may be more logistically challenging, particularly for non-elite or community levels of the game.

An alternative approach to evaluating risk would be to disregard time completely and to calculate injury counts per event – i.e. 10 scrum injuries per 92 scrums. This method has previously been performed for a prospective cohort study [11] and showed the scrum to have the highest propensity to cause injury. Should the primary measure be scrum injuries only, due to the small number of scrums in a match, this method could still be practically feasible.

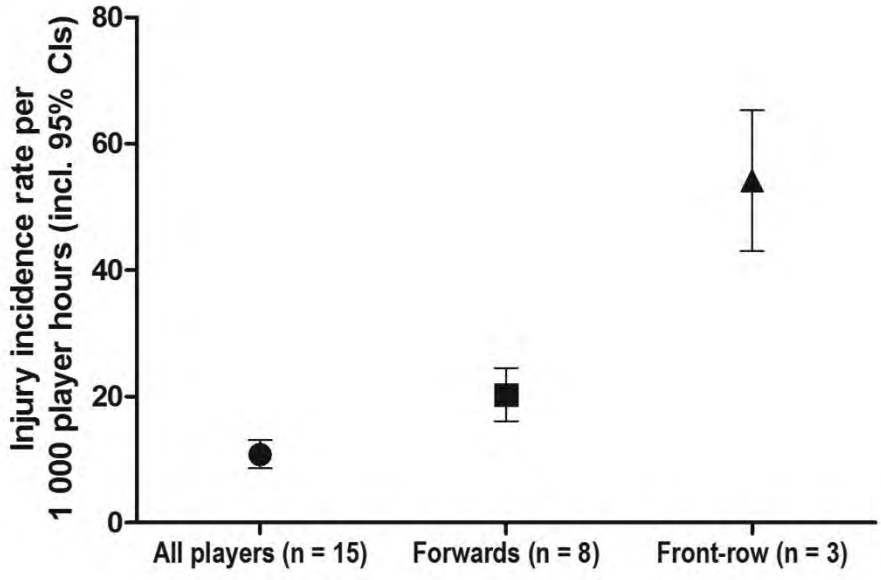

Figure 1. The same number of scrum-related injuries produces three different injury incidence rates, depending on the number of players that are considered to be "at risk" in the exposure time (player hours). The injury incidence rate for all players is significantly less than for the three front-row forwards only. (CIs – confidence intervals)

Worked Example B – evaluation of catastrophic injury rates using the "athlete participation" method

The following raw data were used from a previous publication [7] which investigated the incidence rate of catastrophic injuries in South Africa between 2008 and 2011.

The raw data are used here purely for illustrative purposes. To calculate the national incidence rate of injuries, the "athlete at risk" method would be logistically difficult. Therefore, the "athlete participation" method was used for this particular investigation.[7]

Table 1 provides the estimated player number exposure hours for calculation of relative match-related catastrophic acute spinal cord injury (ASCI) average incidence rates associated with the scrum (4.8 injuries per year) between 2008 and 2011 in South Africa. Hookers (n = 13), props (n = 5) and locks (n = 1) incurred scrum-related catastrophic ASCI. There were an estimated 651 146 active players at the time of the study.

Table 1. The estimated total number of South African rugby players [7] at risk is provided, and the respectively calculated forwards, front-row players (loose-head prop, hooker and tight-head prop), props (loose-head prop and tight-head prop) and hooker position only.

Total player numbers	"Forwards" population[#]	"Front-row" population[*]	"Prop" population[^]	"Hooker" population[&]
651 146	347 278	130 230	86 820	43 410

[#] Calculated by multiplying total player numbers by the fraction of $^{8}/_{15}$.
[*] Calculated by multiplying total player numbers by the fraction of $^{3}/_{15}$.
[^] Calculated by multiplying total player numbers by the fraction of $^{2}/_{15}$.
[&] Calculated by multiplying total player numbers by the fraction of $^{1}/_{15}$.

On the assumption that all 15 playing positions were represented proportionally, if one then multiplied this total number of players by the fraction of forwards that comprise a starting team ($^{8}/_{15}$), one would have a gross estimate of the forwards population at risk (347 278 players -Table 1). This method has been described and used previously for assessing scrum law changes.[12] Furthermore, with the same assumption made as per the above, by then multiplying the total number of players by the fraction of front-row forwards (loose-head prop, hooker and tight-head prop) that are at risk for a catastrophic injury during a scrum ($^{3}/_{15}$), one would have a gross estimate of the front-row forward population at risk (130 230 players). Similarly, one could multiply the total number of players by a fraction of $^{2}/_{15}$ and $^{1}/_{15}$ to get a gross estimate of the number of props (86 820) and hookers at risk (43

410). Intuitively, accurately recording the exposure time for such a large amount of players would be impractical and therefore the "athlete participation" method remains the most feasible for catastrophic injury studies.

Using the "athlete participation" method, and therefore player participation numbers, scrum-related catastrophic injury incidence was calculated in a variety of ways using the respective player numbers at risk (i.e. all players, forwards, front-row players, props, and hookers only) and represented as injuries per 100 000 players. Similarly, only the scrum injuries that occurred to the front-row (n = 18: 4.5 injuries per year) were considered for the "front-row" calculation, only injuries that occurred to props were considered for the "props" calculation (n = 5: 1.3 per year), and only injuries that occurred to the hooker (n = 13: 3.3 injuries per year) were considered for the "hooker" calculation.

Using methods common to sports epidemiology research,[1,10] injury incidence rates for the front-row (3.7 injuries per 100 000 players, 95% CIs: 0.4 – 7.0) would not be statistically different to the incidence rate for all players (0.7 injuries per 100 000 players, 95% CI's: 0.1 – 1.4), despite this representing a five-fold difference (Figure 2). Similarly, hookers (7.5 per 100 000 players, 95% CI's: 0.0 – 15.6) had a five-fold greater injury rate than props (1.4 per 100 000 players, 95% CI's: 0.1 – 4.0), although this would also not be statistically significant due to the overlap of these two confidence intervals. As catastrophic events are rare occurrences, the calculation of a relative rate,[13] using a clinically relevant threshold for a "meaningful" difference, could be a more practical method to assess if the two rates were different. Even though the difference is statistically not significant, the hooker position, from a clinical relevance point of view, would be at far greater risk of catastrophic injury than other positions in the scrum. The definition of "clinical relevance" would depend on the particular research question.

DISCUSSION AND CONCLUSION

The current consensus statement for injury surveillance in rugby union [4] has improved epidemiological rigour within the rugby injury field. However, considering the relatively small number of players at risk of scrum-related injuries, [7,14] and

without acknowledging the reduction in relative exposure, we are in danger of masking the real risk of injury to the front-row, and more specifically the hooker playing position in the scrum. This "masking" effect is evident when data from previous publications [7,9] are recalculated with only those players that are at risk of injury in the scrum (front-row) being considered in the exposure calculation (Figures 1 and 2). While the incidence of spinal cord injury in rugby is generally small, and while the calculated overall risk of a scrum-related catastrophic injury would probably still remain relatively small, it is important not to underestimate this risk.

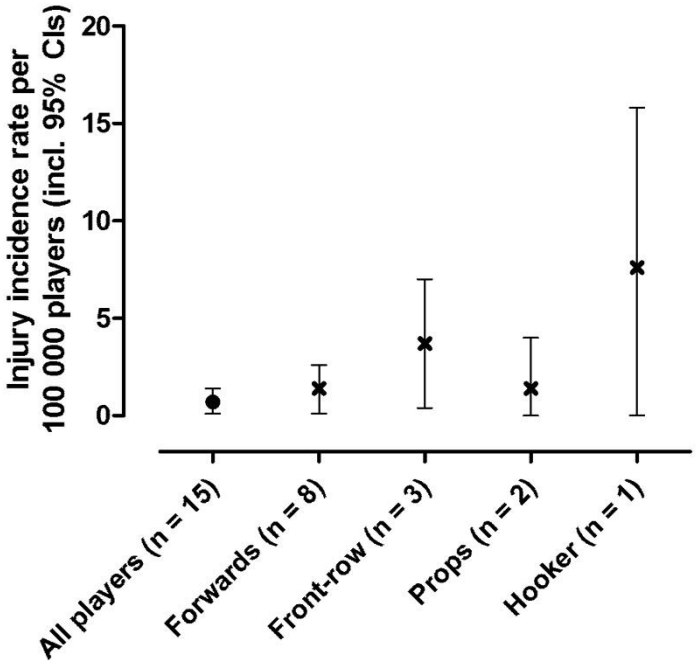

Figure 2. Catastrophic ASCI (acute spinal cord injury) incidence rates for the scrum. The incidence rate is shown for different player exposure numbers (players at risk) for the scrum-related injuries only: total players, eight forwards only, three front-row forwards only (loose-head prop, hooker and tight-head prop), props only (loose-head and tight-head prop) and the hooker position only. (CIs – confidence intervals).

Furthermore, with this "masking" effect, it is possible that changes in scrum injury incidence rates as a result of the modified scrum Laws that SARU [15] and, more recently, the International Rugby Board (IRB) have mandated [16] could be

overlooked. Any injury prevention intervention needs to be accurately evaluated before and after the problem was identified.[17] With the large confidence intervals that would result from reducing the scrum-related exposure to the fraction of the front-row and positional grouping numbers, any statistical effect of the Law changes might indeed be missed. A relative rate change with a clinically relevant threshold or using a Poisson regression, as employed by Quarrie et al.,[18] to assess the effect of *RugbySmart* on neck and spinal injuries, may offer alternative approaches to consider.

The authors propose that future epidemiological studies should, where possible, attempt to more accurately quantify the actual player exposure when assessing scrum-related injury risk. At the very least, this exposure should be changed based on the assumption that only three players – the loose-head prop, hooker and tight-head prop - are effectively at risk for suffering a scrum-related injury (general or catastrophic). Although there is a chance that the lock positions could also be injured during the scrum, the authors contend that this chance is very low, based on only one isolated injury to date that the authors are aware of.[7] Furthermore, although using fractions to recalculate the “forward” and “front-row” populations for catastrophic injuries in the “athlete participation” method may be based on many assumptions, the authors contend that this recalculated exposure is more accurate than calculating an injury rate based on the total playing population, as is currently performed. This would align risk estimates in catastrophic injury epidemiological reports with the majority of non-catastrophic epidemiological reports, which only consider the forwards in the exposure calculation. Similarly, with non-catastrophic scrum injuries included in the “athlete at risk” method, calculating the adjusted player exposure hours using only the three front row players, or using the injuries per event approach, would provide a better representation of the true injury incidence per scrum event than is currently provided.

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6

THE EFFECTIVENESS OF THE NATIONWIDE *BOKSMART* RUGBY INJURY PREVENTION PROGRAMME ON CATASTROPHIC INJURY RATES

SUBMITTED

ABSTRACT

Introduction and objectives: Rugby union ("rugby") has an above-average risk of injury compared to other popular team sports' participants. As a result, *BokSmart* was implemented nationwide in South Africa in mid-2009. *BokSmart* educates coaches and referees with the goal of reducing catastrophic head/neck injuries (CIs) in players. This study investigated if *BokSmart* has been associated with a reduction in these injuries.

Methods: The *BokSmart* programme collected data on all South African rugby-related CIs since 2008. Using a Poisson regression CI numbers were compared pre-*BokSmart* (2008/9) to the years post-implementation (2010-13). Player numbers were assumed to be constant throughout this evaluation: junior = 529,483; senior = 121,663.

Results: In junior players, the 'post-*BokSmart*' period had 2.5 less annual serious injuries than 'pre-*BokSmart*' (IRR: 0.6, 95% CI: 0.5 – 0.7, $p<0.0001$). In contrast, there was no significant difference in these periods in seniors.

Conclusions: The *BokSmart* programme was associated with a reduction in CIs in the four years post-implementation. The absence of effect in seniors may be a result of fewer players or of differences in effectiveness of the intervention in this group - future studies should investigate these questions.

INTRODUCTION

There are numerous benefits associated with being physically active.[1] However, being physically active also presents a level of risk of injury to the individual - the incidence and severity of which is dependent on the *type* of physical activity.[2] [3] Of all popular sports, Rugby Union (henceforth "rugby") is associated with a relatively high incidence of injuries.[4,5] Rugby is also currently the most popular collision sport worldwide,[6] has an enormous participant base with 118 active international Unions, and enjoys particular popularity in South Africa with more than 600,000 players nationwide.[7]

Although rare and hence classified as "acceptable",[8] rugby is also associated with catastrophic injuries - the most severe and tragic of all types of injuries for the player, their family and friends.[9] In South Africa [7] the average annual incidence of rugby-related permanently disabling spinal cord injury was estimated to be comparable (1.0 per 100 000 participants) to other rugby-playing nations such as New Zealand, Ireland, Australia and the United Kingdom – thereby classifying the level of risk of these injuries in South Africa as "acceptable".[8] However, an early South African study [10] concluded that 56% of all rugby-related spinal cord injuries were *preventable*.[10] South Africa is not the only country to have reported "preventable" rugby-related catastrophic injuries [11].

As a result, various preventive programmes have been introduced in various unions to reduce the rate of catastrophic injuries.[12-14] *RugbySmart* of New Zealand, is a notable example of a nationwide catastrophic injury prevention programme that was associated with a significant reduction in scrum-related spinal injuries.[15] Based on the success of this programme, the South African Rugby Union (SARU) adapted and developed it's own programme, *BokSmart*, which was launched in July 2009.[16-17] The two programmes (*RugbySmart* and *BokSmart*) have recognisable similarities, such as their programme structures which educate coaches and referees in an attempt to prevent catastrophic injuries in players. However, the two countries present very different environments to the implementers of these respective programmes (New Zealand and South African Rugby Unions), with South

Africa still classified as a "developing nation" with huge socioeconomic disparity among players, coaches and referees.[18]

Therefore, the aim of this investigation was to examine the rugby-related catastrophic injury rates in South Africa before and after the implementation of the nationwide injury prevention programme, *BokSmart*.

METHODS

Design
Ecological study.

Data collection
Injury data have been prospectively collected by a joint initiative between the Chris Burger Petro Jackson Player's Fund (CBPJPF) and South African Rugby Union (SARU) since 2008 and has been explained in detail previously.[7] In short, a detailed questionnaire was completed by the BokSmart Serious Injury Case Manager (SICM) for every rugby-related catastrophic injury in South Africa (Appendix VI). There is incentive to report rugby-related catastrophic injuries in South Africa, as the CBPJPF provides financial assistance for these players. The detailed questionnaire gathered information about the player, as well as the event which caused the injury (including preceding events). Data that were analysed for this study were: ethnicity, event causing injury, outcome of injury (permanent or non-permanent), year of injury, site of injury (head or neck) and age group that the injury occurred in (junior or senior).

Permission to analyse the SARU/CBPJPF's database was granted by the University of Cape Town's Human Research Ethics Committee, with permission from SARU/CBPJPF to access their data.

Injury Definition and classification
SARU's catastrophic injury definition was as follows:
"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."

This definition includes injuries that fall under the current consensus statement for injury surveillance in rugby definition for non-fatal catastrophic injuries [19], as well as injuries that were thought to be catastrophic, but that recovered fully at a later stage ("near misses"), as well as fatal catastrophic injuries. It has previously been contended that "near misses" should be included in such a definition [20] for effective evaluation of prevention strategies. A recent UK study supported this view. [21] Cardiac events were not considered due to their very low incidence rate and the fact that the event might not be specific to the nature of rugby. Catastrophic injuries were classified into two different groups: Acute Spinal Cord Injury (ASCI) and Traumatic Brain Injury (TBI) and both of groups were comprised of permanent and non-permanent outcomes. These outcomes concern hospital-confirmed diagnoses within one month after the initial injury date as this time frame was thought to be able to provide an accurate diagnosis.

Although player participation numbers have been estimated for South Africa and have been used to estimate catastrophic incidence rates previously,[7] player numbers were not available for specific years. Therefore, one had to assume that player numbers had remained the same in all years of evaluation (2008 – 2013): juniors = 529,483 and seniors = 121,663 .

Statistical analyses

Owing to the count nature of the data, a Poisson regression was used to assess the time trend effect of the *BokSmart* programme on catastrophic injuries between 2008 and 2013. During data exploration, a Pearson Goodness of Fit chi-squared test indicated that considering the effect of the intervention as "pre-" and "post-*BokSmart*" would fit the data better (p=0.923) than using the intervention as a linear predictor (p=0.905) as was performed in the RugbySmart evaluation.[15] The years 2008 and 2009 were considered "pre-*BokSmart*" (2 years) because some of the 14 rugby unions only received *BokSmart* education in 2010. Thus, 2010, 2011, 2012 and 2013 (4 years) were considered as "post-*BokSmart*".

With this study design, the assumption is that only the *BokSmart* intervention could have affected injury rates. While *BokSmart* is not the only injury rate influencer, as a national federation programme it certainly has the single largest influence.

Furthermore, any national safety law or legislation in South Africa, such as change in the scrum engagement sequence, occurs through *BokSmart*."

Robust Standard Errors were calculated and presented to illustrate that over-dispersion (mean greater than the variance) was not present in the data [22]. All analyses were performed using Stata version 12.1 (StataCorp. 2014. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP).

RESULTS

Between 2008 and 2013, there were 71 rugby-related catastrophic injuries in South Africa (Table 1) at an average of 12 injuries per year. A maximum of 15 injuries occurred in 2009 (i.e. the year of implementation of the BokSmart programme) and minimum of 9 injuries in 2012 (the year prior to the implementation of the programme). Neck injuries (ASCIs) accounted for 87% of all injuries (n = 62 of 71). Of these 62 neck injuries, 57% (n = 35) had permanent outcomes (Table 1).

Table 1. Absolute numbers of Acute Spinal Cord Injuries (ASCIs) and Traumatic Brain Injury (TBIs) with non-permanent and permanent groupings.

	2008	2009	2010	2011	2012	2013
Neck (Acute Spinal Cord Injury)	**8**	**11**	**12**	**14**	**8**	**9**
Non-Permanent (+ not provided*)	4	5	5	4	4	5
Permanent	4	6	7	10	4	4
Head (Traumatic Brain Injury)	**2**	**4**	**1**	**0**	**1**	**1**
Non-permanent	0	2	0	0	0	1
Permanent	2	2	1	0	1	0
TOTAL	**10**	**15**	**13**	**14**	**9**	**10**

*Outcomes for which the hospital was still undecided as to the final diagnosis after one month

When examined by age group (junior/senior), the number of head/neck injuries was higher in juniors (n = 6) than in seniors (n = 4) in 2008 (Figure 1). After 2008, junior head/neck injury numbers decreased steadily until 2013 (n = 3), while these injury numbers oscillated between five and nine in senior players (Figure 1).

Initial analyses indicated that the effect of the intervention (*BokSmart*) was significantly different by age group (junior/senior). Therefore, an age/intervention interaction term was created.

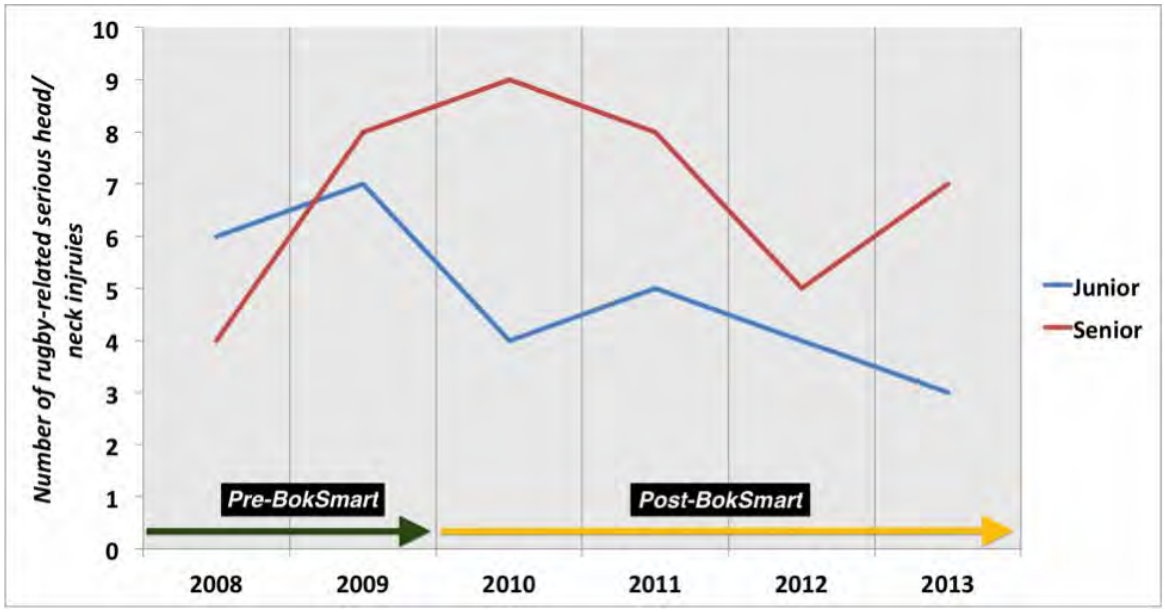

Figure 1. Absolute number of head (traumatic brain injuries/TBIs) and neck (acute spinal cord injuries/ASCIs) pre- (2008-9) and post-BokSmart (2010-13) implementation in South Africa. Note that the player that was of unknown age group was not included in these data.

After adjusting for the effects of age and the age/intervention interaction term, *BokSmart* was associated with a 39% reduction (IRR: 0.6, 95% CIs: 0.5 – 0.8; p<0.001) in the number of head/neck injuries in junior players (Figure 2). Although *BokSmart* was associated with a 21% increase in senior players, this change was not a significant increase (IRR: 1.2, 95% CIs: 0.7 – 2.0, p=0.481).

Similarly, the intervention was associated with a reduction in neck injuries in juniors, although this reduction was not statistically significant (IRR: 0.8, 95% CIs: 0.5 – 1.1, p=0.176). However, head injuries had reduced by 75% (IRR: 0.3, 95% CIs: 0.1 – 0.9, p=0.030). In seniors, BokSmart was associated with non-significant increases in neck and head injuries.

BokSmart was also associated with a non-significant increase in scrum-related neck injuries in juniors (IRR: 1.3, 95% CI: 0.4 – 3.6, p=0.681).

