# CONCUSSION AND RETURN-TO-PLAY: KNOWLEDGE, ROLES AND RESPONSIBILITIES IN THE WESTERN PROVINCE CLUB RUGBY ROLE PLAYERS

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**Thesis presented in partial fulfilment of the requirements for the degree Master of Science in the Department of Sport Science, Faculty of Heath Sciences at Stellenbosch University**

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## DECLARATION

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The two authors that form part of this thesis, Dr Wilbur Kraak (supervisor) and Dr Karen Welman (co-supervisor), hereby give permission for the candidate, Mr Johannes van Vuuren, to include the two articles as part of a Master's thesis. The contribution (advise and support) of the co-authors was kept within reasonable limits, thereby enabling the candidate to submit this thesis for examination purposes. This thesis therefor serves as fulfilment, of the requirements for the degree of Masters in Sport Science at Stellenbosch University.

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## DEDICATION

This thesis is dedicated to the players who have suffered a concussion or any injury for that matter. The safety and well-being of players should at all times be our main concern.

Secondly, I would like to dedicate this thesis to students, coaches and staff who are passionate about rugby. Regardless of circumstances, passion will always trump adversity.

## SUMMARY

Rugby is a sport played globally and has a high risk of injury with concussion making up a fair proportion of these injuries. The knowledge of concussion has been said to influence the reporting of symptoms, and therefore, influencing the management and post-concussion return-to-play. A lack of knowledge has been reported in numerous role players, such as coaches, medical staff, administrative staff and not only in players. Education and translation of relevant information is needed to affect the attitude of role players for the correct implementation of return-to-play post-concussion. Within an amateur environment, medical assistance could be lacking, and therefore, the role of concussion management and post-concussion return-to-play should be shared among all role players. The first objective of the current study was to determine the knowledge and attitudes among amateur club rugby role players in the Western Province Rugby Union regarding concussion. The second objective was to investigate the post-concussion return-to-play implementation, roles and responsibilities among amateur club rugby role players.

The thesis consists of two research articles. The first objective will be addressed in Article one, titled: '*Concussion knowledge, risk- and precaution-taking attitude among amateur club rugby role players'.* The results indicated that overall the participants scored 73% for concussion knowledge. The players scored the lowest (67%) in contrast to medical staff (79%) and referees (78%). Regarding the attitudes towards concussion, players (36%) demonstrated the highest risk-taking score in contrast to referees (90%), who demonstrated the greatest precaution taking score. The findings demonstrated the superior knowledge and attitude of referees and highlighted their importance in player's safety.

Article two, titled: *Post-concussion return-to-play: Roles, responsibilities and implementation among amateur club rugby role players* addresses the second objective of the study. The results indicated that coaches were perceived by players (74%) and other coaches (88%) to have knowledge of post-concussion RTP guidelines. Coaches were also deemed responsible by the majority of players (71%) and other coaches (80%) for monitoring training and matches for injuries. The correct order to the six-stage RTP protocol was successfully identified by less than half (40%) of medical staff and by only a third (37%) of the coaches, which warrants concern

because this protocol was selected to be implemented in the event of a concussion. Coaches therefore, although being selected as responsible role player in RTP, revealed less than optimal post-concussion RTP protocol implementation.

By investigating concussion and post-concussion RTP knowledge, roles, responsibilities within amateur club rugby, will help identify areas of concern. The areas of concern could include misconceptions in concussion knowledge or implementation of post-concussion RTP guidelines. A practical recommendation would be to have a pre-season education workshop strictly for concussion and post-concussion RTP for all role players within the club. This would encompass that concussion management systems are in place, medical staff qualifications are in order and that personnel can implement the post-concussion RTP protocol.