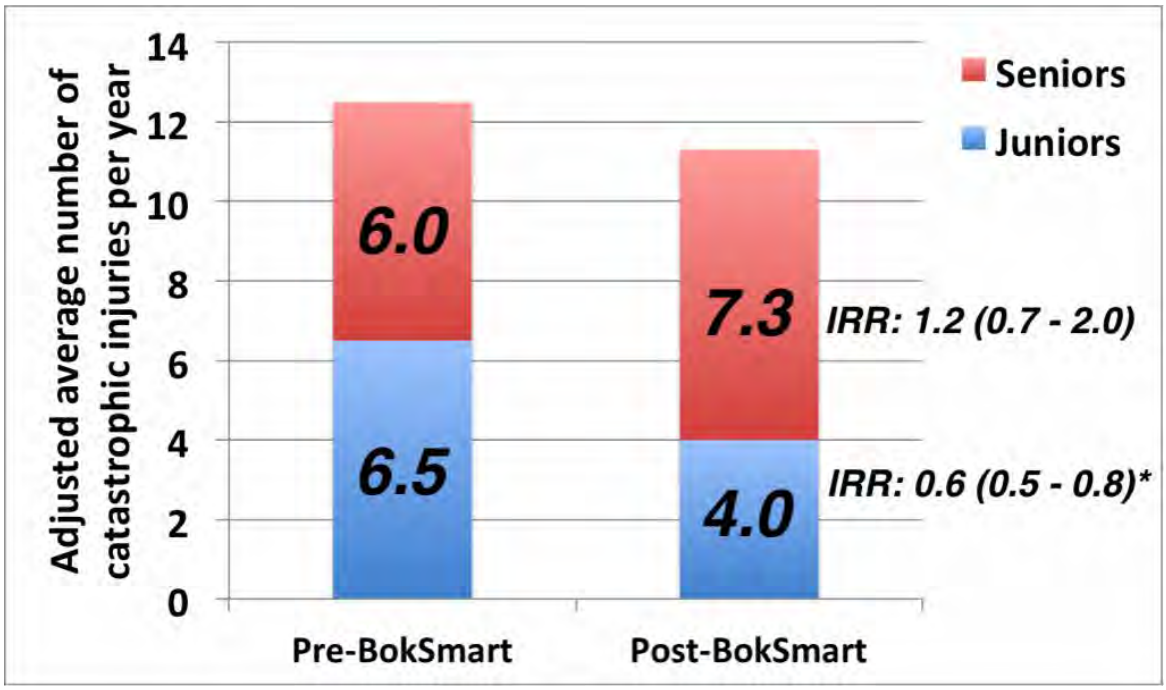

Figure 2. The change in the number of head/neck injuries per year pre-BokSmart compared with post-BokSmart, adjusted for age group (junior/senior). The injury rate ratio (IRR) is a comparison of injury numbers per year post-BokSmart in comparison to pre-BokSmart, and is within the two different age groups (junior/senior). *p<001

DISCUSSION

The main finding of the present study was that the implementation of the *BokSmart* programme was associated with a significant reduction in head/neck injuries in junior players, but not in senior players. This effect was evident after just fours years of complete implementation of the programme, which began in mid-2009. With the growing awareness of the programme and improvement in data collection, one could have expected an increase in injury rates as a form of a reverse Hawthorn Effect. [23] Similarly, the evaluation of *BokSmart*'s parent programme, *RugbySmart* of New Zealand also had a positive outcome. [15] However, the *RugbySmart* evaluation only showed a reduction in permanently disabling scrum-related spinal injuries, not all catastrophic (including "near miss") head/neck injuries as was the case with the present study.

Furthermore, there were distinct differences between the South African and New Zealand evaluation study designs. The South African evaluation included both permanent and non-permanent outcomes, while the New Zealand study only

included the former, more serious outcome. A recent study has justified the inclusion of non-permanent ("near miss") catastrophic injuries due to the valuable information these outcomes provide for injury prevention programmes, such as *BokSmart* and *RugbySmart*. [21] Secondly, the New Zealand evaluation had almost than 30 years (five years "post") of historical data in comparison with the data from 6 years (four years "post") of the present study. As a result, the New Zealand study was able to examine the effect of their intervention (*RugbySmart*) as a linear predictor, whereas it was more statistically accurate for the present study to investigate the effect of intervention as a dichotomous variable ("pre" vs "post").

Nonetheless, the finding in the present study of a significant effect of the intervention in junior, but not in senior player, populations was unexpected and concerning for *BokSmart,* considering that senior players are at greater risk of suffering a catastrophic injury in South Africa.[7] This finding could simply be an artefact of the greater population of junior players, and hence greater exposure. Catastrophic injuries were not corrected for player numbers and at the last estimate conducted in 2010 juniors outnumbered seniors by 5 to 1 in South Africa. An alternative/further explanation is that the *BokSmart* intervention could have been less effective in older age groups possibly due to a greater resistance of more experienced coaches, referees and players to adopt a safety programme. While there is no literature to support this assumption, future research should establish if there is evidence for this effect with the *BokSmart* intervention. It should also be noted that the classifications "junior" and "senior" describe the level at which the injury occurred – there may be cases where the player was too young/old for their particular age group, but this was not considered for the present investigation.

However, it is important to note that rugby coaches and referees, not players are the direct target of the *BokSmart/RugbySmart* interventions. [17,24] Thus, the assumption that the change in head/neck injury rates in players is related to *BokSmart* presumes that the intervention has the ability to influence coaches and referees, and that coaches and referees can influence the behaviour of players and their susceptibility to injury. As it is not feasible to have a control group, the authors can't rule out the possibility that injury rates may have reduced without the introduction of the BokSmart programme, although general injury trends in the sport

would indicate otherwise. [25] Additionally, in accordance with the ecological design used in the present Chapter, the authors could never infer that the introduction of *BokSmart* caused a reduction in injury rates, but simply that the programme's implementation was associated with this described reduction.

Owing to reasons described earlier, this study was underpowered to examine the effects of the intervention on site- (head vs neck) event- and ethnicity-specific outcomes. The discrepancy between *BokSmart*'s effect on head and neck injuries is evidence of this, when one would have expected neck injuries - which comprised the majority of all injuries - to follow the general trend. This could also explain the lack of evidence of an effect on scrum-related spinal injuries in the present study, as described in the *RugbySmart* evaluation. [15] Thus, continued evaluation of the *BokSmart* programme is justified.

CONCLUSION

The *BokSmart* programme was associated in this time trend analysis with a significant improvement in head/neck catastrophic injury rates in junior, but not senior players after four years. The lack of a finding at the senior level may be related to the different effectiveness of the intervention at this older age group, but this assumption needs to be confirmed with further research.

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7

THE *BOKSMART* INTERVENTION PROGRAMME IS ASSOCIATED WITH IMPROVEMENTS IN INJURY PREVENTION BEHAVIOURS OF RUGBY UNION PLAYERS

SUBMITTED

ABSTRACT

Introduction and objectives: Participants of rugby union ("rugby") have an above-average risk of injury compared with other popular sports. Thus, *BokSmart*, a nationwide injury prevention programme for rugby, was introduced in South Africa in 2009. Improvements in injury-preventing behaviour of players is critical to the success of an intervention. The aim of this study was to assess whether *BokSmart* has been associated with improvements in rugby player behaviour.

Methods: An anonymous knowledge, attitude and self-reported behaviour questionnaire was completed by junior (under-18) and senior (adult) tournament players who attended merit-based tournaments (2008-2012). The questionnaire was completed by 2279 junior players (99% of total estimated population) from 111 teams, and 1642 senior players (96% of population) from 81teams. A generalised linear model assessed behavioural changes over this time period.

Results: Nine (50%) of the behaviours improved significantly ($p<0.005$) between 2008-2012 and the remaining behaviours remained unchanged. Improved behaviours included the targeted, catastrophic injury-preventing behaviours of the intervention: practicing of tackling (adjusted overall improvement in odds: 56%) and; scrumming, in forwards only (58%), techniques. Other behaviours that improved significantly were: post-injury compression and elevation as well as alcohol avoidance; mouthguard use (training and matches) and; cooling down (training and matches). Practicing of safe rucking techniques; warming-up before training/matches; ice use; heat, massage and alcohol avoidance post-injury; and pre- and off-season conditioning remained unchanged.

Conclusions: *BokSmart* is associated with improvements in targeted injury-preventing behaviours in players. Future research should ascertain if self-reported behaviours reflect actual behaviour and if the observed improvements translate into changes in injury rates.

INTRODUCTION

Rugby Union (Henceforth "rugby") is one of the most popular team sports globally. [1] In comparison to other popular team sports, rugby carries a relatively high risk of injury. [2,3] As a result, there are numerous examples of injury prevention efforts that have been evaluated for their effectiveness at reducing this injury risk and include protective equipment trials, [4] law changes [5-6] and nationwide injury-prevention programmes such as *RugbySmart* of New Zealand.[7]

Player behaviour has been identified as the "key factor" underlying the success of injury prevention in sport.[8] However, there is only one example of an injury prevention programme for rugby where the behaviour of the intervention target has been assessed.[7] In that study, the *RugbySmart* programme was associated with improvements in self-reported injury-preventing behaviours, concomitant with the reduction in injury rates the same group of players.[7]

Thus, the South African Rugby Union (SARU) adapted and launched *BokSmart* as a nationwide injury-prevention programme in July 2009.[9] The programme aims to educate all rugby coaches and referees in safe and effective injury prevention methods for rugby.[9] SARU achieve this by teaching *BokSmart* educators who then disseminate the *BokSmart* content to all rugby coaches and referees. Coaches and referees are considered key role-players for injury prevention in rugby.[7] By educating these key role-players in South Africa, it was the expectation of *BokSmart* that the injury prevention behaviour of the players under the control of these coaches and referees would improve, as observed in the New Zealand evaluation.[7]

Therefore, the aim of this study was to assess if player behaviour has improved over a period of five years since the launch of the BokSmart nationwide injury-prevention programme.

METHODS

Study design and population

Data for this ecological study were collected through the *BokSmart* programme (www.boksmart.com), which is a joint initiative between the South African Rugby Union (SARU) (www.sarugby.co.za) and the Chris Burger/Petro Jackson Player's Fund (CBPJPF) (www.playersfund.org.za). The CBPJPF is a non-profit public benefit organization (PBO), developed to aid players who have been permanently disabled while playing rugby in South Africa. Permission to analyse the data was obtained, with SARU's permission, from the UCT Human Research Ethics Committee.

Between 2008 and 2012 SARU administered a "*knowledge, attitude and behaviour* (KAB)" questionnaire (Appendix II) annually to players at a junior and senior SARU tournament. Both tournaments were attended by teams representing each of the 14 rugby unions in South Africa. As attendance at a *BokSmart* course has been a mandatory prerequisite for coaching since January 2010, it can be assumed that by 2011 and 2012 all coaches of the surveyed players had attended a course.

The questionnaire was administered at a pre-tournament meeting and completed anonymously by the players. The players were high-level amateur players competing at a provincial tournament in their respective age groups: under-18 (junior) and open/adult (senior). It is important to note that the same group of players was not followed up each year, but rather the players attending these two tournaments between 2008 and 2012 were measured at each time point.

Between 2008 and 2012, a total of 112 junior and 84 senior teams attended these tournaments and were asked to complete the KAB questionnaire. Of these teams, 111 (99%) and 81 (96%) completed them in those age groups respectively. On average, a team squad comprised 22 players, providing an estimated 4 224 players from the 192 compliant teams. In reality there were 2 279 junior and 1 642

senior players that completed the KAB questionnaire between 2008 and 2012, providing a total of 3 921 completed questionnaires (93% of total estimated population). No information was available for those players at the tournament who did not attend the meeting at which the questionnaires were completed.

KAB Questionnaire (Appendix II)

Although the KAB questionnaire was not validated prior to use in this study, it was developed through use in the *RugbySmart* evaluation in New Zealand over a 10-year period which was considered sufficient piloting by SARU for the *BokSmart* evaluation. [7] The players were not asked to disclose their identity when they completed the questionnaire to improve the integrity of answers by eliminating fear of consequential action based on their answers. Thus, it is possible that some of the same players could be in the dataset more than once if they had competed in the tournament in consecutive years. There is however no way to assess this.

While it is termed a "KAB" questionnaire, the majority of questions actually investigate knowledge, self-reported behaviour (henceforth "behaviour") and perceptions (not attitude) of injury prevention (primary and secondary) practices of the players. All questions of the KAB questionnaire (appendix I) were grouped into five categories: demographics, behaviour, perceptions, education and knowledge (appendix II). For example, the "demographics" category included questions on age, ethnicity and year of completion; "behaviour" included questions on how players managed their previous injuries; and "perceptions/attitudes" included questions on which injury prevention practices were perceived to be important in reducing injury. The possible answers for each question of the KAB questionnaire (appendix I) are also provided in Appendix II.

The 18 injury preventing behaviours of the KAB questionnaire were subsequently coded as "correct" or "incorrect" behaviours, based on the respondent's answers and what *BokSmart* programme implementers (SARU) deemed as "correct". Besides those who were subsequently coded to have behaved incorrectly, the "Incorrect" category also included respondents who had not answered a particular question ("no answer"). This decision was made in conjunction with SARU prior to the analyses. The rationale for this categorisation was that the current research question focussed on "correct" (as determined by SARU) answers: thus all other

options were deemed "incorrect". If a particular questionnaire was comprised mainly (> 90%) of "no answer" answers. such a questionnaire was removed from the analyses. The eighteen "specific" behaviours (indicated in parentheses) were grouped based on expert opinion under five "summary" behaviours (Appendix II): *injury management* (ice, elevation, and compression use; and alcohol, heat, massage and exercise avoidance, post injury), *mouthguard use* (at training and matches), *stretching (*warming-up and cooling-down at training and matches), *safe techniques* (tackling, rucking, scrummaging), and *conditioning* (pre- and off-season). Besides this grouping, the *BokSmart* programme also identified two of these eighteen behaviours as "targeted behaviours" due to their potential relationship with catastrophic head, neck and spine injuries: i.e. practicing of safe tackling and scrummaging techniques.

Analyses

Although analyses have been performed on knowledge and perception components of these data, it was not possible to include these results in the current manuscript. A subsequent manuscript will describe the relationships between these knowledge and perception components.

As all behaviour questions had either a ‘‘Correct’’ (=1) or ‘‘Incorrect’’ (=0) outcome, they were therefore modelled with a Bernoulli distribution. [10] A logistic regression model was then fitted for each behaviour to assess whether the proportion of correct behaviours had changed over the time period: 2008 – 2012. Although the analyses could have been conducted as "before/after" the launch of the intervention, it was decided that using "year" as a continuous predictor might be more informative for providing feedback on the intervention.

Besides ‘‘year’’ (2008 – 2012), five other potential predictors were considered: age group, ‘‘age’’ (junior, senior); ethnicity, as questioned by SARU (White, Black, Mixed/Coloured, Other); Rugby Provincial Union, ‘‘Union’’ (n=14); position (back, forward, back/forward); perception of whether or not coaches should take a safety course, ‘‘safety’’; and perception of who was important to preventing injuries, ‘‘role’’ (‘‘Coach’’, ‘‘Referee’’, ‘‘Player’’, or a combination of these options). The predictor ‘‘role’’ was a combination of the three questions for coach, referee and

player as the answers were virtually identical for these three questions (data not shown).

A stepwise model selection approach was applied where Akaike's Information Criterion (AIC) [11] was used to select the predictors to include in each model to obtain the most parsimonious model for each of the 23 behaviours (18 behaviours and their 5 summary behaviours).

Once this behavioural model was established, a chi-squared test was used to assess which of the predictors were contributing statistically significantly ($p<0.05$) to the behaviour. At this point, any non-significant predictors/confounders ($p>0.05$) were removed from the model and the model was re-fitted to produce a final parsimonious and statistically robust model. Therefore, whenever a behaviour is stated to be "significantly different" over the 2008 – 2012 time period, this statement is made at the 95% significance level ($p<0.05$). All "significantly different" findings had lower 95% confidence interval bounds that were not less than 1: these data are also shown for interpretation.

In summary, the proportion change in correct behaviour that is described in the Results has accounted for these other five factors, if they were discovered to be significant confounders of the behaviour's relationship with year. The specific effects of these other five factors are not described here.

Both the unadjusted and adjusted (taking into account confounders described previously) correct behaviour proportions are reported for the time period (2008 – 2012) of interest. Note that the adjusted change over time is shown as an *average* annual change as the magnitude of absolute year-to-year proportional change was different depending on the relative proportions of the confounders for each particular behaviour. The overall change for the five years is calculated by extrapolating this average annual change.

RESULTS

Study population

The average age of junior players was 17 ± 1 years (mean ± SD), while senior players were 25 ± 4 years of age (Table 1). At the senior tournament, the majority of players were "white"(64%), while this ethnicity comprised just less than half of the respondents at the junior tournament. "Black African" players comprised 34%/15%; "coloured/mixed ancestry" players comprised 19%/21% and "other" comprised 1% at the junior/senior tournaments.

Table 1. Details of the junior and senior sample, including average age and proportions of white players, forward positions and those who had never had a sprain, previously.

	Junior (n = 2279)	**Senior (n = 1642)**
Age in years (mean ± SD)	17 ± 1 (n = 2162)	25 ± 4 (n=1586)
Ethnicity – white [a] (%)	46 (n = 2167)	64 (n = 1586)
Forwards (%)	54 (n = 2167)	55 (n = 1590)
Never injured [b] (%)	17 (n = 2161)	11 (n = 1559)
Coach safety [c] – yes (%)	87 (n = 2116)	87 (n = 1558)

[a] This was the ethnicity classification used by SARU in the KAB questionnaire (Appendix I)
[b] Players who answered "Never" to the question "When was your last Rugby ligament sprain or muscle strain?"
[c] Players were asked: *"Do you think it is important that your coach complete an annual safety course?"*

Player behaviour: 2008-2012

Overall, nine of the eighteen (50%) specific behaviours and four of the five (80%) of the summary behaviours improved significantly, after adjustment (Table 2 and Figure 1), while the remaining behaviours did not change significantly.

Table 2. Summarised and specific correct behaviour proportions in 2008 and 2012. Average and total odds, accounted for the effect of confounders, are also shown along with corresponding 95% confidence intervals.

	Unadjusted behaviour (%)		Adjusted odds for behaviour					
Behaviour	**2008**	**2012**	**Average annual change**	**95% confidence intervals**		**Overall change (5 years)**	**95% confidence intervals**	
Injury management	**87.6**	**83.8**	**1.07**	**1.04**	**1.11**	1.42*	1.21	1.67
Ice use	49.2	45.1	1.07	0.99	1.16	1.41	0.94	2.12
Compression use	33.1	31.3	1.09	1.00	1.18	1.54*	1.02	2.33
Elevation use	38.1	45.1	1.13	1.03	1.23	1.73*	1.15	2.61
Heat avoidance	40.6	35.0	1.04	0.95	1.14	1.13	0.74	1.72
Alcohol avoidance	62.2	57.5	1.13	1.03	1.23	1.81*	1.15	2.85
Exercise avoidance	42.3	41.4	1.04	0.95	1.14	1.23	0.78	1.93
Massage avoidance	20.7	21.2	1.02	0.92	1.13	1.10	0.66	1.83
Mouthguard use	**46.7**	**49.2**	**1.08**	**1.05**	**1.12**	1.50*	1.26	1.79
Training	29.5	33.4	1.10	1.04	1.16	1.60*	1.23	2.08
Match	44.4	46.9	1.08	1.03	1.13	1.45*	1.13	1.87
Stretching	**98.9**	**99.4**	**1.03**	**1.00**	**1.06**	1.17*	1.02	1.35
Warming-up (training)	97.3	95.8	0.92	0.81	1.04	0.66	0.35	1.23
Warming-up (match)	54.2	51.6	1.07	0.93	1.23	1.39	0.68	2.84
Cooling-down (training)	96.7	97.0	1.05	1.00	1.11	1.29*	1.00	1.66
Cooling-down (match)	51.8	49.6	1.08	1.02	1.13	1.45*	1.13	1.86
Techniques	**77.8**	**79.5**	**1.06**	**1.02**	**1.09**	1.31*	1.13	1.53
Tackle	49.1	52.2	1.09	1.03	1.14	1.50*	1.18	1.92
Ruck	62.5	62.3	1.05	1.00	1.10	1.26	0.98	1.62
Scrum (forwards only)	65.4	67.6	1.08	1.00	1.17	1.49*	1.00	2.23
Physical conditioning	**90.2**	**86.0**	**0.96**	**0.91**	**1.01**	0.81	0.63	1.03
Off-season	82.0	77.9	0.98	0.92	1.04	0.90	0.65	1.24
Pre-season	85.8	78.7	0.95	0.88	1.02	0.76	0.54	1.08

*Significant increase between 2008 and 2012 ($p < 0.05$).

Injury Management

Although the unadjusted proportion of correct behaviours deteriorated by -4% (88% to 84%). the adjusted odds ratio improved significantly between 2008 and 2012 (annual change in odds: 1.07 times, [1.04; 1.11]) (Table 2). This was due, in part, to significant improvements in the adjusted odds of compression of an injured limb (annual change of 1.09 times [1.00;1.18]), elevation of an injured limb (annual

change of 1.13 [1.03;1.21]) and alcohol avoidance post-injury (annual change of 1.13 [1.03;1.23]) (Figure 1). The alcohol avoidance was very high in juniors. All other adjusted injury management behaviours - ice use on the injured limb and heat and exercise avoidance post-injury - did not change significantly between 2008 and 2012.

Mouthguard use

The unadjusted proportion of correct behaviours for the summary behaviour improved by 2% (47% to 49%), and indicates that mouthguards were being used by less than half of all players at both training and matches between 2008 and 2012 (Table 2 and Figure 1). However, the adjusted odds ratio of the summary behaviour improved significantly (annual change in odds: 1.08 times. [1.05;1.12]) from 2008 to 2012 (Table 1). This was due to large significant improvements in the adjusted odds ratio of mouthguard use at both training (annual change: 1.10 times. [1.04;1.16]) and matches (annual change: 1.08 times [1.03;1.13]).

Stretching

While the unadjusted proportion of correct summary behaviour only improved by 0.5% (98.9 to 99.4%). the adjusted odds ratio improved significantly (annual change in odds: 1.03 times. [1.00;1.06]) from 2008 to 2012 (Table 2 and Figure 1). This improvement in the adjusted summary behaviour was due to significant improvements in the adjusted odds of cooling-down after training (annual change: 1.05 times, [1.00;1.11]) and matches (annual change: 1.08 [1.02;1.13]. The adjusted odds of warming-up behaviours did not change significantly at training or matches between 2008 and 2012 (Table 2 and Figure 1).

Safe techniques

The unadjusted proportion of correct summary behaviours improved by 2% (78% to 80%) and the adjusted odds improved significantly (annual change in odds: 1.06 [1.02;1.09]) from 2008 to 2012. This was due to significant improvements in adjusted behaviours of practicing of safe tackle techniques in all players (annual change: 1.09 times, [1.03;1.14]) and safe scrummaging techniques in forwards (odds ratio 58% larger in 2012 than 2008, annual change: 1.08 [1.00;1.17]). but not safe rucking techniques in all players (not significantly different over the same time period).

Physical conditioning

The unadjusted summary behaviour deteriorated by 14%. between 2008 and 2012, although the adjusted change was not significantly different over this time period. Both off-season and pre-season physical conditioning adjusted odds also decreased, although not significantly, between 2008 and 2012 (Table 2 and Figure 1).

DISCUSSION

The main finding of this study was that the implementation of the *BokSmart* programme has been associated with improvements in targeted catastrophic injury preventing behaviours (practicing safe tackling and scrummaging techniques) of players between 2008 and 2012. These two behaviours were identified as "targeted" by SARU based on the focus of the content included in their *BokSmart* programme. [9] The evaluation of *RugbySmart*, [7] also observed improvements in the proportion of these two correct behaviours (safe tackling and scrummaging) in players over a ten year period: these two behaviours were linked to the concomitant reduction in injury rates observed over the same study period. [7] Subsequent to this evaluation, improvements in behaviour of the intervention target has been identified as critical to the success of any injury-prevention programme, not just rugby. [8]

In total, the New Zealand *RugbySmart* programme evaluated five of the eighteen behaviours from their KAB questionnaire: 1. training of safe rucking techniques, 2. training of safe tackling techniques, 3. training of safe scrummaging techniques (forwards only), 4. warming-up and 5. cooling down. Of these five only warming-up did not improve over the 10 year evaluation (1996 – 2005) in New Zealand. However, this lack of a finding for warming-up was ascribed to the high proportion of players already performing this behaviour correctly at the start of the evaluation.

Table 3. Summary of whether adjusted change in odds of correct behaviours improved or remained unchanged in players between 2008 and 2012.

IMPROVED	UNCHANGED
1. Safe scrummaging*	1. Safe rucking
2. Safe tackling*	2. Ice use
3. Compression use	3. Heat avoidance
4. Elevation use	4. Massage avoidance
5. Alcohol avoidance	5. Exercise avoidance
6. Mouthguard use (training + matches)	6. Pre- and off-season conditioning
7. Cooling-down (training+ matches)	7. Warming up (training and matches)

*targeted behaviours of the *BokSmart* programme because of a potential relationship with catastrophic injury prevention (according to programme implementers)

Importantly, the KAB questionnaire (Appendix I) was designed upon the assumption that 18 behaviours are potentially capable of affecting injury risk in rugby players. While it is well supported in the literature that behaviour does underpin injury-prevention interventions, [8] it is possible that not all eighteen of these 18 behaviours are equally important for injury prevention in rugby. Of the non-targeted behaviours only mouthguard use has evidence for, but not against its relationship with the prevention of injury (dental claims) in rugby. [12] The adjusted odds of mouthguard use for training/matches improved significantly in this evaluation, although the unadjusted proportions were still less than 50% in 2012 (training: 32.1%, matches: 46.7%). This should be a concern for *BokSmart* implementers. Similarly, the finding that just more than half of all players warm-up before matches should also be of concern for implementers, despite this behaviour having equivocal evidence for it's relationship with injury prevention. [13]

Other adjusted odds of correct behaviour that did not improve in this five year evaluation were: ice use; heat, alcohol, exercise and massage avoidance; warming-up before matches and training; and pre- and off-season conditioning. Of these, only pre- and off-season conditioning, and warming-up before training had a possible explanation for a lack of a finding with high proportions of correct behaviour at baseline (2008). It is unclear whether these behaviours are related to injury rates, and thus whether *BokSmart* should be concerned with this finding. However, future *BokSmart* content should focus on those that are clearly associated with injury prevention evidence in the most recent literature.

The present study has a number of limitations. The behaviour measure was self-reported which means that the measure was not reflective of actual behaviour. This study was also not longitudinal in design – the improvement in behaviour was only at a population, and not individual, level. Also, the improvements may not only be as a result of *BokSmart*. However, nationwide interventions such as the *BokSmart* programme are concerned with effectiveness rather than efficacy and thus a population-based improvement is important to the success of the intervention. [14] Another limitation was the possibility that the same players were included in more than one years of assessment: due to the questionnaires being anonymous (to increase integrity of answers) this factor would be impossible to assess. However, due to the age- and merit-based selection criteria for these tournaments, it is unlikely that this was applicable to a large proportion. Also, due to the unspecific wording of the question (Appendix II), the possible confounding effect of a previous injury on a behavioural outcome could not be accounted for statistically. Possibly the most important limitation of this study is that it is not known whether an improvement in correct behaviour can cause a reduction in injury rates. Although this causal link was implied in the comparable evaluation of *RugbySmart*, the effect may be different in South Africa. Through the concomitant injury surveillance project that SARU began at these tournaments in 2011, it is hoped that causal link can be investigated by 2015. A particular strength of the present data was the high response rates of the questionnaire: 99 and 96% of the estimated total populations in junior and senior players, respectively. By comparison, the *RugbySmart* evaluation had response rates between 57 and 83%.[7]

CONCLUSION

The *BokSmart* programme was found to be associated with improvements in targeted injury prevention behaviour in players: practicing of safe tackling and scrummaging (forwards only) techniques. Future research needs to establish if these behavioural improvements are truly longitudinal and consistent with the players' coaches and referees. Furthermore, future research should also assess if these improvements in targeted injury-preventing behaviours translate into reductions in injury rates in these players.

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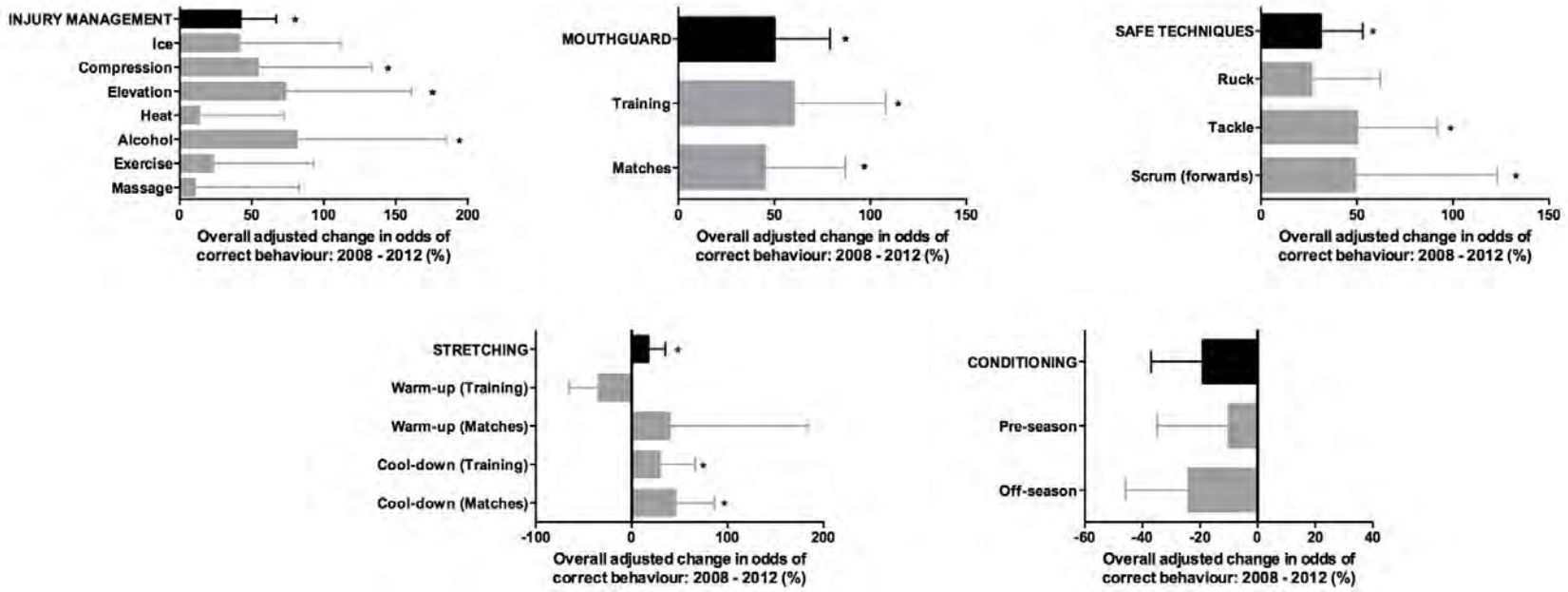

Figure 1. Changes in odds of correct behaviour proportions for Injury Management, Mouthguard use, Training of Safe Techniques (Safe Techniques), Stretching and Conditioning.

8

A QUALITATIVE EVALUATION OF THE COACHES' AND REFEREES' PERCEPTIONS OF THE *BOKSMART* INJURY PREVENTION PROGRAMME USING THE RE-AIM FRAMEWORK

ABSTRACT

Introduction and objectives: Rugby is associated with catastrophic injuries: the most severe and tragic of all injuries. In response to these injuries, the South African Rugby Union (SARU) developed and launched the *BokSmart* nationwide injury prevention programme. To be effective, *BokSmart* must be able to influence the coaches and referees attending the courses. The aim of this qualitative study was to gain insight into the perspectives of coaches and referees.

Methods: Focus groups were the chosen method as coaches and referees often work as a group. In South Africa, team league position closely correlates with socioeconomic status (SES). Thus, 'top' (high SES), 'middle' (mid SES) and 'bottom' (low SES) coaches (n=43 in total) were recruited from junior and senior age groups. Referees (n=7) were recruited in their own group as they work at all league levels (7 focus groups in total). Telephonic interviews were conducted with course trainers (n=14) to verify information gathered during the focus groups. The RE-AIM framework was used to analyse the data.

Results: All coaches and referees agreed that *BokSmart* was capable of reducing catastrophic injuries in players. However, coaches' perceptions were different depending on SES. High SES coaches' felt most of the course information was a waste of their time, and noted difficulties in altering coach and player behaviour. While mid and low SES coaches were more positive about the course, they also had an exaggerated opinion about their gain in knowledge from the course. The barriers that mid and low SES coaches described were more related to the lack of infrastructure that they felt impeded the programme's adoption. Referees felt incapable of policing all *BokSmart* regulations and felt that SARU should provide extra assistance for this. In general, most coaches, referees and trainers felt that the course could be shorter and more practical.

Conclusion: Although there was widespread positivity about *BokSmart*'s potential, the barriers identified in this study could be hindering optimal impact of the programme. These barriers may be different depending on the SES or league position of the coach.

INTRODUCTION

Rugby union (henceforth 'rugby') is currently one of the most popular spectator and participation sports globally.[1] In comparison to other popular sports, rugby is associated with an above-average risk of injury to participants and is associated with catastrophic injuries. [1,2] Although the risk of catastrophic injuries has been classified as "acceptable", [3] these injuries have tragic and long-lasting consequences for those involved.[4]

In response to catastrophic injuries, numerous countries have instituted nationwide prevention interventions such as the International Rugby Board's (IRB) *Rugby ready*, Australia's *SmartRugby*, and New Zealand's *RugbySmart* programme [5]. *RugbySmart* [6,7] was effective in reducing catastrophic injuries in the in New Zealand five years after the programme's introduction in 2001. [7] As a result of this success, *RugbySmart* was adapted for South Africa and launched in the country by the South African Rugby Union (SARU) as *BokSmart* in 2009. [8]

Using a DVD-facilitated educational session, the implementers of *BokSmart* attempted to directly influence the behaviour of coaches and referees ('researcher intervention' [9]). For coaches, this would include coaching safe versions of the tackle to their players and in referees this would include abandoning a match if there were no medical personnel present. Through these key role players (coaches and referees), SARU is trying reduce catastrophic injuries ('injury prevention intervention' [9]) in players.

Although qualitative evaluations of rugby injury prevention programmes exist, [10] no qualitative studies have, to our knowledge, specifically used the RE-AIM framework to qualitatively assess an injury prevention programme. Furthermore, no qualitative research has been performed on *BokSmart* or it's predecessor, *RugbySmart*. While quantitative methods can assess if *BokSmart* has been associated with changes in injury rates or knowledge, these methods do not allow researchers to consider how a programme might be working or not working within the intervention target groups (coaches, referees and players). [11]

Thus, the aim of this paper is to provide a qualitative evaluation of the implementation of the *BokSmart* programme from the perspective of the coaches and referees (intervention target) using the RE-AIM framework. The RE-AIM framework can be seen as part of the evaluation stages (5 and 6) of the TRIPP (Translating Research into Injury Prevention Practice) framework. TRIPP has been suggested for use in evaluating the ability of research to translate into real world changes in injury prevention (see Chapter 1). [18]

METHODS

BokSmart programme

To achieve its main goal of reducing catastrophic injuries in players through education of coaches and referees *BokSmart* has four main interventions. [8] The most prominent of these interventions is the Rugby Safety Workshops (RSWs), which take the form of a DVD-facilitated course that provides the attendees with the DVD and a printed version of the DVD at no charge. During the RSW, reference is also made to freely available online material (such as physical conditioning programmes) and the dedicated emergency telephone hotline, Spineline, for rugby-related catastrophic injuries. Since January 2010 it has been mandatory for *all* coaches and referees at all levels to attend an RSW on a biennial basis in order to keep their education current. [8] The RSWs are led and facilitated by SARU-employed 'trainers' who are nominated by their respective administrative regions (referred to as 'union'). The RSW content ranges from coaching drills through to injury management and a serious injury protocol.

The RSW content is updated every two years by SARU in order to keep content current. These updates also include relevant feedback from attendees: 'cycle 1' began in July 2009, 'cycle 2' began in July 2011, 'cycle 3' began in July 2013 and 'cycle 4' will begin in July 2015. SARU receives feedback on the RSWs as they require trainers to get three attendees to anonymously review the course in terms of content, interest in the course, perception of the trainer, and provide an 'overall' rating between 1 (poor) and 5 (excellent).

The average 'overall' course rating by coaches and referees for cycle 2 (2011-2013) was 4.7 for Western Province Rugby Union (WPRU).[12] The lowest RSW rating was 4.0 and the highest was 5.0. The average 'overall' course rating for cycle 2 for the rest of the country was 4.6 for the all fourteen unions, which included WPRU.

To the lead researcher, who had attended some RSWs and was involved with rugby coaching, these overwhelmingly positive SARU RSW evaluations from attendees did not reflect some of the negative opinions that the researcher had personally experienced. Therefore it was hoped that a qualitative approach might be able to provide some answers to these critical questions.

Study Design

This was a qualitative study, using focus groups and telephonic interviews to evaluate perceptions of attendees (coaches and referees) of the *BokSmart* rugby safety workshop (RSW). Initial perspectives were gained from the coaches and referees during the focus groups. Telephonic interviews were then conducted with the trainers – who facilitate the RSWs – to compare with the focus group findings from coaches and referees. *BokSmart* trainers are well-respected coaches or referees in their particular regions and are employed by SARU to facilitate the DVD-led RSWs in these regions. Before trainers are employed by SARU, they are required to pass through a rigorous screening, training and evaluation process.

There are large disparities in socioeconomic status (SES) among the population of South Africa's that are reflected in rugby-playing populations. [13] It was thought that SES might influence perceptions about *BokSmart* and thus sampling was performed in order to achieve representation from all SES groups. In rugby, SES is also closely associated with league performance. Thus, purposive sampling was used to select participants for one referee and six coach focus groups. The six coach focus groups were chosen to represent the 'top', 'middle' and 'bottom' league (and thus SES) divisions at both the school (juniors: < 19 years of age) and club (senior) age groups. Because referees are required to operate at all league division levels, it was felt that one focus group would sufficiently represent these role players. In summary, the focus groups were bottom school (BS), middle school (MS), top school (TS), bottom club (BC), middle club (MC), top club (TC) and referees (R).

Logistically, it was not feasible to conduct these seven focus groups in all fourteen rugby unions of South Africa. Furthermore, previous RSW evaluation data collected by *BokSmart* indicated that there were no differences in the quantitative perceptions between the 14 unions. Therefore, the Western Cape region with Western Province Rugby Union (WPRU) as its rugby governing body, was selected as the region to study based on proximity to researchers.

For the recruitment of coaches, a representative from potential clubs and schools in the WPRU was contacted and asked to participate in the study. For clubs was one of the top team coaches, while for schools this would be the teacher in charge of rugby. Only one school – a school that was requested to participate as the top school initially – declined the invitation citing 'lack of time' as their reason. The referees were approached through the WPRU Referees' manager who provided a mixture of experienced and inexperienced referees.

This study was part of a greater evaluation of the *BokSmart* programme, which also included quantitative studies. Ethical approval for the focus groups was granted by the Human Research Ethics Committee of the University of Cape Town (HREC REF 443/2011). All participants provided written informed consent for their participation. For the trainers' telephonic interviews and SARU RSW evaluations, data were collected and added to the BokSmart database. Permission was granted by the Human Research Ethics Committee of the University of Cape Town (HREC REF 438/2011) to access this database.

Data collection

Focus groups with coaches and referees

Rugby coaches and referees often work within a school or club structure and therefore we decided that focus groups would be an ideal method to gain insight into the established social norms within their school or club. [14] Focus groups place similar individuals – in this case, from the same school or club – together in a room and ask the group leading questions that are intended to generate debate and discussion among the participants. Through the discussion and debate that result from focus groups, one is able to gain insight into an individual's perspectives within a group structure. Although the SARU RSW evaluations were anonymous, it was felt that if the evaluators might fear repercussions from SARU if they provided negative

feedback, which would have affected the evaluation's integrity. Thus, to maintain the integrity and openness of the discussions, the researchers decided not to mention that the outcome of interest was an evaluation of the *BokSmart* programme. Instead, the researchers stated they wanted to ask prospective focus group attendees their opinions about catastrophic injuries in rugby. This topic was chosen as the prevention and reduction of catastrophic injuries in rugby is the main goal of the *BokSmart* programme, and therefore it was assumed these coaches and referees would mention the RSWs unprompted and without fear of repercussion from SARU. The researchers were concerned that if a group had experienced a catastrophic injury to a player, the questions and discussion could be a sensitive issue for the participants. However, focus groups are deemed appropriate for unlocking honest discussion from participants on sensitive topics. [15]

The focus groups were semi-structured with guide questions. The questions were prepared by JB and CD (experienced qualitative researcher) and approved by the programme implementers (SARU). The questions were then tested at a pilot session that included past and present coaches, referees and players. Based on this pilot, questions were then refined. For example, a question specifically asking if the group had experienced a catastrophic injury to a player was removed as it was deemed too probing. This version of questions was then tested on a group of coaches and edited once more before the final version was approved by all authors and the programme implementers (Supplementary material I). The lead author (JB) was the moderator for each focus group.

After an ice-breaker question, participants were provided with *BokSmart*'s definition of a rugby-related catastrophic injury verbally and in writing: "*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."* The actual questions ranged from asking participants about their perceptions toward rugby-related catastrophic injuries, to asking them what they would do to prevent catastrophic injuries if they were in charge of the rugby administration in South Africa. Participants were also posed with a hypothetical catastrophic injury situation and then asked how they would respond to such a situation at their particular school or club. There were between three and 12

coaches at all focus groups. Although a minimum of five coaches or referees were requested for each focus group, the BS only had three teachers involved in rugby and this was the total number of attendees for this group. Some of the attendees at the senior level were not currently coaching, but were senior players or administrators of the particular club. Most of the junior coaches also refereed – which was expected. There was lively debate between the participants of all groups, except for the BS. Of the coaches and referees, only one group (MS) had a coach (one of the five present) attend the focus group who had not yet attended a *BokSmart* cycle 1 or 2 RSW. This same group was the only group that had experienced a catastrophic injury in a player during a match – the participants mentioned this themselves, without prompting.

Telephonic interviews with trainers

The SARU-employed trainers act as intervention delivery agents of the *BokSmart* intervention and are not under any influence of the researchers. [9] Owing to their interaction with many different groups of attendees, these trainers have a unique and possibly more objective insight into the attendees' perceptions of the RSW and thus add to the opinions gleaned during the focus groups. Trainers run the RSWs individually and thus the researchers felt an interview approach would be more appropriate. Telephonic interviews are more time- and cost-effective and also elicit better responsiveness due to the shorter time demands in comparison to face-to-face interviews.[16] Furthermore, telephonic interviews are easier to use when the participants are geographically disparate. [16] In comparison to the coaches and referees, the nature of the questions to trainers had no risk of being sensitive in nature as the researchers only asked questions relating to perceptions of RSW attendees'. Of the trainers interviewed, one was female and two other trainers mentioned that they mainly taught in rural underprivileged/rural areas (although trainers are used for all areas). This information was volunteered, not asked of the trainers. These interviews were also semi-structured with guide questions that had been prepared by JB and CD. As these interviews took place after the focus groups, the questions were based on some initial data from the focus groups. For example, based on feedback from some coaches about trainers not doing a full course with them, the following question was included for trainers: "Do you always go through all the RSW content?" The full set of questions was trialled telephonically on two former

players and the questions refined based on this feedback. The final questions were approved by all authors and programme implementers (SARU). In this case, the trainers were specifically asked about their RSWs and response to the programme from coaches and referees (Supplementary material II). The questions asked trainers about their best/worst experiences while conducting an RSW, if they thought their RSWs were capable of changing knowledge and behaviour in attendees and if they had any suggestions to improve the RSWs. All 17 WPRU trainers were phoned, but only 14 were available for an interview. Although some trainers are designated to conduct RSWs in lower socioeconomic status areas, they are trained to run RSWs with attendees of all levels and were thus not purposively sampled or stratified. All sessions of the focus groups and telephonic interviews were audio recorded and then transcribed verbatim by a third party. These transcriptions were checked against the audio files for accuracy and edited where necessary (by JB). It was felt by the lead author (JB) that information saturation was reached in both the focus groups and telephonic interviews due to recurring themes.

RE-AIM framework for BokSmart

To organise the data, the perceptions were grouped into the five components of the RE-AIM framework. The RE-AIM framework [17] has been suggested for guidance in developing, implementing and evaluating intervention programmes. The framework component's accepted definitions (Table 1, column 2) [18] suggest the use of quantitative research methods, however it was felt these accepted quantitative definitions could be adapted for this present qualitative evaluation of the coach and referee perspectives of *BokSmart* (Table 1). While the *BokSmart* programme aims to ultimately prevent catastrophic injuries in players, the direct target of the intervention is actually the coaches and referees who attend the RSW ('researcher intervention') [9]. The adapted qualitative RE-AIM framework definitions for this *BokSmart* evaluation were therefore separated into coach/referee and player definitions (Table 1).

Table 1. Adapted RE-AIM framework for BokSmart qualitative analysis.