# OPSOMMING

Rugby is ‘n internasionale sport wat ‘n hoë risiko van beserings inhou, veral harsingskudding aangesien dit ‘n kontaksport is. Kennis van harsingskudding kan die aanmelding van simptome asook die bestuur daarvan en die terugkeer na spel affekteer. ‘n Tekort aan kennis is deur menige rolspelers onder andere afrigters, mediese en administratiewe personeel en nie slegs spelers nie, gerapporteer. Opleiding en die oordrag van relevante kennis word benodig om die terugkeer van spelers na harsingskudding te vergemaklik. Binne ‘n amateur omgewing kan mediese sorg ‘n tekortkoming wees en daarom moet harsingskudding deur alle rolspelers, voordat die speeler(s) na die spel kan terugkeer bestuur word. Die eerste doelwit van die studie was om te bepaal wat die kennis en ingesteldheid in Westelike Provinsie Rugby Unie klubs oor harsinskudding was. Die tweede doelwit was om na die na-konkussie terugkeer te bepaal wat die implementering, rolle en verantwoordelikhede in amateur rugby klub rugby rolspelers was.

Die tesis is vervat in twee navorsingsartikels. Die eerste doelwit word aangespreek in Artikel een: ‘*Harsingskudding kennis, risiko- en voorsorg-ingesteldheid van amateur klub rugby rolspelers’*. Die resultate het getoon dat die deelmemers 73% verwerf het vir harsingskudding kennis, met spelers wat die laagste (67%) in kontras met mediese personeel (79%) en skeidsregters (78%) verwerf het. Aangaande die ingesteldheid tot harsingskudding het spelers (36%) die hoogste risiko totaal verwerf in kontras met skeidsregters (90%) wat die hoogste voorsorgmaatreel verwerf het. Die bevindinge demonstreer die uitmuntende kennis en ingesteldheid van skeidsregters en die belangrike rol wat hulle in speler veiligheid speel.

Artikel twee is getiteld: ‘*Harsingskudding terugkeer-na-spel implementasie, rolle en verantwoordelikhede in amateur klub rugby rolspelers’* en spreek die tweede doelwit aan. Die resultate het aangedui dat spelers (74%) en afrigters (88%) glo dat afrigters kennis behoort te dra van harsingskudding en die terugkeer na die spel. Afrigters was ook geag as verantwoordelik vir die monitering van oefening en wedstryde vir beserings deur beide spelers (71%) en afrigters (80%). Die korrekte ses-vlak terugkeer na spel protokol is slegs korrek geïdentifiseer deur (40%) van mediese personeel en slegs ‘n derde (37%) van die afrigters, wat kommerwekkend is

aangesien dit die voorgestelde protokol is in die geval van harsingskudding. Alhoewel daar verwag is dat afrigters die meeste verantwoordelikheid moet dra met die terugkeer na die spel na harsingskudding, is hul implementering hiervan kommerwekkend.

Deur ondersoek in te stel na harsingskudding en die terugkeer tot die spel, rolle en verantwoordelikhede in die amateur klub rugby kan help om areas van bekommernis te identifiseer. Dit kan tekortkominge in harsingskuding kennis en of die terugkeer na spel wees. ‘n Voorstel sal wees om ‘n voor-seisoen opleidingsessie vir harsingskudding en die terugkeer na die spel vir alle rolspelers binne die klub aan te bied. Dit behoort die korrekte harsingskudding bestuurssisteme, evaluasie van mediese kwalifikasies en dat rolspelers verstaan hoe om die terugkeer na die spel protokol te implementeer.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| RTP | Return-to-play |
| WR | World Rugby |
| NCAA | National Collegiate Athletic Association |
| SCAT | Sports concussion assessment tool |
| CKI | Concussion Knowledge Index |
| CAI | Concussion Attitude Index |
| ROCKAS-ST | Rosenbaum concussion knowledge and attitude survey student version |
| SARU | South African Rugby Union |
| WPRU | Western Province Rugby Union |

# APPENDICES

# CHAPTER 1

# INTRODUCTION AND PROBLEM STATEMENT

*Referencing within the chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.*