RE-AIM component	***Definition*** [18]	**Qualitative definition for coaches and referees**	**Qualitative definition in players**
		Coaches and/or referees (bold text indicates) perception that:	
Reach	*Proportion of target population that participated in the population*	**Both coaches and referees:** all coaches and referees have attended the RSW	N/A
Effectiveness	*Success rate if implemented as intended: positive outcomes minus negative outcomes*	**Coaches:** learn RSW techniques at the course. **Referees**: learn safe regulations at the RSW. **Both:** learn how to manage catastrophic injuries	**Both:** *BokSmart* can prevent and reduce catastrophic injuries in players
Adoption	*Proportion of people, settings, practices and plans that adopt the intervention*	**Coaches:** capable of coaching players RSW techniques. **Referees:** capable of employing RSW regulations. **Both:** capable of managing a catastrophic injury in a player	**Both:** players use RSW techniques and that players are aware of safer conduct towards other players.
Implement-ation (Delivery)	*Extent to which the intervention is implemented as intended in the real world*	**Both:** Educational trainer-led DVD session is enjoyed. Trainers are well respected.	N/A
Implement-ation (Content)	*Extent to which the intervention is implemented as intended in the real world*	**Both:** The RSW content is interesting and creates lively debate between coaches and referees.	N/A
Maintenance	*Extent to which the intervention is sustained over time.*	**Both:** continue to refer to the RSW material and upskill themselves with the BokSmart online content after the RSW	**Coaches:** players continue to use RSW techniques after the coach/referee initially instructed them.

Using an editing style of analysis, [19] all transcripts were read through twice before codes were developed, by the lead author (JB), under the general themes of "negative", "positive" and "suggestions for improvement". These codes were then re-organised based on the *BokSmart* qualitative RE-AIM evaluation definitions (Table 1) and presented in the Results section as such. The codes were developed by JB, but checked against the raw data by CD before proceeding. Transcripts were then coded using Atlas.ti Qualitative Data Analysis Software (Scientific Software Development GmbH, Berlin, Germany).

To improve the internal validity of the study, the coaches and referees codes were developed and organised first before this process was repeated for the trainer's

noting similarities and differences between the coaches/referees as the analyses progressed. This step was performed as a means of checking or triangulating the coach/referees' information.[19]

Before the study and for ease of reference, a 'majority opinion' was decided before to indicate more than 70% of the total groups. For the focus groups, this equated to an opinion being mentioned in five or more of the seven groups. For the trainers, this would equate to 10 or more individuals expressing a particular opinion.

RESULTS

Table 2 summarises the qualitative findings of the present study, using the RE-AIM framework to categorise these findings. The in depth description of these summaries are provided in the sub-headings below Table 2.

Reach in coaches/referees

Only the low SES (BS) coaches and the referees felt that *BokSmart* was missing coaches and referees who were should be attending the RSWs: while the coaches blamed SARU, the referees felt it was the individuals' rather than SARU's fault.

> *"…we must be careful also not to blame SARU too quickly. I think SARU is doing a good job and they can only do so much. They've implemented the BokSmart [RSW], but the thing is the communities aren't utilising those offers. SARU is advertising the BokSmart thing [RSW] but people aren't taking note of it, so we need to be careful as a community not to blame someone else, rather look at what we are doing first and then if we can actually get to those courses because there are courses offered."* (Referee)

The referees could have felt it was not SARU's fault as these teams are unregistered or unofficial teams that do not subscribe to any national federation requirements. However, coaches felt that it was SARU's job to engage these unofficial teams. These unregistered teams generally only exist in the lower socioeconomic areas of the country and this could explain why only low SES coaches raised this as an issue.

In contrast to this isolated view, there was a more general opinion from bottom and top SES coaches (BS, BC, TC) as well as referees that other role-players, besides coaches and referees, should be required to attend RSWs. The reason for including these role players were to instil a greater sense of responsibility for player's injuries, in parents of players (BS + R) and players themselves (BS). Some trainers also mentioned that parents should be required to attend the RSW and noted that

attendees who were coaches that still also played the game improved their behaviour and also made the *BokSmart* content more relevant for other attendees of the course.

The low SES (BS) coaches also felt that the awareness of *BokSmart* should be increased in the general public through advertising as has been done for other nationwide interventions such as those for preventing HIV/AIDS. The fact that this suggestion was only made by lower SES coaches may imply that the awareness of *BokSmart* is greater in higher SES areas. To increase awareness of the programme, trainers suggested using the big screens at big rugby stadia during matches or in build-ups to big matches on television to increase awareness.

Effectiveness in Coaches and referees

Over two thirds of the coach groups from all SES levels (BS, MS, TS, MC), as well as the referees and trainers mentioned that the RSW increased their *awareness* of catastrophic injuries in players. Furthermore, a catastrophic injury event to one of the MS coach's players gave this coach an increased sense of responsibility for his players and made him more of an active participant in the second RSW he attended:

> *"I went to the BokSmart, the first BokSmart I didn't ask much questions, I went to the second BokSmart I asked all those questions. Why? I was confronted with it [a catastrophic injury to a player] and when I go to a field to play a match I must make sure is it conducive for rugby, is my child safe?"* (Coach, middle school)

However, the perception that the RSW had the ability to change attendees' knowledge differed by SES level. The less privileged coaches (BS and MS) were certain that the RSW was able to improve the knowledge of attending coaches/referees. In contrast, the more privileged coaches (TC coaches) felt that attendees did not remember the course information. This difference could be explained by the different perceptions toward the RSW of the coaches from the different SES levels: while the lower SES coaches (MS) felt proud to be attending the RSW, some high SES coaches (TC) described the RSW as a "waste of time" for experienced coaches like them. This was consistent with research in South Africa that showed that high SES coaches are more likely to rely on their coaching colleagues, watching rugby and "their own playing experience" than workshops for coaching information. [20] As rugby was historically viewed as a game for privileged individuals in South Africa, [21] it is likely that playing experience is more common in

high than low SES coaches. Trainers confirmed this discrepancy: just over a third indicated that the RSW knowledge gain was better in low SES than in high SES coaches.

> *"… you can do the course [BokSmart] but it goes in here and out the other side."* (coach, top club)

> *"I mean its more of a safety course, but the people who are new to the game are excited, they learning technical things, they see it as even a form of qualification, they proud of it…I mean if you played rugby your whole life and coached your whole life it [RSW] can be monotonous to a degree."* (Trainer)

However, one of the trainers also mentioned that if the pre-existing rugby knowledge of attendees was too low when they arrived at the RSW, the content would be meaningless to them as they would not understand the terms used in the RSW DVD.

Of concern was that the perception of knowledge gain in the lower SES coaches may have been false in some instances. For example, the lower SES (MS) coaches were convinced that they knew the emergency number to contact in the case of a catastrophic injury in a player, but one of the them mentioned "911" which is not prescribed by the RSW and does not exist as a telephone number in South Africa. These MS coaches also stated that the RSW should provide coaches with a set protocol for dealing with a catastrophic injury, even though this is exactly what is described in the RSW already. The lower SES (BS and MS) coaches said they needed physical conditioning equipment, while the RSW provides access to online physical conditioning programmes that do not require any equipment. This discrepancy in perceived and actual knowledge gain from the RSW was despite the MS coaches feeling that they had learnt more in their RSW as a result of having experienced a catastrophic injury to a player previously.

The same group of coaches (MS) also indicated that they would like to learn more and suggested that the RSW should pose a hypothetical catastrophic injury situation to attendees (as was performed in the focus group sessions) to increase knowledge gain. The referees also suggested that the events surrounding a catastrophic injury be shared and discussed so that others might learn from mistakes or possible

preventable situations (de-briefing). One of the trainers also suggested this 'de-briefing' to improve knowledge about rugby-related catastrophic injuries.

Effectiveness in players

Despite these mixed feelings about the RSW for coaches and referees, the majority of coaches across all SES (all except TS), as well as the referees thought that *BokSmart* was a good way to reduce, prevent or minimise catastrophic injuries in players. However, they did not mention at which SES level they thought the RSW was effective. Based on previous opinions, it could be assumed that the high SES coaches perceived the effectiveness to be in low SES area. A few of the trainers confirmed this positive perception of the main goal of the *BokSmart* programme:

> *"I do think that with the programme that they put together [RSW] it's definitely going to help to lessen the amount of catastrophic injuries."* (Referee)
> *"I think the implementation of the* BokSmart *programme is definitely ... they're definitely trying to help improve the standards at schools and clubs wherever rugby is being played. I do think that with the program that they put together it's definitely going to help to lessen the amount of catastrophic injuries."* (Coach, top club)

Adoption in Coaches/Referees

Adoption is a particularly crucial component as the anticipated outcomes of a particular behaviour is an important barrier or facilitator for behaviour change.[22] The low SES (BS) coaches were the only coaching group who showed evidence of adopting RSW techniques and also felt this resulted in a reduction in catastrophic injuries. In contrast, the more privileged coaches (TC) implied that coaching these RSW-techniques was difficult. This difference in adoption could be explained by previously discussed differences in perceptions towards the RSW from the different SES groups: while low SES coaches had positive perceptions, high SES coaches had negative perceptions of the RSW. However, this difference in perceived adoption could also reflect greater self-awareness in the high SES coaches as the RSW techniques are inherently complex due to the nature of rugby. Also, that coaches did not mention coaching RSW techniques does not eliminate the possibility that they are coaching RSW-prescribed techniques unwittingly. For example, one a high SES (TC) coach described doing RSW-prescribed scrummaging training in their players despite mentioning that the RSW information "goes in here and out the other side" ('Effectiveness in coaches'). A few of the trainers supported this notion that low SES coaches were more likely to adopt RSW-prescribed behaviours than high SES coaches. Nonetheless, the majority of trainers

felt that, in general, they had positively influenced their coaches' behaviour during the RSW.

> "*Being Boksmart [certified] is one thing, but actually being able to coach it is another thing and that's also a big issue…*(Coach, top club)

> *"…you know I had one the other day: there was an injury and the guy [coach] said 'you must stop the game' and I said 'Ja, we've both signed a code of conduct so therefore you must know that the players are more important than the result of the fixture – it's not a world cup final'…"* (Trainer)

Referees also showed evidence of adopting RSW techniques and they mentioned specific instances of delaying the start of games if there were no medical personnel present and also felt capable of removing a player if they thought he was injured, even if the coach did not agree.

All coach groups except for the low SES (BS and BC) coaches stated that knowing how to deal with a catastrophic injury at a practice session was something they did not need to worry about as coaches. This was related to the fact that higher SES teams usually have medical support on duty to deal injuries at training and matches. However, there seemed to be confusion across all coach SES levels (BC, MS and TC) about what the RSW intended coaches to do in the event of a catastrophic injury to a player. Some of the lower SES coaches (BC and MS) thought the RSW intended for them to actually *treat* the catastrophically injured player themselves and thus felt that the RSW did not prepare them with sufficient 'first aid' training for this responsibility. However, the confusion could be explained by differences in resources available to coaches at the different SES levels. This discrepancy was highlighted by a debate among the TC coaches: while some felt that a coach would only get in the way of the medical staff, others who had previously coached lower SES teams stated that this catastrophic injury management responsibility was forced upon coaches at lower levels as they did not have adequate medical support. To correct this confusion, the RSW-prescriptions would have to be tailored based on the SES or league level of the attending coaches. Basing the course on league level would be less discriminatory that SES level. Furthermore, research on how coaches prefer receiving information indicates that aspiring top level coaches require different methods of teaching than other coaches. [23]

All coach groups (except BS) as well as the referees mentioned that they would attempt to stabilise the injured player until the emergency services had arrived on

the scene. However, half of the coach groups at middle to high SES levels (MS, MC, TS) specifically mentioned that they would not touch the injured player, although this was for different reasons: a lower (MS) SES coach, who had previously experienced a catastrophic injury to a player, said that he would "run away" from a catastrophically injured player, as he would not know what to do in the situation. This is particularly concerning because the same coach felt that he had learnt a lot from the previous RSW based on his previous injury experience. In contrast, the TS and MC coaches' hesitation in getting involved was related to fear of legal repercussions that are more of a reality at higher, but not lower, SES levels.

The middle SES (MS) coaches felt that just knowing the correct number to call was sufficient to deal with a catastrophically injured player, although they did not mention Spineline – *BokSmart*'s free emergency number for catastrophically injured rugby players that is described during the RSW. This is consistent with the findings in these MS coaches: while they perceived that they had gained knowledge from the RSW, they did not actually exhibit any knowledge gain on the topic of catastrophic injury management.
All coach and referee groups mentioned calling an ambulance in this event, and all except MS coaches mentioned that they would call Spineline. The BS even mentioned that their players know the number and would call it in the event of a catastrophic injury. However, it was evident that not all group members actually knew the actual Spineline number (0800678678) even though the said they would call it. There was a suggestion from TC coaches to add the Spineline number to the *BokSmart* certification cards that coaches are expected to carry with them at all times to increase it's awareness and use.

High SES coaches (TS and TC) felt that referees do not or can not enforce *BokSmart* regulations – the referees also mentioned this in their group. For example, RSW prescribes that referees are supposed to check that the coaching staff of both teams have *BokSmart* certification cards and that these certifications are current (not expired) before allowing the match to begin. A coach can only obtain a current certification card if he/she has attended a RSW within the previous two years. The TC and TS coaches said that they had never had these certification cards checks by referees, and even if they did happen, the punishment for not having one would not

be harsh enough to make them worry. The trainers reiterated this lack of policing of *BokSmart* cards and that this could be detrimental to optimal RSW adherence. TC coaches also felt junior and inexperienced referees were less likely to be able to able to enforce RSW regulations. The reasons that only high SES coaches mentioned this lack of policing of certification cards is unclear – it could either indicate that policing is only performed for lower SES teams or that lower SES coaches are unaware of the lack of policing. The referees confirmed this notion that they were unable to regulate certain RSW prescriptions. A difference in how this issue was perceived by coaches and referees was that some of the referees felt that SARU should not leave it to referees to police the coaches.

> "*I think it's a little bit unfair to give that [job of assessing whether field/pitch is up to RSW-prescribed standards] to the third team referee. Remember that third team ref is a junior; he's an inexperienced referee to deal with that...*" (Referee)

Both low and high SES coaches (BS and TC) felt that RSW regulations, in general, should be randomly assessed by BokSmart or SARU-appointed 'policemen' rather than referees and also not just restricted to match days but also practices as well.

Adoption in Players

The high SES senior coaches (TC) felt that junior (school) players were easier to influence than senior players. This opinion could well have emerged from personal experience as senior coaches have generally progressed from junior to senior teams during their career. If the negative perception of the effectiveness of the RSW has been transferred from the high SES coaches to their players, then the players' perceptions of the RSW could be also be influencing their adoption.

> *"…a kid is going to trust his coach, I mean at school. I mean you can tell an oke [junior player] to do flipping whatever and the oke [junior player] is going to listen to you…"* (Coach, top club)

This was in contrast to low and mid SES coaches who only considered external influences on players as having an effect on their adoption, rather than the players themselves. The high SES coaches also felt that lack of resources would affect adoption in low SES teams. BS and MS coaches felt that rugby players that their players watched on television and lack of infrastructure negatively influenced players' adoption. With regards to role-models influencing injury prevention behaviour – the FIFA 11 programme has only mentioned the positive effects role-models can have in enhancing adoption, [24] but it is clear from this study that they can also have a negative effect. With regards to infrastructure - while the BS

coaches mentioned that they could not teach RSW scrumming techniques without grass fields, the MS mentioned that their players' lack of access to fitness centres limited their adoption. While some of this socioeconomic-related negativity is a reality of the disparities which exist within South Africa, there were instances where underprivileged coaches seemed to be using it as an excuse. For example – only having a sand field to practice on is a valid barrier to not being able to adopt the coaching of RSW scrumming techniques and this barrier could only be removed by providing better resources for this team. However, a lack of an ability to perform physical conditioning is more of a perception than a reality as the RSW provides coaches with a conditioning programme that does not require a gymnasium or any gym equipment. Trainers confirmed this perception of the negative influence of role models on young players, which affected the coach's ability to influence their behaviour, particularly during matches:

> *"… there was two tackles on Saturday that the guy who tackled had his head on the wrong side, when he got injured… Now, I'm talking about when you busy with u11s and u9s, that's fine in theory to show them how to tackle, where to have your head, but when it comes to the big game, the big guys [international players on TV], the big boys just tackle [with no regard for correct technique] so…as a coach, you coach these things [correct, BS, techniques], but when the players go on the field, they just do their own things sometimes.* (Trainer)

There were both negative and positive opinions about player regulations. While coaches across all SES (MS, BC, TC) as well as the referees mentioned that RSW regulations enable coaches and referees to keep their players safer, some mid to high SES senior coaches (MC and TC) also felt that certain RSW regulations were unnecessary. A TC coach mentioned the 'age-banding law' (players participate with fellow players within two calendar years of each other) as an example of an unnecessary law, although there was disagreement among his peers about this opinion. The TC coaches also mentioned that the internationally regulated scrum engagement sequence was endangering their players and that this law needed to be changed to keep their players safer.

Implementation in coaches/referees (delivery)

Mid and high SES coaches felt that making the RSW compulsory created problems in attendees, although their reasons were quite different. Mid (MS) coaches were concerned that coaches developed an inflated sense of their capability as a coach – this lack of self-awareness of mid and low SES coaches was also demonstrated in the effectiveness and adoption of RSW. In contrast, high SES (TS) coaches were

concerned that because coaches were not able to attend voluntarily, it was negatively impacting their perception of the RSW. High SES coaches also felt that to achieve its goal of reducing catastrophic injuries, SARU's BokSmart resources would be better invested in improving the poor resources of low SES teams than in delivering a nationwide standard safety course (RSW). However, one of the trainers felt that telling people that course attendance was legislated and compulsory was the only way to get attendees to sit through the RSW. However, just because the RSW is compulsory does not necessarily indicate it is being effective or adopted, as has been indicated in previous sections.

Furthermore, the mid and high SES coaches as well as referees felt that some of the negativity of the RSW was caused because the RSW was advertised as a safety course, which wouldn't interest prospective attendees. To relieve some of this negativity, these groups suggested that the RSW should be advertised as a coaching or refereeing course that showed coaches and referees how to perform their roles in an effective manner that also happened to be safe for the players instead of labelling it as a safety course only.

Having said this, coaches from all SES teams (except BC and TC) felt that the RSW would be largely unnecessary if SARU improved their existing coaching and refereeing courses. Furthermore both coaches (TS) and some of the trainers felt that there would be better engagement and learning at the RSW if attendees were required to attend a good quality coaching or refereeing course as a pre-requisite to attend the RSW. This would also prevent the issue raised by trainers of certain RSW attendees having insufficient knowledge to be able to understand the course content that was raised by some of the trainers. Low to mid SES coaches may not have mentioned this as they possibly see the RSW as more of a coaching course than a safety course.

> *"… if you are a good coach and you coach properly and you know the correct techniques and everything, it will help, it will go a long way to prevent injuries. So by helping the coaches coach properly - coaching the correct techniques coaching winning rugby - you will prevent injuries. That is my opinion. So the focus should actually be on the coaching courses: level I, II and III that the unions offer because if those were good, well structured, run by the right people, you wouldn't have injuries…well you would still have injuries but it cut down a lot of the injuries."* (Coach, top school)

While high SES (TC) coaches mentioned that the RSW was long in duration, this opinion was not echoed by the low or mid SES coaches. Although this could be related to the opinion of the high SES coaches' opinion that the course was unnecessary for them, about two thirds of trainers expressed that attendees felt that the RSW was too long. Trainers mentioned a variety of sections of the RSW that were perceived to be superfluous by attendees, although these probably differed by SES of the attendees: drills in general (especially ball carrying/evasion), code of conduct and sponsorship sections.

Just over half the trainers specifically mentioned that the RSW was too long for re-certifying attendees – attendees who had previously completed a course. The trainers mentioned that these re-certifying attendees felt entitled do a shortened 'refresher' version of the course, rather than the entire course again two years later. While the low SES (BC) coaches and referees thought the fact that the RSW accreditation only lasted two years was good, one of the trainers suggested that this was too short and even implied he thought SARU did this for financial gain. Given their lack of resources, it is not surprising that low SES coaches wanted more regular training – this is in contrast to high SES coaches who felt the RSW was largely unnecessary for them and that they didn't ever want to do the RSW again. Another trainer thought that coaches really enjoyed the RSW in general, but then said they enjoyed it more when doing the course for the first time rather than a re-certification

> *"their [re-certifiers] argument…is that they did a four hour course before [for cycle 1], now they doing another four to five hour course [for cycle 2]…material that's overlapping [with previous cycle's]…can't it be a refresher course where its maybe like two hours for them or less than four hours or even get new material for them, then you just touch on the previous [cycle 1] material…"* (Trainer)

All coach groups felt that the RSW training should be more practical in general, including the catastrophic injury management component. They felt that coaches would respond better to practical, rather than theoretical, training. A few of the trainers also mentioned this desire for more practical training for their attendees. This is in contrast to Canadian coaches who, even when presented with a practical option, chose formal courses (such as RSW) as their ideal method of input. [23] Other ideal methods chosen by Canadian coaches included interaction with other

coaches and being mentored by a senior coach. The high SES (TC) coaches and trainers also suggested the addition of a practical first aid component for non-rugby players to the RSW who could to assist with first aid at rugby games. Logistically, these suggestions would be very costly for SARU to implement.

> *"…there's no practical [component to the BokSmart RSW] at all…it was just in the classroom environment…it was just all theory. You know we should be on the field, being shown how this is what you do when you believe there is a neck injury or whatever as opposed to…here's a video..." (Coach, top school)*

All trainers who were asked the question (n=13) stated that they went through all the course material that they were required to during their courses. Furthermore, there was a feeling from a few trainers that any negative feelings towards the RSW from attendees were alleviated once they actually sat through the course. However, the TC coaches stated that not all trainers did the full five-hour RSW and sometimes just gave the attendees the material to look at in their own time and were "not the sharpest" implying the were not as well respected as SARU required. Some of the trainers were aware of other trainers not doing a full course:

> *"I spoke to a guy who's attending cycle 2 course and he said his cycle 1 course was only 1.5 hours…so then you not doing an effective job of it!" (Trainer)*

Although these may be isolated cases, the lowest rating for a course in WPRU was 4 out of 5 (5 = 'excellent') indicating that these perceptions are not also being reflected in the SARU review process. This suggested that SARU should consider supplementing the existing review process with a qualitative assessment as well.

Although SARU deliberately places coaches and referees together for the RSWs to create lively discussion between these two groups, there was no mention of this actually happening from the coaches or referees. However, a few trainers reported good discussion between coaches and referees that facilitated learning between the two groups with sections such as the *QuickSmart* quizzes (quiz which tests the attendees' knowledge) and new scrum laws. Two of the trainers stated that there was no lively discussion due to the attendees wanting to not increase the already long course duration. One of the trainers suggested separating the coaches and referees as he felt that a lot of the content was not applicable to the referees.

Implementation in coaches and referees (content)

A third of the trainers described that they had only ever had positive reactions from RSW attendees about the content and that attendees thought the content was really good. While one trainer felt that attendees did not enjoy the safety content specifically, two other trainers described how attendees actually enjoyed this particular content. However, all referees and the majority of coaches, including high SES coaches (but not BC and MC) thought the RSW was teaching them correct techniques for safer rugby. This was despite the negative perceptions of the course previously. A high SES (TS) coach suggested focussing the content of the RSW on the highest risk areas of the game for catastrophic injury (e.g. scrum and tackle) and leave out all other information from the RSW.

> *"They did highlight in the BokSmart course quite a lot… they went over the tackle quite a bit and they showed that the best way to tackle is often the safest way to tackle. And it worked in a lot of other situations." (Coach, top school)*

Maintenance in coaches and referees

Trainers mentioned that the coaches/referees never look at the material again after leaving the course. However, low and mid SES (BS and MS) coaches showed evidence of using the course materials. This was expected based on the difference of opinions of the RSW from high and low SES coaches and the fact that low SES coaches would have less resources. Referees also mentioned using the using the RSW concussion checklists at matches that are provided during the course. However, the low SES coaches (BS and BC) felt that there should be more regular workshops (e.g. monthly meetings) on topics ranging from practical sessions for dealing with a catastrophic injury through to the latest recovery methods for players so that the coaches could continually up-skill themselves. This was also expected based on their general excitement about the course and lack of resources at this level. Trainer's supported this suggestion of more regular workshops and this option would also provide the opportunity for coach interaction, which is a preferred method of training.[23] The low and mid SES (BS, MS and MC) coaches also thought that there should be more access to databases and educational resources for coaches. A TS coach felt that the *BokSmart* conditioning programmes, which are freely

available online, needed to be advertised better to the general public as the majority of the TS coaches were unaware of them.

> *"I sometimes put the BokSmart [RSW DVD] in my laptop TV and watching it at the game, then we analyse the wrong and the right things that have been done…then we minimise [catastrophic injuries]…" (Coach, bottom school)*

DISCUSSION

This is the first qualitative study to describe the perceptions of an injury prevention intervention, from the perspective of coaches and referees (intervention target), using the RE-AIM framework. The main finding of this study was that the implementation of *BokSmart* elicited both positive and negative perceptions in coaches, but that these perceptions differed by the SES of the coach. *BokSmart* uses coaches and referees as delivery agents for the intervention that is aimed at reducing catastrophic injuries in their players. Thus, any negative perceptions in these intervention targets represent a potential barrier to the success of the programme as was described for a similar intervention in rugby union [10] and ice hockey coaches. [25] Understanding these perceptions, as well as the differences in perceptions, is critical not only to the on-going success of the programme, but also for the design and implementation of similar interventions in future.

In general, the high SES coaches were more negative about the RSW than that the low SES coaches for all components of the RE-AIM framework. The high SES coaches' negativity may have been related to a perception that they were at low-risk of experiencing a catastrophic injury to a player. This assumption of high SES coaches could have been made based on (1) a long period of time involved in the game without experiencing a catastrophic injury, [26] and (2) a comparison to their low SES coach counterparts which would result in a relative perception of low risk. There is some evidence to support this perception of the high SES coaches that low SES coaches are 'high risk' groups for experiencing a catastrophic injury in South Africa [27]. Risk mitigation in sport suggests that national sport federations should identify and focus on these high risk groups. [2]

However, there is a danger that these high SES coaches are underestimating their true risk of experiencing a catastrophic injury – while the risk is low and acceptable,

it is certainly not absent. [3] Ignorance of this fact could compromise optimal management of these rare events, if they occurred. For example, when a catastrophic injury occurred to a professional, 'low-risk', player recently the medically qualified personnel did not react to the situation optimally despite their medical training. [28] Although UK class classifications are different to SES, the present study findings are also contrary to a study on flood risk in the UK that found higher SES individuals had a better awareness of their true flood risk. [26] To improve awareness and knowledge, the suggestion from referees to discuss depersonalised information about catastrophic injury from a "what could have been done better" perspective may be worthwhile to improve reflective learning in coaches and referees. [29] Nonetheless, this perception of low risk of high SES coaches may cause the negative perceptions about the Effectiveness of the RSW – as with their assumed very low risk of injury, they feel the RSW information is not necessary for them. This negativity about the Effectiveness of the RSW in the present study could be underpinning their negativity observed in other RE-AIM components for high SES coaches such as Adoption, Implementation and Maintenance. This relationship between RE-AIM components in the high SES coaches might also explain the positivity of the lower SES coaches as well as referees in all these RE-AIM components.

However, positive perceptions of RE-AIM components may not be sufficient for intervention success. Despite their positive perceptions, the low SES coaches appeared to have a lack a self-awareness that meant their perceptions of Effectiveness and Adoption did not always match their knowledge and behaviour. The only difficulty the low and mid RSW coaches mentioned with adopting RSW techniques was related to their lack of resources which appeared to dominate their perceptions. Furthermore, a greater awareness of catastrophic injury risk – particularly in the coach group that had experienced an injury to a player recently – did not necessarily appear to improve Effectiveness and Adoption of RSW prescriptions in the mid SES group. The low and mid SES positivity towards the RSW could also have been inflated by their inherent lack of resources and access to materials. Thus, these groups may be positive about any free training and materials that they receive, not just the RSW material.

Making the RSW a practical course could solve some of the issues discussed, although this may not be logistically feasible with an approximate 45,000 coaches and referees that need to be trained on a biennial basis in South Africa. This suggestions is also not supported by international literature describing coaches' ideal methods of training. [23] Another suggestion from the coaches and trainers that may be more pragmatic would be for SARU to add voluntary workshops in between the biennial RSWs which would both up-skill attendees and create a open and direct dialog between policy makers and these intervention targets. This open dialog could manage the coach and referee perceptions towards *BokSmart* – which was critical to the implementation of New Zealand's *Tackling Rugby Safety* injury prevention project. [10] Additionally, these workshops would create more coach interaction, which is another popular methods of training suggested in Canadian coaches. [23]

Limitations

Although BokSmart is a nationwide programme, the present study only examined one of the fourteen rugby unions of South Africa. This means that the studies results are not generalizable to the other fourteen regions although there is no reason to assume that the findings would be very different. Also, although the researchers had planned for a minimum of five coaches per focus group, the low SES (BS) only had three coaches. However, this small rugby coaching staff was a reality of a low SES team and therefore was felt to at least represent this stratification.

CONCLUSION

While there is consensus from coaches and referees that the *BokSmart* programme is capable of reducing injuries in players, SARU needs to be cognisant of SES-related barriers to implementation of the *BokSmart* programme. High SES coaches do not feel they have a true risk of experiencing a catastrophic injury to a player: this false sense of security results in negativity towards the RSW. In contrast, low SES coaches have more positive perceptions about the RSW, but also appear to have an inflated opinion about the impact that the RSW has had on their injury prevention abilities. A change in these perceptions in high SES coaches would require a continued effort from SARU to involve stakeholders and media [10]. Low SES coaches may require more regular, voluntary workshops, besides the biennial RSW to improve actual injury prevention behaviours.

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Table 2. Summarised findings according to the RE-AIM framework.

RE-AIM component	**Summarised qualitative perceptions of implementation in coaches and referees**	**Summarised qualitative perceptions of coaches and referees of the implementation in players**
Reach	Coaches and referees felt that everyone who *should* be doing the *BokSmart* RSW is not actually doing it and other role-players such as players should be required to do the course.	*N/A*
Effectiveness	While there was general consensus that attending the RSW increased their awareness of injuries, it was less clear if it had actually changed their knowledge. Mid SES coaches incorrectly perceived that they gained knowledge from the RSW. The high SES coaches thought that the RSW was a waste of time for experienced coaches as they already knew all the information.	The majority of coaches across all SES (all except TS) as well as the referees thought that *BokSmart* was a good way to reduce catastrophic injuries in players.
Adoption	Only low SES coaches showed evidence of adopting RSW-prescribed techniques, while higher SES coaches mentioned difficulties in adopting these techniques. The lack of adoption could be related to their negativity towards the RSW or recognition of the complexity of the techniques. Coaches across all SES levels showed confusion in understanding how the RSW intended them behave with a catastrophic injury. Although referees indicated good adoption, they also were incapable of enforcing all RSW regulations.	High SES coaches demonstrated more self-awareness when they mentioned difficulties in getting players adopt the RSW techniques. Low and mid SES coaches were more concerned about international rugby players negatively influencing their players' behaviour. These coaches were also concerned that their lack of resources limited their ability to teach RSW techniques to their players – although this perception may only be a reality for low SES coaches.
Implementation (Delivery)	There was general negativity from high SES coaches about the delivery components of the RSW- they felt that the course should: be shorter, should have better trainers and should be more practical and should not be compulsory. To reduce catastrophic injuries, high SES coaches felt that RSW resources would be better invested in improving conditions of low SES teams. There was a suggestion from some coaches that a high quality coaching or refereeing qualification should be a pre-requisite to attend an RSW. It was evident that some trainers were not doing what was required of them and were not as well-respected as SARU required.	*N/A*

Table 2 continues on the next page

Table 2 (continued). Summarised findings according to the RE-AIM framework.

RE-AIM component	**Summarised qualitative perceptions of implementation in coaches and referees**	**Summarised qualitative perceptions of coaches and referees of the implementation in players**
Implementation (Content)	The majority of coaches (including high SES coaches) thought the RSW content was teaching them correct techniques for safer rugby.	*N/A*
Maintenance	Low and mid SES coaches as well as referees showed evidence of using the course materials after the RSW. This was despite some trainers' perception that the coaches/referees never look at the material again after leaving the RSW.	*No quotes for players*

9

GENERAL DISCUSSION

The main purpose of this thesis was to evaluate the implementation of *BokSmart* – a nationwide injury prevention programme for rugby union ('rugby') in South Africa. Within this evaluation the main goal of the programme implementer, SARU, was also embedded: i.e. to evaluate the effectiveness of the programme in reducing catastrophic injuries in players. [1]

MAIN FINDINGS

This thesis used the 6 TRIPP stages to evaluate the implementation of *BokSmart* (figure 1). [2]

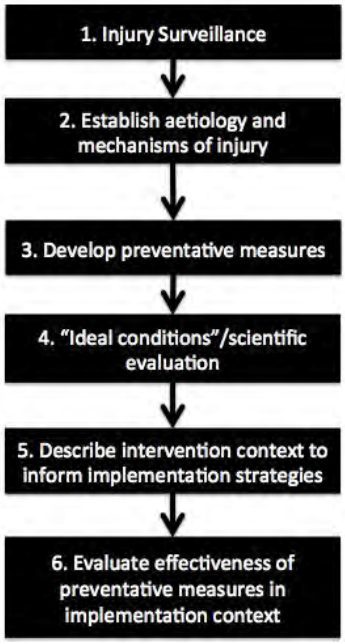

Figure 1. Six stages of TRIPP (Translating Research into Injury Prevention Practice) model. [2]

The main findings, according to TRIPP stages are summarised and discussed in this chapter. Based on this TRIPP evaluation, some practical recommendations are suggested. Also, the limitations of the study are discussed, some future research is suggested and finally a conclusion of the entire thesis is provided.

TRIPP stages 1 and 2

The extent of the injury problem and aetiology of injuries in rugby in South Africa is described in Chapters 2 – 5 of this thesis.

The incidence and severity of general rugby injuries has been well described in youth [3] and in adult [4] populations. However, in South Africa the only well-conducted injury incidence study was performed in one region of South Africa over 30 years ago. [5] Using a prospective design, Chapter 2 describes the incidence and severity of all injuries at four SARU youth tournaments –with players ranging in age from under-13 to under-18. While the findings of this chapter confirmed that the injury rates were not different to other youth rugby studies, [6] some practical suggestions were made for SARU for the future medical planning of these youth tournaments. For example, based on this chapter SARU now schedule the number of medical doctors, based on the observed number of 'time-loss' injuries per match at each age group (see also the 'Practical Implications' section in Chapter 2 and this General Discussion).

While the economic burden of injuries associated with rugby league had been estimated previously, [7] there were no such studies in rugby union. The economic burden of injuries is commonly overlooked as a measure of severity of sports injuries in general. [8] This economic measure of severity is particularly important for the parents of children involved in sport – particularly in a high-risk sport such as rugby. [4,6] Chapter 3's findings were consistent with Chapter 2 in that injury costs and rates were not different by age group (under 13 – under 18). However, Chapter 3 revealed that costs were significantly less in players who did not have medical insurance in comparison to those players who did. This suggests that player's without medical insurance are not receiving optimal treatment for their injuries. This phenomenon of medical insurance presence or absence affecting optimal medical treatment has been described previously in South Africa with hypertension treatment. [9]

Although a previous study described the absolute number of rugby-related catastrophic injuries in South Africa, [10] Chapter 4 provided the first prospective investigation in the country of injury incidence and severity of these life altering injuries. As a result, this chapter established the following risk factors: senior age group players, hooker playing position and the scrum phase of play (mainly the engagement phase of the scrum). As with Chapter 2, SARU also introduced a policy change as a result of the findings of Chapter 4. In January 2013, SARU altered the

laws of the scrum engagement sequence at all amateur levels of play, in an attempt to reduce the effect of these risk factors identified in this chapter.[11]

Using conventional methods for reporting rugby injuries, [12,13] in Chapters 2 - 4 it became clear that the true risk of scrum-related injuries to front-row players (hooker and two props) was being under-estimated. This chapter concluded that only those players who were at risk of suffering a scrum-related injury should be included in the exposure value when calculating injury incidence. The players at risk of injury should be determined through epidemiological studies. When using this altered calculation, although the injury rate was obviously much higher for props and hookers and lower for other positions, it was a more realistic assessment of the risk of scrum-related injury to the different playing positions.

TRIPP stage 3

As the *BokSmart* programme was introduced by SARU on an immediate and pragmatic basis and without the authors' input, the development of the intervention will not be described here. However, the details of the programme have already been described in Chapter 1 (subheading 'The *BokSmart* programme'). Although implementation theory suggests that intervention development should be guided by an established framework such as Intervention Mapping (IM) [14] the *RugbySmart* and *BokSmart* programmes were not developed according to such a framework.

TRIPP 4

BokSmart was never assessed for its efficacy in a randomised control trial, but was implemented by SARU based on the effectiveness of its parent programme, *RugbySmart*, in New Zealand. [15,16]

TRIPP 5 and 6

While South Africa and New Zealand are comparable in their passion for rugby, there are numerous differences between the two countries that could affect the implementation of an injury prevention programme. [17] The most prominent of these differences may be the socioeconomic disparities within the general and rugby populations of South Africa. [17] Furthermore, the science of the evaluation of the implementation of injury prevention programmes has advanced rapidly since the *RugbySmart* programme was evaluated in 2009. [14] For example, the implementation of *RugbySmart* was described as successful mainly due to its effect on general and catastrophic injury rates. [15,16,18] However, it is now recognised

that intervention success is underpinned by a requirement for behaviour change in the intervention targets. Accordingly, these intervention targets need to be a part of the evaluation. [19,20] Moreover, contemporary implementation research requires that a comprehensive description is provided of the ecological context of the intervention. [14] The RE-AIM framework was initially proposed for public health programmes or interventions that required behaviour change and thus provided the perfect tool for the evaluation of *BokSmart*. [14] Owing to its use in intervention evaluation, the RE-AIM framework can also be incorporated as part of TRIPP stages 5 and 6: this was described in Chapter 1. [2]

The RE-AIM definitions specific to this programme are described in detail in Chapter 1 ('*BokSmart* evaluation'), however they are also repeated here in (Table 1) for reference and context. *BokSmart* has two distinct target groups for which the programme's goals are different: [21] (i) the coaches and referees who attend the rugby safety workshops ('researcher intervention'), and (ii) the actual players ('injury prevention intervention') (Table 1).

Table 1. BokSmart RE-AIM definitions

RE-AIM component	Researcher intervention: coaches and referees	Injury prevention intervention: players
Reach	All 40,000-50,000 coaches and referees attend RSW	N/A
Effectiveness	Acquire RSW knowledge	Reduction in catastrophic injury rates **(SARU Internal goal)**
Adoption	Employ RSW methods/regulations	Adopt RSW behaviour
Implementation	Positive about the RSW format and content	N/A
Maintenance	Make use of RSW material after the RSW	Employ RSW behaviours after initial teaching

A comprehensive RE-AIM evaluation requires the use of both quantitative and qualitative methods. [21] In this thesis, quantitative evaluations of Effectiveness and Adoption of the *BokSmart* programme (in players – injury prevention target) are presented in Chapters 6 and 7, respectively. To supplement this, a qualitative evaluation was performed on the perceptions of *BokSmart* from coaches and referees (researcher intervention). These results were then categorised using the RE-AIM framework (Chapter 8). While there are numerous quantitative evaluations of injury prevention programmes using RE-AIM, [22-24] this is the first time the

findings from a qualitative investigation of an injury prevention programme have been analysed using this framework.

Based on the *BokSmart* RE-AIM definitions described in Table 1, the following summarises the qualitative and quantitative results described in Chapters 6 - 8.

Reach

Establishing the Reach of an intervention enables one to understand what proportion of the target population that received the intervention. In this case, SARU expected all active coaches and referees to attend the *BokSmart* rugby safety workshop, as this course was mandatory from January 2010. Chapter 8 describes a qualitative evaluation of the perceptions of the coaches and referees (researcher intervention target) of the *BokSmart* programme they had attended. The coaches and referees felt some teams were missing the *BokSmart* rugby safety workshop. However, the teams that these coaches and referees were referring to were independent and therefore not actually under SARU's control. Nonetheless, the coaches felt that it was SARU's role as the national federation to involve these independent teams. However, the coaches and referees also felt that other role players, beside themselves, should be required to attend the rugby safety workshops: parents of junior players and the players themselves were mentioned. In reality, this could be difficult for SARU to implement, as this would carry an enormous financial and logistical burden. However, there may be less expensive methods such attracting parents through *BokSmart*'s social media (Facebook and Twitter) portals.

According to *BokSmart*'s records, 56 732 coaches and referees have attended the rugby safety workshops at least once since July 2009.[25] The only objective quantification for the Reach of *BokSmart* was a 'rugby census' conducted by SARU with the support of the Sports Science Institute of South Africa in 2012. This census found that between 70-94% of active rugby coaches had attended the rugby safety workshops in juniors and seniors. [26] Although this is not the required 100% of SARU, this is acceptable considering the huge number of coaches and referees across the country. Although this report did not investigate referees, they are also required to attend the rugby safety workshop as part of their required training and therefore it is highly unlikely that any active referee has not attended the course.

Effectiveness

For coaches, the perception of rugby safety workshop knowledge acquisition was skewed by their socioeconomic status (SES) in the qualitative investigation of *BokSmart* (Chapter 8). While coaches with a high SES generally thought the course was a waste of their time, as they knew all the information already, coaches with a low SES felt that they had gained knowledge from the course. Owing to the negativity of the coaches with a high SES, it is unlikely that the coaches with a high SES retained any knowledge from the course - this effect has been described in a similar intervention for ice-hockey coaches. [27] Future studies should attempt to quantitatively establish if knowledge is different in coaches, referees and players of different socioeconomic statuses. Because the data from the behaviour study in Chapter 7 were obtained from a merit-based tournament, the majority of respondents would be from a relatively high SES and thus it would not be possible to investigate this effect in the current data.

Although coaches with a low SES were more positive about the course's effectiveness, it emerged that they had an exaggerated opinion of their knowledge gain from the rugby safety workshop. This became apparent when these coaches were found to be unaware of some critical information that the rugby safety workshop would have provided, such as what to do in case of a catastrophic injury (Chapter 8). This was even observed in coaches who had recently had a player in their team experience a catastrophic injury. This is unexpected considering that other literature describing catastrophic events suggests that these coaches should have the best knowledge of how to respond.[27,28]

The effectiveness of *BokSmart* in players (reduction in catastrophic injuries) is also the main goal from the perspective of the programme implementer: SARU. According to Chapter 8, the perceptions of almost all coaches and referees were that the rugby safety workshop was able to reduce catastrophic injuries in players. Furthermore, this positivity about the anticipated outcomes of a particular behaviour is an important enabler for behaviour change in intervention targets. [22]. Similarly, in the quantitative evaluation of the effectiveness of *BokSmart* (Chapter 6) the programme was partly successful. In the four years after its implementation, there had been a nationwide reduction of, on average, 2.5 catastrophic injuries per year in junior players over a four-year period. However, the injury rate was unchanged in

senior players over the same time period. The reasons for the differences in effectiveness at junior level may be related to the 5:1 ratio of junior to senior players (and thus the potential for effect). Alternatively, Chapter 8 suggests that coaches felt that junior players might be easier to influence than senior players. To investigate this theory, future studies could assess if specific self-reported behaviours of Chapter 7 where better in juniors than senior players. Similarly, Chapter 8 also suggests that senior coaches might also be less receptive to the rugby safety workshop than junior coaches. While this difference in effectiveness at junior and senior age groups was not described in the evaluation of *RugbySmart* [16] there was only one catastrophic injury in the post-*RugbySmart* period and thus no stratification of age group.

Adoption

Similarly to perceived effectiveness, the perception of the adoption of *BokSmart* prescriptions in coaches and referees was different, depending on their SES (Chapter 8). As described in Chapter 8, there was some evidence of referees and coaches with a low SES adopting rugby safety workshop prescriptions, while coaches with a high SES mentioned the difficulties in adopting the course's prescriptions. Both the lack of knowledge gain described in coaches with low SES in the previous section ('Effectiveness') and the difficulties described by coaches with high SES in the current section ('Adoption') are barriers to overall Adoption.

According to social cognitive theory, for a behaviour to be adopted, intervention targets need to feel they have the necessary knowledge and skills to implement the specific behaviour. [22] To overcome this issue, all coaches, regardless of SES, felt that the rugby safety workshop could be less theoretical and more practical: for example a field-based course with active examples and interaction rather than a passive DVD-facilitated session. In reality, this would have far greater financial implications for SARU, as the administration of practical courses to the same number of coaches and referees would require more employees that could deliver the courses. In players, Chapter 7 describes that some behaviours had improved since *BokSmart* was launched. Most importantly, the targeted behaviours (according to SARU - programme implementer) of the practicing of safe tackling and scrummaging techniques had improved significantly between 2008 and 2012. However, due to the differing injury risks depending on the forward's role in the

scrum (Chapter 5), it would have been interesting to compare these scrumming behaviours between the different forward positions. A shortcoming of the KAB questionnaire that collected the behaviour data presented in Chapter 7 was that it only assessed whether the player was a forward or a back, but not what type of forward (e.g. prop or hooker) the player was. Chapter 8 described the perceived barriers to adoption in players, from the perspective of coaches. Again, these perceptions varied by SES. Coaches with low SES mentioned their lack of resources as a barrier to the adoption of safety prescriptions: this was a legitimate problem in some cases – such as not having access to grass fields to practice safe techniques. Coaches with high SES described difficulties of altering player behaviour, in general, not just in response to the rugby safety workshop prescriptions.