## Introduction

Rugby Union (hereafter referred to as rugby) is a dynamic, high intensity contact sport played worldwide by participants in teams of all ages and sexes (Walker, 2015:50; Lopez *et al*., 2016:1320). Due to the contact nature of the game and amount of collisions, there is always an inherent high risk of injuries in rugby participation (King *et al*., 2012; Roberts *et al*., 2013; Williams *et al*., 2013; Brown *et al*., 2016). On a professional level the incidence of rugby injuries has been estimated at 81 per 1000 match hours (Williams *et al*., 2013). However, a review of amateur rugby injuries indicated an incidence of 47 per 1000 match hours (Yeomans *et al*., 2018). These findings are also indicative of a greater incidence of injuries on a higher level of play; however, injury incidence at amateur level could be under-reported due to a lack of reporting regimes and their implementation (Makdissi *et al*., 2013).

Of the various reported injuries in rugby, concussion is one of the most frequent serious injuries with regards to long-term consequences (Marshall & Spencer, 2001). It is considered a mild traumatic brain injury, which involves a complex pathophysiological process because of biomechanical forces (Chow *et al*., 2018). Concussions make up 4 to 14% of all rugby-related injuries at school level, although at senior level it ranges from 3 to 23% per season (Walker, 2015). From a South African perspective, a high incidence of concussion has been observed from 2011 to 2014 in youth week tournaments. The average concussion incidence across the under (u) 13, u16 and u18 youth week rugby was 6.8 concussions per 1000 match hours (McFie *et al.*, 2016). This is similar to previously reported incidences by McIntosh *et al*. (2010) who reported 6.9 concussions per 1000 match hours between 2002 and 2003. Silver *et al*. (2018), however, found nearly double the incidence in youth community rugby at 12.7 concussion per 1000 match hours. According to Martin *et al*. (2017) players have different risk profiles depending on the level of play, which can be attributed to experience and attitude towards the match. The unsafe attitude towards concussion has been associated with under reporting of concussive symptoms (Register-Mihalik *et al*., 2013). Younger or less experienced players and their coaches may, therefore, differ in their attitudes and knowledge regarding concussions compared to older or more experienced players. In addition, numerous other factors such as baseline testing, player-physician relationships and the testing environment

could affect the reporting of suspected concussion and subsequently this could affect the removal of players from the field (Martin *et al*., 2017)

Unlike other injuries, the symptoms of a concussion might not be that apparent to various individuals with specifically assigned tasks within the sport known as role players. These role-players can be in the form of coaches, teammates or the players themselves (Chinn & Porter, 2013). In fact, these symptoms (following a concussion) may go unreported, because it may seem standard to role players in contact sport and go seemingly unnoticed following a match (Porcher & Solecki, 2013). The underreported concussion rates on amateur level could also be because medical assistance being non-existing at matches, as well as a lack of funding (Viljoen *et al*., 2017). According to Patricios *et al*. (2017), at a lower level of competition with limited medical staff, the standard procedure should be to recognize and remove any player with a suspected concussion. Recognize and remove is a protocol advocated by World Rugby (WR), consisting of the six R's. Recognizing the signs, remove the player immediately, referring them to a healthcare professional, resting until asymptomatic, recovering before commencing with return-to-play (RTP) and thereafter only retuning (World Rugby,2014) .To implement this, it is assumed that role players should have some concussion knowledge. Underreporting of symptoms could explain low incidence rates; however, since 2012 WR has implemented a head injury assessment and educational programs, which have been advocated to address this issue (Rafferty *et al.,* 2019). Consequently, knowledge, attitude and the behaviour of the role players who attend to concussed players are of vital importance in identification and treatment.