Unfortunately, the negative perceptions described in this section may affect the overall impact of *BokSmart*: interventions need to be widely adopted if they are to have a good impact. [29]

Implementation

In coaches and referees, Chapter 8 describes the general positive perception that the rugby safety workshop content was capable of reducing catastrophic injuries in players. However, in the same chapter there was a negative perception from coaches with high SES about the chosen delivery strategy. Coaches with high felt that SARU's investment in the rugby safety workshops would be better spent on improving the low SES teams' infrastructure. As described in the previous section, low SES coaches also felt they needed more resources. Furthermore, coaches with high SES felt the rugby safety workshops should be more of a coaching course with an emphasis on correct techniques rather than a safety course that instilled negative reactions in attendees. Coaches with high and a number of SARU trainers felt that the course could be shorter if the content focused purely on high risk areas of the game and that a shorter course would also reduce negativity. These high-risk areas have already been identified and mentioned in the TRIPP stages 1 and 2 of this section. Another suggestion from coaches and SARU trainers was for SARU to provide free optional and informal workshops for coaches on topics they find relevant, such as recovery or supplement use. These workshops could also solve the problem described in the 'Reach' section if other interested parties, including parents of rugby players and players themselves, could attend the workshops.

There was no objective quantitative evaluation of the implementation of *BokSmart*. However, there are *BokSmart* biannual internal reports that summarise the evaluations of each rugby safety workshops (Appendix III). These evaluations show very high ratings of between 4 (= 'good') and 5 ('excellent') for each component of the course. [30]

Maintenance

In coaches and referees, only the low and mid SES coaches, as well as referees, showed evidence of making use of the RSW DVD and associated materials after the course (Chapter 8). This was not surprising, given the general negativity of the high SES coaches towards the RSW described throughout the effectiveness and adoption components of Chapter 8. There was no quantitative evaluation of Maintenance in coaches and referees or players.

SUMMARY

While rugby-related injury rates do not appear worse in South Africa than in other countries, the large amount of participants in the sport warranted the implementation of a nationwide injury prevention programme by the national rugby federation, SARU.[31] The programme was implemented based on the success of *RugbySmart*, its parent programme developed in New Zealand, and fulfilled a pragmatic and immediate need in South Africa. Thus, the programme development did not follow a comprehensive intervention development procedure as is suggested for injury prevention interventions. [14,32]

There were positive indications towards quantitative evaluations of Reach, Effectiveness, Adoption and Implementation of *BokSmart*. However, if the negative perceptions of the Effectiveness, Adoption, Implementation and Maintenance of the programme are not addressed, these factors may reduce *BokSmart*'s quantitative effectiveness in the long term.

The positive effects of the quantitative evaluations of Effectiveness and Adoption in players were comparable to findings in the evaluation of *RugbySmart* in New Zealand. [15,16] However, the barriers identified through qualitative research (Chapter 8) are not comparable to those in New Zealand, as the New Zealand

qualitative study was not performed in as structured a manner as it was in the present study.[33] In contrast, the qualitative component of the safety education for ice-hockey coaches had similar effects in that negativity reduced the programme effectiveness. [27]

LIMITATIONS

There are a number of limitations of this thesis. Although *BokSmart* was evaluated using the RE-AIM framework in this Chapter, neither *RugbySmart* nor *BokSmart* were originally developed with this framework in mind. [14] As a result, it is possible that the RE-AIM definitions may have been different if the programme had been developed using this framework. Nonetheless, it was felt that the RE-AIM framework provided a structured format to evaluate BokSmart and thereby provide useful information to the programme implementers, SARU.

The qualitative data described in Chapter 8 were only collected from one of the fourteen rugby regions of South Africa. Qualitative research is location specific and is not generalizable to other settings.[34] Thus, the qualitative evaluation in Chapter 8 may not explain the nationwide quantitative evaluations of Chapters 6 and 7. However, the findings of Chapter 8 indicate the importance of socioeconomic disparity in determining perceptions of the programme. This socioeconomic disparity is a nationwide issue and would probably supersede any region-specific differences.

The quantitative assessment of adoption in players in Chapter 7 is based on self-reported information. Thus, the fidelity of *BokSmart* – whether the players were actually using course-prescribed techniques is unknown. To truly assess the fidelity of the programme one would require a more focused observational investigation. However, it was felt that it was too early for such a study on a nationwide intervention and that the larger, more descriptive effects were an important first investigation.

Besides players, coaches and referees should also be assessed, as they are the actual direct researcher intervention targets. Understanding the effectiveness and adoption of *BokSmart* in coaches and referees could explain the effects in the injury prevention intervention target (players). For example, Chapter 6 showed that

BokSmart was more effective in reducing catastrophic injuries in junior than senior players. If the programme is more likely to be adopted by the coaches of junior players, then it would be logical that this effect would reflect ultimately in player injury rates.

Also, both quantitative studies that assessed the effectiveness and adoption of the *BokSmart* assumed that this programme was the only change that could have improved safety in players over this time period: 2008 – 2013. Having said this, due to *BokSmart* being a nationwide intervention, it encompasses any nationwide safety change, from rules and laws to coaching and refereeing input. Thus, it is likely that any safety-related changes are most probably attributable to the BokSmart.

PRACTICAL IMPLICATIONS AND RECOMMENDATIONS

The present study showed that a nationwide injury prevention programme was partly effective in achieving the stated goals of reducing catastrophic injury. This occurred despite significant barriers to the widespread adoption of the rugby safety workshop prescriptions in the intervention target (coaches and referees).

The structured evaluation of the present study, using the RE-AIM framework which is recommended for the evaluation of injury prevention interventions, [14], identified specific and manageable areas for improvement for the programme implementers. Although *BokSmart* has achieved its internal goals in a short period of time, the suggestions below are made with the intention to further optimise the impact of the programme:

1. **Address barriers in perceived effectiveness and adoption of *BokSmart* prescriptions (identified in Chapter 8)**. These barriers are mainly SES-specific, so the programme may have to be tailored based on the league position of the team, which in most cases closely matches SES in South Africa. This would eliminate concern about SES discrimination. However, from the qualitative study in Chapter 8 coaches and referees of all SES levels suggested a more practical and interactive course. While this would provide a logistical and financial issue to SARU with its 50,000+ attendees, addressing these barriers could improve the impact of the RSW.

2. **Understand the lack of effectiveness of the RSW on catastrophic injury rates in senior players (identified in Chapter 6)**. This difference could simply be related to greater player numbers in junior levels and thus have potential for impact. However, in Chapter 8 there was some indication that the perceived effectiveness was less in senior than junior players. If this is confirmed through further research, this could indicate that the *BokSmart* rugby safety workshop is less effective at the senior level. If this were indeed the case, SARU would need to act on this information to ensure optimal uptake of the *BokSmart* in future. On the positive side, the current junior players will eventually become senior players as they progress through their careers, thus improving this situation, in part, without intervention.
3. **Improve delivery (implementation) with a shorter course, focused on high-risk areas**. Coaches with high SES as well as most SARU trainers mentioned that coaches and referees felt the rugby safety workshop was too long. A suggestion from the coaches with high SES was to focus the course content purely on the high-risk areas of the game, identified through epidemiological research.
4. **Continue to evaluate the RSW in a structured, objective manner**. These findings and recommendations are specific to the period in which the evaluations were performed: 2008 – 2013. It should be recognised that perceptions of the intervention target may change over time, as was observed with the implementation of a New Zealand injury prevention programme. [33] Changing perceptions could have a knock-on effect to components of the RE-AIM framework, and thus ultimately effect the adoption and effectiveness of the programme.
5. **Evaluate effect of law changes**. As a result of research conducted for TRIPP stages 1 and 2, SARU changed two major policies. Part of the continued evaluation of *BokSmart* should examine the effect of these law changes.
6. **Have regular informal *BokSmart*-associated workshops for coaches, referees and other interested parties on a range of topics**. Both SARU trainers and coaches with low SES requested more regular informal workshops where topics of interest are discussed in a non-threatening manner. These courses might be a way to introduce other attendees such as

parents of players and players themselves to the *BokSmart* materials. Additionally, these informal workshops would provide a direct communication line between the general public and SARU.

SUGGESTED FUTURE RESEARCH

The preceding sections: 'limitations' and 'practical implications and recommendations for future research' suggest some directions for future research.

- To date, there has been no quantitative evaluation of Maintenance of the programme. The qualitative perceptions of coaches and referees appeared to indicate that Maintenance would be reduced in coaches with high SES. A one-year follow-up of the coach adoption study described in the previous paragraph may provide some of this information.
- Finally, any injury prevention programme evaluation is incomplete without a fidelity study assessing if the player's self-reported behaviours are truly reflective of their actions. For example, while they may think they are practicing 'safe' techniques, their actual technique may not be safe or *BokSmart*-prescribed. To truly understand if coaches, referees and players are adopting *BokSmart*-prescriptions, an observational study would need to be conducted.
- Besides players, the adoption of the programme goals needs to be assessed in the researcher intervention target: coaches. This would enable researchers to answer the question of whether *BokSmart*'s effectiveness is determined by level (junior or senior) of the coaches.

CONCLUSIONS

The present study identified that the *BokSmart* programme was at least partly successful in achieving the implementer's goal of a reduction in catastrophic injuries. However, recent research has indicated that simply evaluating the effectiveness of an intervention is insufficient to understanding the implementation context. Without widespread adoption of the intervention, an effective intervention could still be at risk of ultimately failing. [14,35] It is critical to understand the implementation context when a previously successful intervention is introduced into a new environment, as occurred with *RugbySmart*. [2] South Africa presents a different implementation context to that of New Zealand. [17] Thus, the barriers identified in this thesis and

summarised in the section headed 'Practical implications and recommendations' may be specific to South Africa and should be addressed by SARU if the impact of programme is to be optimised.

Despite the specificity of the findings to South Africa and the *BokSmart* programme, this thesis provides a blueprint for the structured evaluation of an injury prevention programme in any context. A continual evaluation of the *BokSmart* programme, will provide evidence to guide the implementers of the programme in making decisions which will optimise the impact of the *BokSmart* programme in future years.

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APPENDICES

APPENDIX I – KNOWLEDGE, ATTITUDE AND BEHAVIOUR (KAB) QUESTIONNAIRE

Team: | **Province:**

BokSmart KAB STUDY 2010 - Rugby Player Questionnaire

Please tick the box or circle the number that matches your answer. The target group is males over the age of 19 for the Club study and between the ages of 16-19 in the School study.

1a. When was your last **Rugby** ligament sprain or muscle strain?

In the last… ❋ Week ❋ Month ❋ Year ❋ Longer (***go to Q2***) ❋ Never (***go to Q2***)

Area affected… ❋ Ankle ❋ Knee ❋ Leg ❋ Upper limb/shoulder ❋ Trunk/pelvis ❋ Head/neck

1b. Was ice applied to the injury? ❋ No (***go to Q1d***) ❋ Yes (***if yes when was it applied?)***

❋ Within 10 mins ❋ 11-59min ❋ 1-4hrs ❋ 4-8 hrs ❋ 8+ hrs

1c. During the next 24 hours, ice was **applied** for about

❋ ____ mins ❋ every _____ hour/s ❋ when I remembered ❋ don't know

1d. Was compression/bandaging used on the injury? ❋ No (***go to Q1e***) ❋ Yes (***if yes when was it applied?)***

❋ Within 10 mins ❋ 11-59min ❋ 1-4hrs ❋ 4-8 hrs ❋ 8+ hrs

1e. In the 24 hours after injury did you elevate the injury? ❋ No (***go to Q1f***) ❋ Yes (***if yes when was it elevated?)***

❋ Less than 1 hour ❋ 2-4 hours ❋ Most of the time ❋ Whenever possible ❋ Don't remember

1f. In the first 72 hours after the injury did you:

(i)	apply heat to the injury?	❋ No	❋ Yes	
(ii)	drink alcohol?	❋ No	❋ Yes	
(iii)	exercise the injured part?	❋ No	❋ Yes	
(iv)	massage the injured part?	❋ No	❋ Yes	**If yes by whom** ❋ Self ❋ Physio ❋ Masseur ❋ Friend ❋ Doctor

---

2a. At **practice** this season, do you…

warm up at the beginning?	❋ always	❋ usually	❋ occasionally	❋ never
cool down at the end?	❋ always	❋ usually	❋ occasionally	❋ never
wear a mouthguard?	❋ always	❋ usually	❋ occasionally	❋ never
spend time on the safe tackling techniques?	❋ always	❋ usually	❋ occasionally	❋ never
spend time on the safe rucking techniques?	❋ always	❋ usually	❋ occasionally	❋ never
spend time on the safe scrummaging techniques?	❋ always	❋ usually	❋ occasionally	❋ never

2b. If you play in the backs and spend time on safe scrummaging techniques, then why? _____

2c. At **games** this season, do you…

warm up at the beginning?	❋ always	❋ usually	❋ occasionally	❋ never
cool down at the end?	❋ always	❋ usually	❋ occasionally	❋ never
wear a mouthguard?	❋ always	❋ usually	❋ occasionally	❋ never

3a. In relation to rugby, have you received information in the last year on…

3b. What do you think is/are the best way/s of receiving that information (select only 1 option per ROW e.g. "Warm-up", "Cool-down" etc.)?

	Yes	No	Don't know	Coach	Physio	Via Club	Sports Medic	TV	Medical Insurance Resources	Via Web
Warm-up										
Cool-down										
Hydration/nutrition										
Physical conditioning (fitness)										
Safe rugby techniques										
Protective equipment										
Injury management (e.g. RICED)										

4. How **should** you treat a ligament sprain or muscle strain?

Use Ice ❋ Don't know ❋ No ❋ Yes

If yes, when? ❋ Within 10 mins ❋ 11-59min ❋ 1-4hrs ❋ 4-8 hrs ❋ 8+ hrs ❋ Don't know

Use compression or a bandage

❋ Don't know ❋ No ❋ Yes

If yes, when? ❋ Within 10 mins ❋ 11-59min ❋ 1-4hrs ❋ 4-8 hrs ❋ 8+ hrs ❋ Don't know

Raise or elevate the injury

❋ Don't know ❋ No ❋ Yes

If yes, for how long? Ranging from "Minimal amount of time" (1) to "Most of the time" (6) ❋ 1 ❋ 2 ❋ 3 ❋ 4 ❋ 5 ❋ 6

Avoid applying heat	❋ Don't know	❋ No	❋ Yes	
Avoid drinking alcohol	❋ Don't know	❋ No	❋ Yes	
Avoid exercising the injured part	❋ Don't know	❋ No	❋ Yes	
Avoid massaging the injured part	❋ Don't know	❋ No	❋ Yes	
See a health professional	❋ Don't know	❋ No	❋ Yes	**If yes,** ❋ Always ❋ Sometimes

---

5a. Following an injury that caused you to miss practice or game time, how do you decide **when to return** to rugby training or competition?
Advice of…

❋ Doctor ❋ Physio ❋ Sports Medic ❋ Trainer ❋ Coach ❋ How it feels ❋ Don't know

5b. Before returning to rugby training or competition after an injury that caused you to miss practice or game time, you need to be…
At least…

❋ 100% fit ❋ 90% fit ❋ 80% fit ❋ 70% fit ❋ 50% fit ❋ Depends on the injury ❋ Don't know

---

6. Do you think these people have a role in preventing injuries in sport?

Referee	❋ No	❋ Yes	**If Yes**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Players	❋ No	❋ Yes	**If Yes**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Coach	❋ No	❋ Yes	**If Yes**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree

---

7a. Do you undertake **off-season** training for Rugby? ❋ No ❋ Yes

7b. If there was an **off-season** training guide for Rugby freely available, would you use it? ❋ No ❋ Yes ❋ Don't know

---

8a. Do you undertake **pre-season** training for Rugby? ❋ No ❋ Yes

8b. If there was a **pre-season** training guide for Rugby freely available, would you use it? ❋ No ❋ Yes ❋ Don't know

8c. How long before the season did you take part in pre-season **strength** training?

❋ Never ❋ 1-2 weeks prior ❋ 1 month prior ❋ 2 months prior ❋ 3 months or more prior

8d. How long before the season did you take part in pre-season **fitness** training?

❋ Never ❋ 1-2 weeks prior ❋ 1 month prior ❋ 2 months prior ❋ 3 months or more prior

---

9a. Is it important to you that your coach completes compulsory annual Rugby safety courses? ❋ No ❋ Yes

---

10. What is your age? _____

---

11. What is your position? ❋ Forward ❋ Back

---

12. What is your ethnic origin? ❋ African ❋ Coloured ❋ White ❋ Asian ❋ Other (specify) _____

---

13. There would be fewer rugby injuries if players… (Provide an answer for every ROW)

Were fitter	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Did not play when injured	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Used good technique	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Played fair	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Always wore a mouthguard	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Cooled down	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Were conditioned for physical impact	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Warmed up	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree
Played within the rules	❋ Disagree	❋ Agree	**If agree**, slightly agree	❋ 1	❋ 2	❋ 3	❋ 4	❋ 5	❋ 6	strongly agree

Today's Date_____/_____/2010

THANK YOU FOR YOUR HELP

APPENDIX II – ATTENDANCE REGISTER FOR *BOKSMART* RUGBY SAFETY WORKSHOPS

BokSmart Workshop Report Form

ABSA BokSmart WINNERS PLAY SMART ABSA

BokSmart TRAINER & CONTACT DETAILS		DATE & VENUE OF WORKSHOP:			PROVINCE E.g. Bulls	REGION E.g Tshwane	ZONE E.g. Ga-Rankuwa				
					Border						
*NOTE: No individual will be granted BokSmart certification unless they have attended the **WHOLE COURSE** from beginning to end, have **COMPLETED ALL THE DETAILS REQUIRED** below, and have acknowledged and **SIGNED** to uphold the BokSmart Code of Conduct*											
FORENAMES AND SURNAME E.g. Johan Lodewikus Pretorius	ID number E.g. 7405627006085	COACH/ REFEREE E.g. Coach	QUALIFICATION E.g. IRB level 1	POSTAL ADDRESS E.g. 75 Eagle Crescent, Pinelands, Cape Town, 7405	REGISTERED/ UNREGISTERED (COACH/ REFEREE) E.g. Unregistered	CELLULAR TELEPHONE NUMBER E.g. 083 459 8652	YEARS OF EXPERIENCE E.g. 5 years	LEVEL INVOLVED AT E.g. School/club/ provincial/national & Team E.g. U13 b, WPRU U20	SIGNATURE IN AGREEMENT TO UPHOLD THE BokSmart Code of Conduct	BOKSMART TOOLKIT RECEIVED (√)	AGREE TO BE CONTACTED BY Absa (Yes/No)
PLEASE COMPLETE ONE PAGE FOR EVERY 9 COURSE PARTICIPANTS											

APPENDIX III – *BOKSMART* RUGBY SAFETY WORKSHOP TRAINER EVALUATION FROM (COMPLETED BY ATTENDEES OF THE COURSE)

BOKSMART WORKSHOPS

PEER-REVIEWED CRITICAL ASSESSMENT OF PRESENTERS

1. EXPECTATIONS OF THE PEER-REVIEW PROCESS

- Please be honest and unbiased in your assessment of the BokSmart Workshop presenter
- This will assist BokSmart in having the right people presenting the courses around the country and ensuring that the complete BokSmart message is getting to all involved in rugby in South Africa
- In the categories below, please rate your Course Presenter for ***each*** question by circling e.g.(1) or crossing e.g. X the appropriate rating e.g. 5 – Excellent, 4 – Good, 3 – Average, 2 – Fair, 1 – Poor
    - *Excellent (**5**), means the best be far, fantastic, wow. Good (**4**), means it was really good and informative, well presented. Average (**3**), means it was OK, and learnt from it. Fair (**2**), means it was below average, and could have been better presented. Poor (**1**), means, it was really bad, and needs to be relooked at*
- Provide only ONE option for each question!
- This forms an important part of the program's quality assurance process. Thank you for taking the time to complete this brief questionnaire.

2. COURSE PRESENTER EVALUATION

COURSE PRESENTER:	**DATE:**	**VENUE & PROVINCE:**
NAME & CONTACT NUMBER OF ASSESSOR →	**Name:**	**Contact Number:**

- Welcome and Introduction

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 1:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 2:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 3:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 4:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 5:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 6:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 7:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 8:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 9:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 10:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 11:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 12:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 13:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Chapter 14:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Course conclusion summary:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Certification/Hand-out process:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Overall course presentation:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Communication ability of the presenter:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Neatness and appearance of the presenter:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Overall organisation by the presenter:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

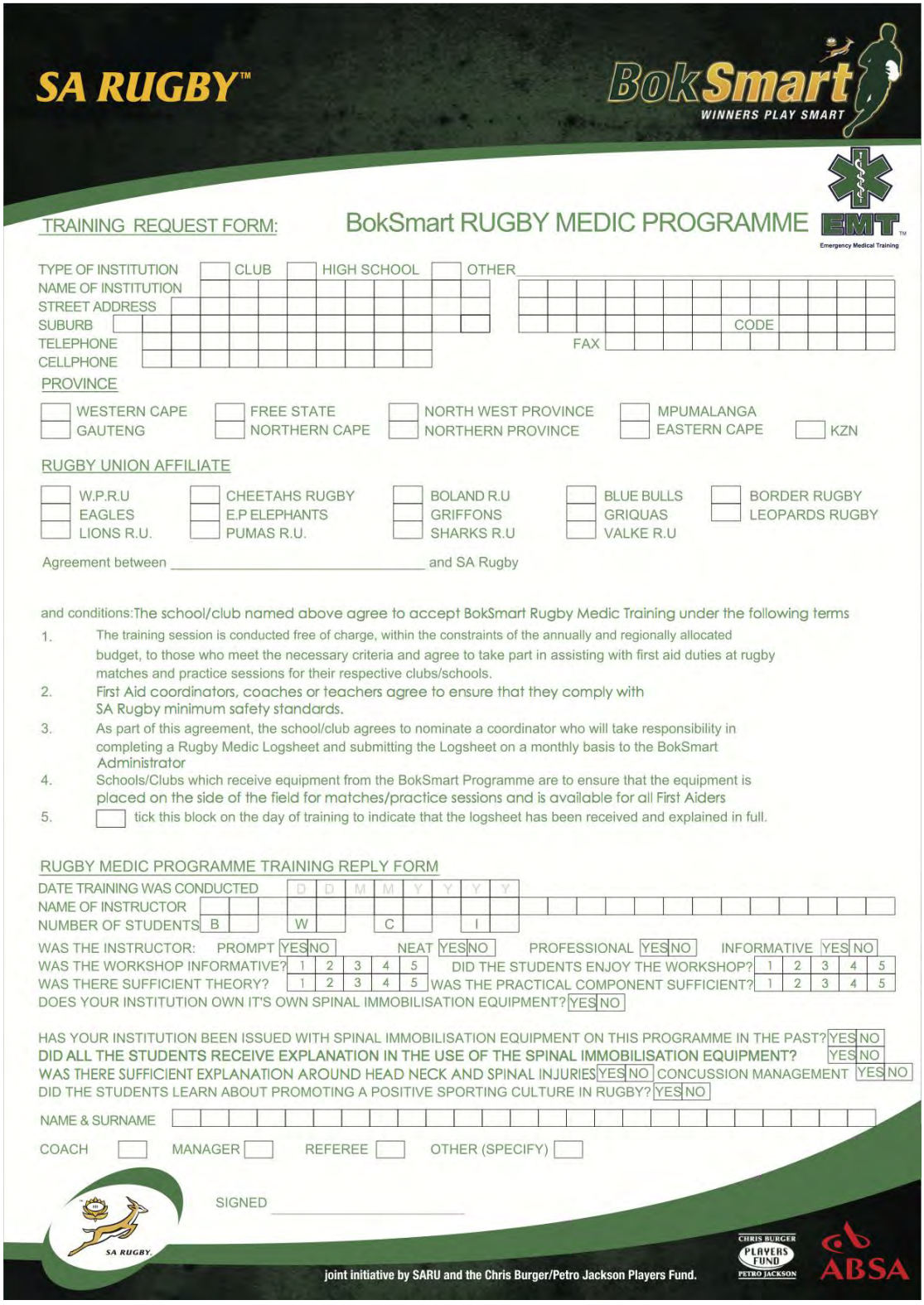
- Knowledge and understanding of the presenter:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

- Overall BokSmart workshop:

5 – Excellent; 4 – Good; 3 – Average; 2 – Fair; 1 – Poor

APPENDIX IV – *BOKSMART* RUGBY MEDIC PROGRAMME REPRESENTATION INFORMATION SHEET AND COURSE EVALUATION



SA RUGBY™

BokSmart
WINNERS PLAY SMART

EMT™ Emergency Medical Training

TRAINING REQUEST FORM: BokSmart RUGBY MEDIC PROGRAMME

TYPE OF INSTITUTION ☐ CLUB ☐ HIGH SCHOOL ☐ OTHER _____
NAME OF INSTITUTION
STREET ADDRESS
SUBURB CODE
TELEPHONE FAX
CELLPHONE

PROVINCE

☐ WESTERN CAPE ☐ FREE STATE ☐ NORTH WEST PROVINCE ☐ MPUMALANGA
☐ GAUTENG ☐ NORTHERN CAPE ☐ NORTHERN PROVINCE ☐ EASTERN CAPE ☐ KZN

RUGBY UNION AFFILIATE

☐ W.P.R.U ☐ CHEETAHS RUGBY ☐ BOLAND R.U ☐ BLUE BULLS ☐ BORDER RUGBY
☐ EAGLES ☐ E.P ELEPHANTS ☐ GRIFFONS ☐ GRIQUAS ☐ LEOPARDS RUGBY
☐ LIONS R.U. ☐ PUMAS R.U. ☐ SHARKS R.U ☐ VALKE R.U

Agreement between _____ and SA Rugby

and conditions:The school/club named above agree to accept BokSmart Rugby Medic Training under the following terms

1. The training session is conducted free of charge, within the constraints of the annually and regionally allocated budget, to those who meet the necessary criteria and agree to take part in assisting with first aid duties at rugby matches and practice sessions for their respective clubs/schools.
2. First Aid coordinators, coaches or teachers agree to ensure that they comply with SA Rugby minimum safety standards.
3. As part of this agreement, the school/club agrees to nominate a coordinator who will take responsibility in completing a Rugby Medic Logsheet and submitting the Logsheet on a monthly basis to the BokSmart Administrator
4. Schools/Clubs which receive equipment from the BokSmart Programme are to ensure that the equipment is placed on the side of the field for matches/practice sessions and is available for all First Aiders
5. ☐ tick this block on the day of training to indicate that the logsheet has been received and explained in full.

RUGBY MEDIC PROGRAMME TRAINING REPLY FORM

DATE TRAINING WAS CONDUCTED D D M M Y Y Y Y
NAME OF INSTRUCTOR
NUMBER OF STUDENTS B ☐ W ☐ C ☐ I ☐

WAS THE INSTRUCTOR: PROMPT YES NO NEAT YES NO PROFESSIONAL YES NO INFORMATIVE YES NO
WAS THE WORKSHOP INFORMATIVE? 1 2 3 4 5 DID THE STUDENTS ENJOY THE WORKSHOP? 1 2 3 4 5
WAS THERE SUFFICIENT THEORY? 1 2 3 4 5 WAS THE PRACTICAL COMPONENT SUFFICIENT? 1 2 3 4 5
DOES YOUR INSTITUTION OWN IT'S OWN SPINAL IMMOBILISATION EQUIPMENT? YES NO

HAS YOUR INSTITUTION BEEN ISSUED WITH SPINAL IMMOBILISATION EQUIPMENT ON THIS PROGRAMME IN THE PAST? YES NO
DID ALL THE STUDENTS RECEIVE EXPLANATION IN THE USE OF THE SPINAL IMMOBILISATION EQUIPMENT? YES NO
WAS THERE SUFFICIENT EXPLANATION AROUND HEAD NECK AND SPINAL INJURIES YES NO CONCUSSION MANAGEMENT YES NO
DID THE STUDENTS LEARN ABOUT PROMOTING A POSITIVE SPORTING CULTURE IN RUGBY? YES NO

NAME & SURNAME

COACH ☐ MANAGER ☐ REFEREE ☐ OTHER (SPECIFY) ☐

SIGNED _____

SA RUGBY

joint initiative by SARU and the Chris Burger/Petro Jackson Players Fund.

CHRIS BURGER PLAYERS FUND PETRO JACKSON

ABSA

APPENDIX V – *BOKSMART* INJURY SURVEILLANCE FORM FOR SARU TOURNAMENTS

BokSmart
National Rugby Safety Programme

YOUTH WEEKS INJURY SURVEILLANCE DATA CAPTURE FORM

1. **PERSONAL DETAILS**

Surname:	Date of birth (dd/mm/yyyy):
Full names:	Date of injury (dd/mm/yyyy):
Known as (nickname):	I.D. Number:
Ethnic origin:	Gender:

Height (cm):	Weight (kg):	Age (yrs/months):

Club/school/team name:

Provincial Union:	Estimated Date of Return from injury (dd/mm/yyyy):
Do you have medical insurance?	Number of days missed due to injury:
Did the player consult with a medical professional regarding their injury?	

I understand that the information obtained from the injury report will be treated confidentially with my right to privacy assured. I also understand that should the information be used for a statistical analysis or a scientific report, my identity will not be disclosed in the report.

Player signature	Date:

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

INSTRUCTIONS FOR USE: Circle the relevant answer in each section. For "Pitch Conditions", circle one selection under each "Option" provided. Under "**Injury Definition**" the following definitions should be used: A "**Time-loss injury**" is defined as an injury that results in more than one (1) day absence from training and/or match play. A "**Medical attention injury**" is defined as an injury that simply requires medical attention.

APPENDIX VI – SERIOUS INJURY QUESTIONNAIRE

WHAT TO DO!

- In the event of a serious and/or catastrophic injury meeting the above mentioned criteria, the following form should be completed by the injured player and/or coach in conjunction with the Serious Injury Case Manager(Ms. Gail Ross – Cell: 0728903538, email: gailross@mweb.co.za, fax: 021-6595653)
- If for some reason this is not possible, then the questionnaire should be completed by the Serious Injury Case Manager in consultation with the coach, other players, and family who might have seen the incident
- Although it might be sensitive and emotional to recall the incident, it would benefit rugby and future rugby players if the follow-up questionnaire is completed while the incident is still fresh in everyone's minds
- This form should then be kept on record pending any inquest or investigation
- Copies should be sent to the SARU Medical Manager and BokSmart General Manager

RESEARCH

All serious injury data collected will be recorded and stored on a SARU database. Personal details will be provided to the Chris Burger/Petro Jackson Players Fund, who may provide financial assistance and support to catastrophically injured rugby players. This information will be stored at SARU's offices for official records of these injuries. The injury data may be used for research and publication purposes to help improve the safety standards of the game of rugby in South Africa, and to potentially prevent other injuries of this nature from occurring in the future. However, in this instance, all personal information will be regarded as confidential in any ensuing research analyses and reports on the catastrophically injured players.

☐ By ticking this box, the player agrees to the above

INTERNATIONAL RUGBY BOARD (IRB)

All data collected will be forwarded anonymously to the IRB and stored in a secure IRB database of catastrophic injuries. These data may be analysed by the IRB for audit, player welfare, research purposes in relation to the prevention, and management of Rugby-related catastrophic injuries.

☐ By ticking this box, the player agrees to the above

PLAYER'S CONSENT

It is hereby confirmed that the player or player's family, whichever may be applicable, has given permission to use and submit the information requested by this form and that they agreed that the information can be forwarded to the IRB, and be

used by both SARU and the IRB for the purposes of monitoring and investigating the causes of catastrophic injuries sustained in Rugby Union.

☐ By ticking this box, the player agrees to the above

SECTION A: PERSONAL DETAILS (PRINT CLEARLY)

Surname: _____ Age of Player: _____
Forenames: _____ Known as (nickname): _____
Date that form was completed: D D / M M / Y Y Y Y
Email address: _____
ID Number:

Passport Number:

Passport type (country of issue): _____
Marital status: _____
Playing position: _____
SARU Registration number: _____
Residential address: _____
Tel./Cell. Number: _____
Next of Kin: _____
Contact number (next of kin): _____
Name of Rugby Club/School: _____
Provincial Union (e.g. Bulls): _____

1. Date of Birth D D / M M / Y Y Y Y

2. Gender: ☐ Male ☐ Female
3. Player's Weight in Kilogram (kg)
    a. At the time of Injury: _____kg
    b. What is the player's current weight? _____kg
4. Player's Height in Cm at the time of injury (cm): _____cm
5. Country of birth: _____
6. Ethnicity:

☐ Arabic
☐ Asian
☐ Black African
☐ Black Caribbean
☐ Pacific Islander
☐ White
☐ Coloured/Mixed Ancestry
☐ Indian
☐ Other

7. What age did the player start playing rugby? _____
8. Number of years that the player has been playing rugby: _____
9. How many seasons of rugby has the player played prior to this season:_____
10. Grade of play
    a. Player's <u>current</u> grade of play (please select highest level of play)

☐ School
☐ School Provincial
☐ School International
☐ Club
☐ Non-professional Provincial
☐ Professional Provincial
☐ International

    b. Player's <u>current</u> playing age-group

☐ Junior (<U13)
☐ U13
☐ U14
☐ U15
☐ U16
☐ U17
☐ U18
☐ U19
☐ U21
☐ U23
☐ Senior

    c. Is the player registered at their Province?

☐ Yes ☐ No

d. Is the player registered at SARU?

☐ Yes ☐ No

11. Player's *Usual* playing position:

☐ 1 – Loose-head prop
☐ 2 – Hooker
☐ 3 – Tight-head prop
☐ 4 – Lock
☐ 5 – Lock
☐ 6 – Open-side flank
☐ 7 – Blind-side flank
☐ 8 – Eighth man
☐ 9 – Scrum/Inside half
☐ 10 – Fly/Outside half
☐ 11 – Left Wing
☐ 12 – Inside centre
☐ 13 – Outside centre
☐ 14 – Right Wing
☐ 15 – Full back

12. Number of years the player has been playing in this position: _____

13. Provide any specific, relevant information about the player's background:

_____
_____
_____
_____
_____
_____
_____

SECTION B: INJURY CIRCUMSTANCES (PRINT CLEARLY)

14. How well did the player recall the events of the day?

☐ No recollection
☐ Vaguely remembered
☐ Somewhat
☐ Well
☐ Extremely well

15.

a. Date of Injury

D	D	/	M	M	/	Y	Y	Y	Y

b. Time that the injury occurred:

H	H	:	M	M	am / pm

16. Did the injury occur during:

☐ Match
  ☐ 15-a-side match
  ☐ 7-a-side match

- ☐ Training activity
  - ☐ Rugby skills training, Full contact
  - ☐ Rugby skills training, Semi-contact
  - ☐ Rugby skills training, Non-contact
- ☐ Was match/training under:
  - ☐ Natural light
  - ☐ Artificial light
- ☐ Other (please specify): _____

17.

a. At what stage of the season did the injury occur?

- ☐ Off-season
- ☐ Pre-season
- ☐ In-season
  - ☐ First month of the season
  - ☐ Mid-season
  - ☐ Last month of the season

b. What type of match was it?

Level of the game

- ☐ School
- ☐ School Provincial
- ☐ School International
- ☐ Club
- ☐ Non-professional Provincial
- ☐ Professional Provincial
- ☐ International

Type of game

- ☐ Tournament/Competition
- ☐ Friendly match
- ☐ League match
- ☐ Practice match
- ☐ Social match
- ☐ Hostel league match
- ☐ Farm league match
- ☐ Informal league match

c. Grade of opposition

- ☐ School
- ☐ School Provincial
- ☐ School International
- ☐ Club
- ☐ Non-professional Provincial
- ☐ Professional Provincial
- ☐ International

d. In which period of the game did the injury occur?

- ☐ Warm-up
- ☐ 1st Quarter
- ☐ 2nd Quarter
- ☐ 3rd Quarter
- ☐ 4th Quarter

☐ Cool-down

e. Was the incident leading to the injury as a result of foul or dangerous play as defined in Law 10.4 “Dangerous Play and Misconduct”?

☐ Yes ☐ No

If *Yes*, then answer *17f* and if answered *No*, then complete *17g*

f. Classifications of dangerous play

☐ Punching or striking
☐ Stamping or trampling
☐ Kicking
☐ Tripping
☐ Early or late tackle
☐ Tackle above the line of the shoulders
☐ Stiff-arm tackle
☐ Playing a player without the ball
☐ Tackling an opponent whose feet are off the ground
☐ Dangerous charging
☐ Scrum front row rushing opponents
☐ Scrum front row lifting opponents
☐ Collapsing a scrum, ruck or maul
☐ Tip/lifting/spear tackle
☐ Retaliation

g. Did the referee take any action?

☐ Yes ☐ No

Explain:_____
_____
_____
_____

h. Playing position *at the time of injury*

☐ 1 – Loose-head prop
☐ 2 – Hooker
☐ 3 – Tight-head prop
☐ 4 – Lock
☐ 5 – Lock
☐ 6 – Open-side flank
☐ 7 – Blind-side flank
☐ 8 – Eighth man
☐ 9 – Scrum/Inside half
☐ 10 – Fly/Outside half
☐ 11- Left Wing
☐ 12 – Inside centre
☐ 13 – Outside centre
☐ 14 – Right Wing
☐ 15 – Full back

i. Was the player playing in his/her usual playing position?

☐ Yes ☐ No

If the player answered No, and was not playing in his/her usual position, then give the reason why?

_____
_____
_____
_____
_____
_____

18. Who was officiating or leading the match / training session?

☐ Referee
☐ Coach
☐ No-one
☐ Player
☐ Spectator
☐ Teacher
☐ Other (Please specify)_____

19. Was a Union-appointed referee in control of the game?

☐ Yes ☐ No

20.

a. Had the referee attended a SARU or IRB Level referee-training course?

☐ Yes ☐ No

b. If Yes then give details of referee's training:

_____
_____
_____

c. Date of the most recent course attended

D D / M M / Y Y Y Y

d. Had the referee attended a BokSmart Rugby Safety course?

☐ Yes ☐ No

e. If Yes then provide the referee's BS-number: _____

f. Had the coach attended a SARU or IRB Level coaching course?

☐ Yes ☐ No

g. If Yes then give details of the coach's training:

_____
_____
_____

h. Date of the most recent course attended

D D / M M / Y Y Y Y

i. Had the coach attended a BokSmart Rugby Safety course?

☐ Yes ☐ No

j. If Yes then provide the coach's BS-number: _____

21. Briefly describe the events that led up to the injury (if possible in the player's own words):

_____
_____

_____
_____

SECTION C: INJURY EVENT (PRINT CLEARLY)

22.

a. Did the player warm-up properly before the match or training session?

☐ Yes ☐ No

b. Did the player stretch before the match or training session?

☐ Yes ☐ No

23. Indicate the <u>event</u> causing the catastrophic injury (thereafter, please describe and answer the *relevant and corresponding <u>event</u>* section):

☐Collision
☐Tackle
☐Scrum
☐Ruck
☐Maul
☐Lineout
☐Kicking
☐Running
☐Other:_____
☐Unclear
☐Not applicable

24. ☐ *<u>Tackle</u>*

a. What was the injured player's role in the tackle?

☐ Ball carrier
- ☐ Tackled from behind
- ☐ Tackled from the side
- ☐ Tackled from the front

☐ Support player to ball carrier

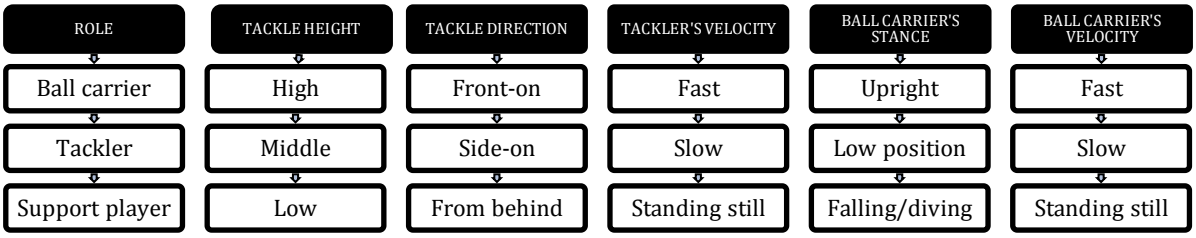
☐ Tackler
- ☐ Tackling from behind
- ☐ Tackling from the side
- ☐ Tackling from the front

☐ Support player to tackler

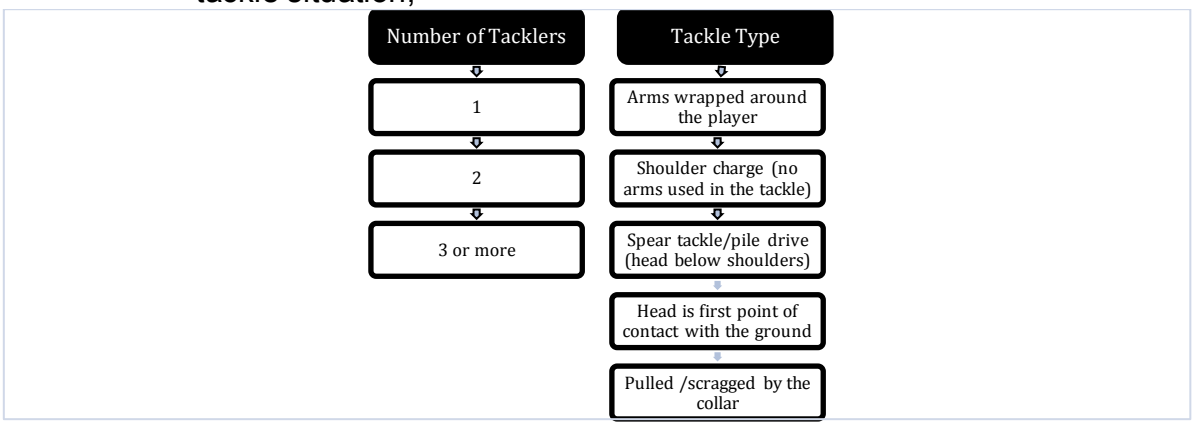
b. What type of contact was involved?

☐ Arm
☐ Collision (no-arms, deliberate)
☐ Jersey
☐ Lift (example spear)
☐ Shoulder
☐ Smother
☐ Tap

c. Indicate the following specifics as best you can with regards to the tackle situation;



d. Tick off all the additional specifics as best you can with regards to the tackle situation;



e. Please provide any further information relevant to the tackle e.g. head was first point of contact with the ground, upper body was first contact with the post, etc.

_____
_____
_____
_____
_____

25.

☐ *Scrum*

a. Was the scrum part of a training session or match

☐ Training session
☐ Match

b. If during Training, then was this against a scrum machine or live opposition?

☐ Scrum machine
☐ How many players were going in against the machine?____

☐ Live opposition
Indicate below how many players were contesting the scrum for both packs?

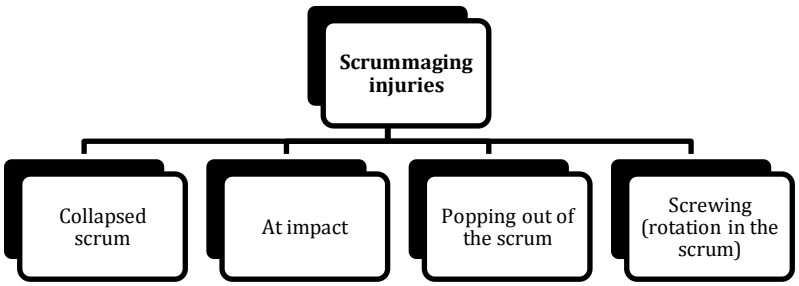
Injured player's team	Opposition team
☐ 3	☐ 3
☐ 5	☐ 5
☐ 6	☐ 6
☐ 7	☐ 7
☐ 8	☐ 8

c. Which team had the put-in in the scrum?

☐ Player's own team
☐ Opposition team

d. Did the injury involve any of the following:

☐ Collapsed scrum
☐ Impact on engagement
☐ Player popping out of the scrum
☐ Scrum wheeling/rotating



e. Please provide any further information relevant to the scrum e.g. which player popped first, which team collapsed first, number of scrum resets, make and age of scrum machine etc.

_____
_____
_____
_____
_____

26.

☐ *Ruck* or ☐ *Maul*

a. What was the injured player's role in the ruck/maul?
☐ Ball carrier
☐ Support player to ball carrier
☐ Tackler
☐ Support player to tackler

b. Body position at the time of injury
☐ On feet
☐ Off feet
☐ Bridging
☐ Supported

c. During the ruck/maul did the injury occur during any of the following?
   ☐ Cleaning out
   ☐ Cleaned out
   ☐ Collapsed maul
   ☐ Squeeze ball (ball pinned between legs)
   ☐ Other (please specify)_____

d. Please provide any further information relevant to the ruck/maul
   _____
   _____
   _____
   _____
   _____

27.
☐ *Lineout*

a. Identify how the injury occurred:

   ☐ 'Lifted player' fell during landing (no other player involved)
   ☐ 'Lifted player' fell during landing (other player(s) involved)
   ☐ 'Lifting player' injured (no other player involved)
   ☐ 'Lifting player' injured (other player(s) involved)
   ☐ Other (please specify below)

b. Please provide any further information relevant to the lineout e.g. which body part first made contact with the ground, etc.
   _____
   _____
   _____
   _____
   _____

28. Other categories

☐ Non-contact training
☐ Collision (if accidental, then describe below)
☐ Kicking
☐ Running

a. Please provide relevant information to the activity being undertaken at the time of injury e.g. weight training, passing drills, running drills, phase play simulations etc.
   _____
   _____
   _____

_____
_____

SECTION D: IMMEDIATE POST-INJURY CARE (PRINT CLEARLY)

29.

a. Who of the following *medical or allied health professionals* were the first to provide on-field treatment or support to the injured player during the match or training session?