Once a concussion has been sustained and identified, the process to RTP begins with the use of RTP protocols. Typically, the RTP protocols advocate no same-day RTP and incremental stages of activity to be completed before being cleared by a healthcare professional. RTP before the necessary exclusion time period has passed could lead to more severe consequences for the sportsperson, like second impact syndrome (Harmon *et al.,* 2013; Melander & Moen, 2014). Kemp *et al.* (2016) found that athletes also have a greater risk of musculoskeletal injury following their RTP protocols which could be because some RTP protocols do not focus on re-training of neuromuscular control, but rather just rest. Brown *et al*. (2016) stated that there have

been numerous RTP protocols, which could be opposing and cause indecision amongst the implementing role players. In an attempt to consolidate the RTP strategies, the 2016 Berlin consensus statement on sport-related concussions suggested RTP guidelines after which the sport person may RTP. RTP is a responsibility, which is to be shared across different role players of which players are only one of the many individuals involved (Hollis *et al.*, 2012). Conversely, even though the current RTP guidelines are more consistent than previous versions, research is lacking in timing, type and intensity of RTP (Leddy *et al*., 2018). Strict adherence to the RTP protocol should ensure that all the symptoms have been resolved, which can decrease the rate of re-injury (Giza *et al*., 2013). Clarity regarding recommendations such as a cognitive rest, which can be considered ambiguous and result in premature RTP.

Globally governing bodies, coaches and medical professionals, now more than ever, have a greater responsibility to implement guidelines in the event of a concussion. As concussion is prevalent in contact sport, there is an increasing need to educate coaches, players and administrators regarding the recognition of a concussion, the immediate management protocol, signs and symptoms and recommended RTP protocols available (Delahunty *et al*., 2015). In the South African context regarding educational safety programs, disparities have been found between coaches in different socio-economic environments. Coaches in high socio-economic environments did not believe they had a risk of experiencing catastrophic injuries, whereas coaches in low socio-economic environments overestimated the effect safety workshops have on injury prevention (Brown *et al.*, 2016). A study by Zuckerman *et al.* (2017) on concussed student-athletes from lower socio-economic status found that they missed less school, consequently not adhering to the prescribed cognitive rest. The abovementioned phenomenon could thus give us context into community rugby and explain the limited adherence to RTP advice. As in community rugby, numerous role players can have the responsibility to implement concussion protocols.

When looking at previous studies regarding attitudes and knowledge of concussions, numerous questionnaires were developed. Rosenbaum from Pennsylvania State University created the *Rosenbaum Concussion Knowledge and Attitude Survey – for*

*Students Version* (RoCKAS-ST) and it was found to be valid and reliable in assessing knowledge and attitude of concussion in assessing age-grade students (Rosenbaum & Arnett, 2010). Delahunty *et al*. (2015) only investigated attitudes concerning concussion in Irish schoolboy-rugby by using a questionnaire for the same age group developed by Sye *et al*. (2006). Walker (2015), however, measured the knowledge of concussion using a 13-item questionnaire developed by Jansen van Rensburg (2013). Most of the research about concussion knowledge and attitudes has been done with adolescents due to their vulnerability to repeated concussions.

Role players attitudes towards and knowledge of concussion may influence their decisions and judgments. Sye *et al*. (2006) investigated adolescent sport persons and found a 50% RTP without medical clearance and 27% believed match importance should influence the RTP decision. It is possible that these decisions may have been based on the role players' attitude and understanding of concussion. According to the theory of planned behaviour, which has been previously used to explain concussion reporting (Register-Mihalik *et al*., 2013), self-efficacy has been found to be one of the key components in predicting behaviour. Behaviour in concussion could refer to reporting of symptoms or adherence to RTP post-concussion. Whether the role-players implement a RTP protocol is consequently dependent on these individuals confidence to perform this behaviour under specific conditions (Kroshus *et al*., 2014). Therefore, to guide concussion management, as well as policymaking and implementation, it is important to investigate concussion and RTP knowledge, as well as the roles and responsibilities of role players within Western Province Rugby Union (WPRU) club rugby.

**Problem statement**

According to Rosenbaum and Arnett (2010), it is uncertain whether the effort to improve the safety of players by increasing awareness of concussion has practically made a difference. McCrea *et al*. (2004) found players did not believe concussion was serious enough to report, as well as not wanting to be removed from play following a suspected concussion. If medical staff are not available, coaches are often left with the responsibility of managing the concussed player. There is, thus, a need to examine

concussion knowledge and attitudes among players and role players involved in training and matches.