- ☐ Medical Doctor
- ☐ Physiotherapist
- ☐ Biokineticist
- ☐ Emergency Service Medic (paramedic)
- ☐ First Aider
- ☐ Nurse
- ☐ None

b. When was the injured player FIRST attended to by the medical or allied health professional?

- ☐ On the pitch
- ☐ Off the pitch

30. Was the player FIRST attended to by someone OTHER than a medical or allied health professional?

☐ Yes ☐ No

a. If answered Yes, then by whom?

- ☐ BokSmart Rugby Medic
- ☐ Coach
- ☐ Referee
- ☐ Spectator
- ☐ Team official
- ☐ Other (Please specify)_____

b. What actions were taken by this person?

- ☐ Player moved on the pitch
- ☐ Player removed from the pitch
- ☐ None e.g. waited for arrival of the paramedics/doctor
- ☐ Other (Please specify)_____

31. Who managed/assisted with the removal of the player from the pitch?

- ☐ Medical Doctor
- ☐ Physiotherapist
- ☐ Biokineticist
- ☐ Emergency Service Medic (paramedic)
- ☐ First Aider
- ☐ Nurse
- ☐ BokSmart Rugby Medic
- ☐ Coach

- ☐ Referee
- ☐ Spectator
- ☐ Team official
- ☐ Player walked off unassisted
- ☐ Other player(s)
- ☐ Other (Please specify)_____

32. What equipment was used in the removal of the injured player from the pitch?

    a. Did they place a brace/collar over the neck? ☐ Yes ☐ No
    b. Was the injured player placed on a stretcher? ☐ Yes ☐ No
    c. Was the injured player placed on a spinal board? ☐ Yes ☐ No
    d. Was the injured player stabilised using a spider harness? ☐ Yes ☐ No
    e. Were head-blocks used to immobilise/stabilise the injured player's head and neck? ☐ Yes ☐ No
    f. Was Oxygen used? ☐ Yes ☐ No
    g. Other (Please specify)_____

33. Did the player *leave* the field at any time during the match *before* the injury and *return* to the field of play?

    ☐ Yes ☐ No

34. Was the BokSmart Spineline number (***0800 678 678***) contacted at any given stage during the management of the injured player?

    ☐ Yes ☐ No

    If answered No, then why not?

    _____
    _____
    __

35. Was the player taken *immediately* to hospital?

    ☐ Yes ☐ No

    a. How long did the player have to wait before being taken to hospital?

    ☐ < 1 hour
    ☐ 1-2 hours
    ☐ 2-3 hours
    ☐ 3-4 hours
    ☐ > 4 hours

    b. If more than 4 hours passed before being taken to hospital, then please specify the reasons why?

    _____
    _____
    _____

36. How was the injured player taken to hospital?
    ☐ Ambulance

☐ Car
☐ Helicopter
☐ Other (Please specify)_____

37. What hospital/medical facilities was the player taken to?
_____
_____
__

38. Was the injured player wearing any of the following at the time?
☐ Mouthguard
☐ Shoulder pads
☐ Headgear

SECTION E: EXPERIENCE AND TRAINING (PRINT CLEARLY)

39. The number of games played by the injured player *this season* prior to injury?
_____

40. Within the last 12 months did the injured player receive training from a qualified coach/trainer on how to *safely* and *correctly* perform the following activities?
    a. Tackling techniques ☐Yes ☐No
    b. Ball carrying techniques ☐Yes ☐No
    c. Safe techniques in contact ☐Yes ☐No
    d. Scrum techniques ☐Yes ☐No ☐Not relevant
    e. Scrum engagement ☐Yes ☐No ☐Not relevant
    f. Falling correctly in a collapsed scrum ☐Yes ☐No ☐Not relevant
    g. Ruck techniques ☐Yes ☐No
    h. Entering the ruck ☐Yes ☐No
    i. Maul techniques ☐Yes ☐No
    j. Entering a maul ☐Yes ☐No
    k. Lineout techniques ☐Yes ☐No ☐Not relevant
    l. Supporting in a lineout ☐Yes ☐No ☐Not relevant
    m. Supporting a jumper at kick-off ☐Yes ☐No ☐Not relevant

41. Did the player have a *regular coach* other than the head coach of the team in charge of his/her rugby development?

    ☐ Yes ☐ No

    If Yes, then answer 41 (a- e)

    a. Had the coach attended a SARU or IRB Level coaching course?

    ☐ Yes ☐ No

    b. If Yes then give details of the coach's training:
    _____
    _____

c. Date of the most recent course attended
D D / M M / Y Y Y Y

d. Had the coach attended a BokSmart Rugby Safety course?

☐ Yes ☐ No

e. If Yes then provide the coach's BS-number: _____

42.

a. Did the player receive specific coaching for his/her position by a qualified coach?

☐ Yes ☐ No

b. Did the player receive specific conditioning for his/her position by a qualified trainer?
☐ Yes ☐ No

43. How long before the season did the player take part in pre-season strength and fitness conditioning?
☐ Never
☐ 1-2 weeks
☐ 3-4 weeks
☐ 1-2 months
☐ 2-3 months
☐ ≥ 3 months

44. How many training sessions did the player undertake each week during the pre-season training period? (Please give number of sessions or 0 if none was undertaken)
a. Individual training sessions per week _____
b. Team training sessions per week _____

45. On average, how many formal structured rugby training sessions did the player perform per week (at the time of injury)?

☐ Never
☐ 1
☐ 2
☐ 3
☐ More than 3

46. Other than the official team training sessions, what individual training did the player perform? Specify how often, the type of activity, average duration of each session, etc.

Activity	**Intensity**				**How many times per week**	**Average duration (min)**
	Easy	*Moderate*	*Tough*	*Very hard*		
_____	E	M	T	VH	_____	_____min
_____	E	M	T	VH	_____	_____min
_____	E	M	T	VH	_____	_____min

_____ E M T VH _____ _____min
_____ E M T VH _____ _____min

47. Did the player participate in any strength/resistance/weight training at least twice per week during the season?

☐ Yes ☐ No

If YES, then for how many years has the player been performing structured strength/resistance/weight training and specify to what degree?

_____
_____
__

48. Did the player participate in any neck strengthening exercises?

☐ Yes ☐ No

If YES, specify:

☐ Rarely, no more than 1 session per season
☐ Occasionally, less than 1 session per month
☐ Often, at least 1 session per month
☐ Regularly, at least 1 session per week

For more detail on *neck strengthening*, please complete the table below:

Activity	**Intensity**				**How many times per week**	**Average duration (min)**
	Easy	*Moderate*	*Tough*	*Very hard*		
_____	E	M	T	VH	_____	_____min
_____	E	M	T	VH	_____	_____min
_____	E	M	T	VH	_____	_____min
_____	E	M	T	VH	_____	_____min
_____	E	M	T	VH	_____	_____min

49. Compared to the injured player's *normal* training regime, in the week preceding the injury, what was the training level?

a. Training Volume

☐ Lower
☐ The same
☐ Higher

b. Training Intensity

☐ Lower
☐ The same
☐ Higher

50. If injured in the *scrum*, then please answer the following:

a. How many scrum engagements did the injured player typically practice per session? _____

b. Compared to the injured player's *normal* training regime, in the week <u>preceding</u> the injury, what was the SCRUM SPECIFIC training level:

i. Training Volume

☐ Lower

☐ The same
☐ Higher

ii. Training Intensity

☐ Lower
☐ The same
☐ Higher

51. Did the player follow any special diet/eating plan before or during the season?

☐ Yes ☐ No

52. Did the player use any specific supplements before or during the season?

☐ Yes ☐ No

a. If YES, elaborate

_____
_____
__

SECTION F: PLAYING CONDITIONS (PRINT CLEARLY)

53. What was the weather like on the day of injury? Please tick all of the appropriate answers:

☐ Hot
☐ Dry
☐ Light Rain
☐ Overcast
☐ Cold
☐ Heavy Rain
☐ Windy
☐ Other (Please specify):_____

a. Were the weather conditions on the day of the player's injury ***<u>typical</u>*** for the location and time of year?

☐ Yes ☐ No

b. If NO, what are the typical weather conditions for the location and time of year at which the injury occurred?

_____
_____
__

c. What was the temperature at the time of injury? (You can get this information from the local weather service)_____

54. On what type of surface did the injury occur?

- ☐ Wood e.g. gym floor
- ☐ Tarmac or similar
- ☐ Concrete
- ☐ Natural grass
- ☐ Artificial turf – rubber infill
- ☐ Artificial turf – sand infill
- ☐ Dirt or sand
- ☐ Gravel
- ☐ Other (Please specify):_____

55. How hard was the field or surface?

- ☐ Soft
- ☐ Firm
- ☐ Very hard

56. How was the surface of the field?

- ☐ Slippery
- ☐ Medium grip
- ☐ Good, solid footing (hard grip)

57. What was the condition of the playing surface?

a. ☐ Even
   - ☐ Flat and rough
   - ☐ Flat and smooth

b. ☐ Uneven
   - ☐ Sloping and rough
   - ☐ Sloping and smooth

58. Does the player feel that the field condition contributed towards the injury?

☐ Yes ☐ No

59. If answered YES, please specify

_____
_____

60. What type of footwear was the player using at the time of injury?

- ☐ None
- ☐ Trainers/tekkies
- ☐ Studded boots
- ☐ Other (Please specify):_____

61. If wearing studded boots, please tick all applicable answers below:

- ☐ Brand new
- ☐ Worn in
- ☐ Old/damaged
- ☐ Short studs
- ☐ Long studs
- ☐ Multi studs
- ☐ Six studs
- ☐ Other (Please specify):_____

62. In the player's opinion, what was the main cause of his/her injury?

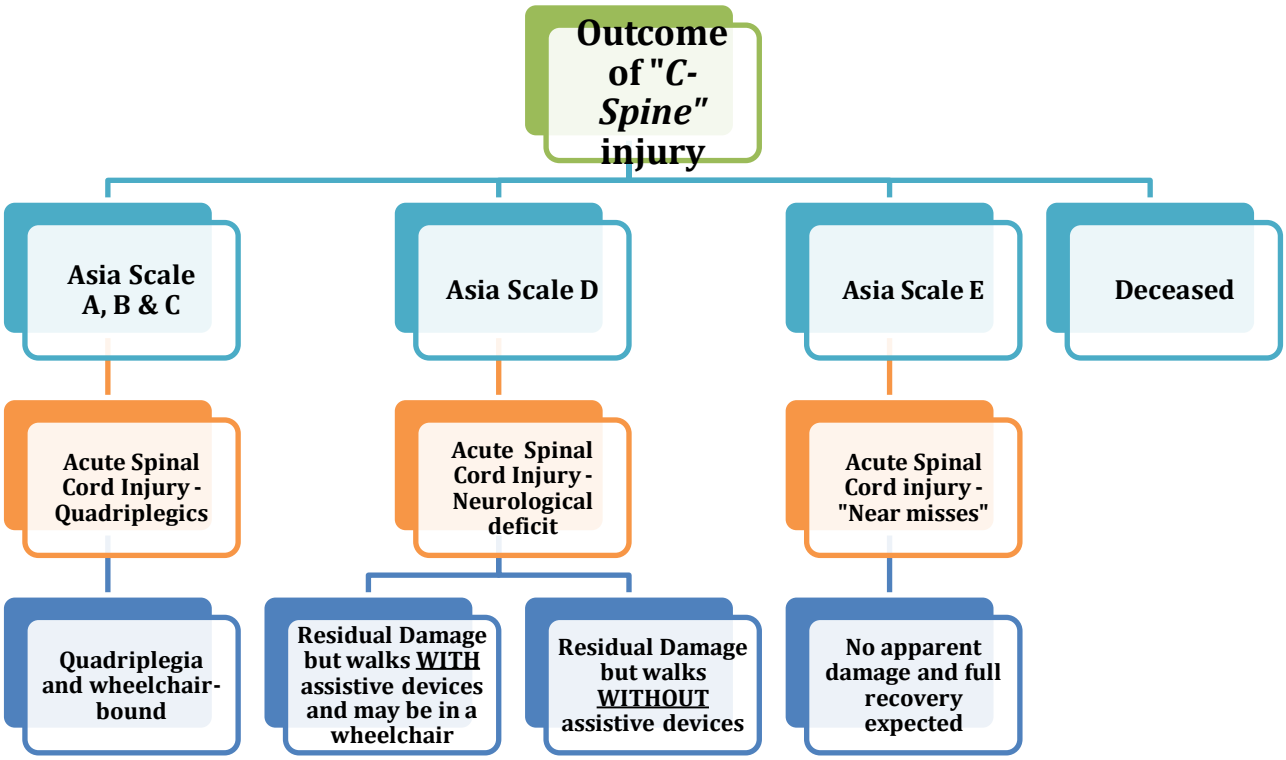
_____
_____
_____
_____

63. Does the player have any recommendations to prevent others from sustaining a similar injury?

_____
_____
_____
_____

SECTION G: OUTCOME OF INJURY (PRINT CLEARLY)

Outcome of Injury Classification Matrix for *Cervical Spinal Cord* Injuries (C1-C7):



64. What was the initial hospital-based *diagnosis*?

- ☐ Deceased
  - ☐ A fatal spinal cord injury
  - ☐ A fatal head injury
  - ☐ Cardiac event
  - ☐ Other e.g. stroke:_____

- ☐ Non-fatal Spinal Cord Injury

☐ Quadriplegia and Wheelchair bound

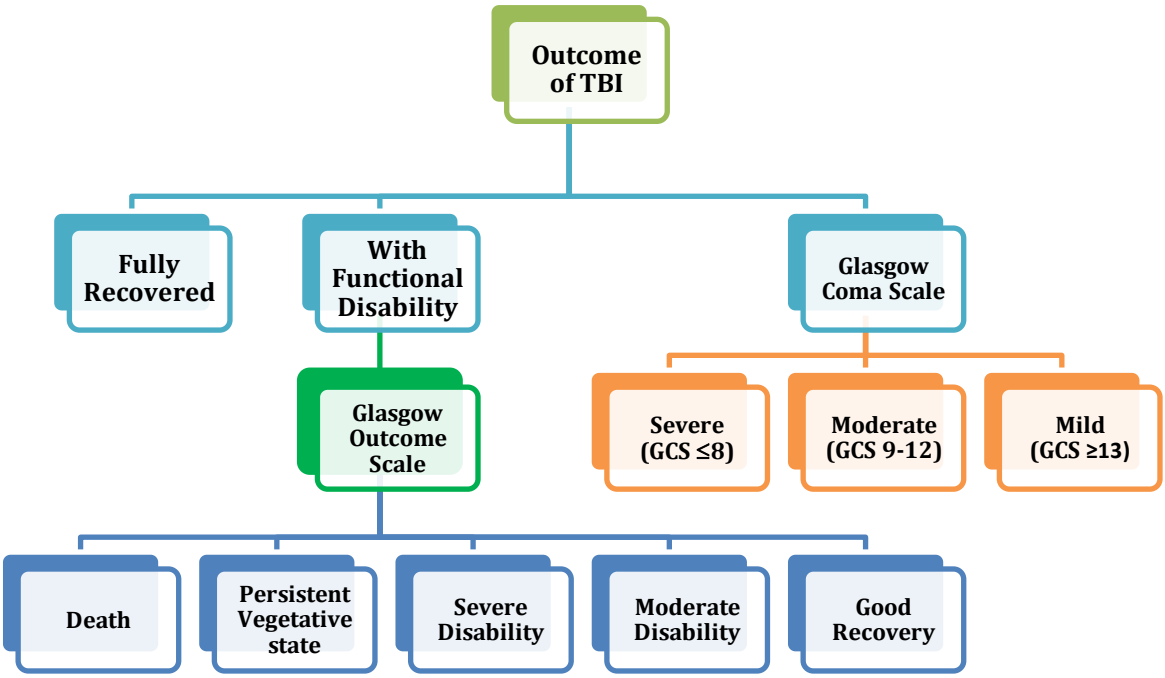
☐ Potential catastrophic injury with recovery (residual damage but walks with assistive devices and may be in a wheelchair)
☐ Potential catastrophic injury with recovery (residual damage but walks without assistive devices)
☐ No apparent residual damage and full recovery expected

☐ Head injuries (see Question 66)
☐ Fully recovered
☐ With disability

65. Asia Impairment Scale for *Cervical Spinal Cord* injured players at time of diagnosis

☐ A – *Complete*: no motor or sensory function is preserved in the sacral segments S4-S5
☐ B – *Incomplete*: sensory but not motor function is preserved below the neurological level, and includes the sacral segments S4-S5
☐ C – *Incomplete*: motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3
☐ D – *Incomplete*: motor function is preserved below the neurological level and at least half of key muscles below the neurological level have a muscle grade of 3 or more
☐ E – *Normal*: motor and sensory function are normal

Outcome of Injury Classification Matrix for *Head or TBI* Injuries



66. *Glasgow Coma Scale* (GCS) for Head or Brain (TBI) injured players at time of *diagnosis*:

    ☐ *Mild (GCS ≥ 13)* – loss of consciousness and/or confusion and disorientation was shorter than 30 minutes
    ☐ *Moderate (GCS 9-12)* – loss of consciousness >30 minutes; physical or cognitive impairments that may or may not resolve; benefit from rehabilitation
    ☐ *Severe (GCS ≤ 8)* – Coma; unconscious state; no meaningful response; no voluntary activities

67. *Glasgow Outcome Scale* (GOS) for Head or Brain (TBI) injured players at *discharge*:

    ☐ *Death*
    ☐ *Persistent Vegetative state* – A vegetative state that lasts for longer than 1 month. A vegetative state consists of sleep-wake cycles, arousal but no interaction with the environment and no localised response to pain
    ☐ *Severe Disability (conscious but disabled)* – patient depends on others for daily support due to mental or physical disability or both
    ☐ *Moderate disability (disabled but independent)* – patient is independent as far as daily life is concerned. The disability found includes varying degrees of dysphasia, hemiparesis, ataxia, as well as intellectual and memory deficits and personality changes
    ☐ *Good recovery* – Resumption of normal activities even though there may be minor neurological or psychological deficits

SECTION H: PLAYER'S MEDICAL HISTORY (PRINT CLEARLY)

68.

a. Did the player suffer from any medical conditions or illnesses that interrupted their training or match play in the week prior to the injury?

   ☐ Yes ☐ No

b. If YES, then describe the conditions/illnesses:

_____
_____

69.

a. Does the player have any long-term medical conditions or illnesses that may be relevant to the injury e.g. epilepsy, diabetes?
   ☐ Yes ☐ No

b. If YES, then describe the conditions/illnesses:

_____
_____

70.

a. Does the player have a history of "stinger" (also known as burner, nerve pinch and brachial plexus injuries)?

   ☐ Yes ☐ No

b. If YES, then describe the history:

_____
_____

71.

a. Had the player ever sustained a previous *neck/spinal injury* before?
   ☐ Yes ☐ No

b. If YES, then please provide details of the nature and circumstances of the previous neck/spinal injury:

_____
_____

c. Had the player ever sustained a previous *SIGNIFICANT neck/spinal* injury (that is requiring hospital admission or scans (MRI or CT scan), with prolonged symptoms for over 1 month, associated with arm symptoms or preventing play for more than 2 weeks):
   ☐ Yes ☐ No

d. If YES, then please provide details of the nature and circumstances of the previous SIGNIFICANT neck/spinal injury:

_____
_____

e. Had the player fully recovered from the previous SIGNIFICANT neck/spinal injury before starting the match/training session in which the current injury was sustained?
☐ Yes ☐ No

f. Did the player receive treatment for the previous neck/spinal injury?
☐ Yes ☐ No

g. Briefly describe the treatment received:

_____
_____

72.

a. Had the player ever sustained a previous *head/brain/concussion* injury before?
☐ Yes ☐ No

b. If YES, then please provide details of the nature and circumstances of the previous head/brain/concussion injury:

_____
_____

c. Had the player ever sustained a previous *SIGNIFICANT head/brain/concussion* injury (with symptoms lasting more than 3 weeks or requiring hospital admission or scans (MRI or CT scan)):
☐ Yes ☐ No

d. If YES, then please provide details of the nature and circumstances of the previous SIGNIFICANT head/brain/concussion injury:

_____
_____

e. Had the player fully recovered from the previous SIGNIFICANT head/brain/concussion injury before starting the match/training session in which the current injury was sustained?
☐ Yes ☐ No

f. Did the player receive treatment for the previous SIGNIFICANT head/brain/concussion injury?
☐ Yes ☐ No

g. Briefly describe the treatment received:_____

APPENDIX VII – COST DIARY FOR QUANTIFICATION OF MEDICAL TREATMENTS SOUGHT AND WORK AND SCHOOL MISSED

SARU Youth Tournaments 2012:

Injury Cost Diary

Injury period: __/__/_____ - __/__/_____

STOP RECORDING AS SOON AS PLAYER RETURNS TO PLAY (contact practice or match)

Are you speaking with the <u>Parent (preferable)</u> OR <u>Player</u> (PLEASE CIRCLE)

Player name:_____

Player Cell number:_____

Player Parent Name:_____

Parent Cell number:_____

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CONFIRMED AS TIME-LOSS (missed >1 match or >1 day training or usual activities)	**YES/NO**
MEDICAL AID (includes Hosp. Plan)?	**YES/NO**
COMPANY (e.g. Discovery, Momentum)	
SCHEME (e.g. Key Care, Hospital Plan only, Health Saver)	

WEEK____ OF INJURY: DATE:___/___/____ - ___/___/_____
(TODAY'S DATE)

Medical professional (e.g. GP, Dentist)	Details (e.g.,ankle brace, surgery)	OOP/C?	Cost and currency	Date
e.g. Dentist	*Root Canal and stitches removed*	*C*	*R4000*	*13/07/2012*
e.g. GP	*Follow-up and neck brace*	*OOP*	*Zim$1600*	*15/07/2012*
1.				
2.				
3.				
4.				

OOP – Out of Pocket expense; C – covered expenses

Player/Parent/Caretaker of Player	Time lost (e.g total school hours/total work hours)
e.g. Player	*5 days of school (7 x 5 = 35 hours)*
1.	
2.	
3.	

Extra notes:

_____

_____