Due to different factors that could play a role in concussion, various resources need to be used in the assessment and rehabilitation process (Melander & Moen, 2014). There are numerous RTP protocols' but the main concern is whether they are being followed to the full. The current guidelines that are being implemented still only provide a vague framework, which relies completely on subjective measurements of symptoms. In the United States of America, a study was performed on concussion management within the National Collegiate Athletic Association (NCAA) schools. The study found that there was minimal compliance with the existence and implementation of concussion components (Baugh *et al*., 2015). The NCAA study by Baugh *et al*. (2015) suggested the implementation of institutional officials to monitor compliance with concussion policies within these schools.

The same tools that are used in the assessment of concussion can be used in RTP, but should be used under the supervision of licenced health care professionals. Various factors affect sport persons' decision to prematurely RTP; sport persons are under pressure by coaches, spectators and most of all themselves. Without the proper knowledge of this injury, sport persons can potentially be putting their health, as well as sport futures, at risk (Chermann *et al*., 2014). Lack of concussion knowledge has been found to be the main problem in players, but also in parents and has a significant impact on the detection and management process of concussion (Fraas & Burchiel, 2016). The lack of a universal tool in diagnosing concussion has led to a spike in both self-diagnosis and under-reporting of incidences. The main component of any RTP protocol is the ability of the sport person to exercise at their sport level without a re-occurrence of symptoms.

There is a lack of published research investigating the various role players' knowledge and implementation regarding concussion and RTP in WPRU club rugby. It is possible that due to role players' lack of concussion knowledge and/or disregard for current RTP recommendations within WPRU club rugby that players' safety may be neglected. A similar conclusion has previously been made by Clacy *et al*. (2017) at community

rugby level, who stated a general confusion regarding the roles and responsibilities in the event of a concussion. It is for these reasons that the primary researcher set out to investigate the concussion knowledge of players, coaches, medical staff, administrative staff and referees.

**Aim of the study**

The primary aim of the current study was to investigate concussion and post-concussion RTP knowledge, roles and responsibilities among WPRU club rugby role players (i.e. players, coaches, medical staff, administrative staff and referees).

**Specific objectives**

The specific objectives were to determine the concussion knowledge and attitudes among amateur club rugby role players. This objective will be discussed in research article one (Chapter 4).

The objective to investigate the post-concussion roles, responsibilities and implementation among amateur club rugby role players will be discussed in research article two (Chapter 5).

**Motivation**

The investigation of concussion and post-concussion RTP knowledge, roles and responsibilities within the WPRU club rugby will help identify key areas of concern regarding concussion management. The study might identify key misconceptions and show the need for better knowledge dissemination, as well as how to effectively apply guidelines in amateur rugby environments. Investigating the roles and responsibilities could identify key stakeholders who are perceived by others to be able to assist in the event of a concussion and who can assist concussed sport persons with post-concussion RTP. Brown *et al*. (2016) stated that at amateur level, medical assistance could be lacking, thus, all role players should share the responsibility of concussion management.

**Structure of thesis**

The thesis is presented in research article format. The two research articles (Chapters Four and Five), were prepared according to the guidelines of the specific journals (appendix D & E). Consequently, the referencing style used in the different chapters of this thesis will differ.

Chapter One: This chapter contains the introduction and problem statement. The Harvard method of reference was used in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.

Chapter Two: Literature review: The purpose of this chapter was to summarise the existing literature relating to rugby in the context of South Africa, specifically in the Western Province. Secondly, to provide insight on concussion and post-concussion RTP knowledge, roles and responsibilities. Again, the Harvard method of reference was used in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.

Chapter Three: This chapter includes the methodology and the Harvard method of reference was used in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.

Chapter Four: Research article one titled Concussion knowledge with risk- and precaution-taking attitudes among amateur club rugby role players. This chapter was written according to the author guidelines of the International Journal of Sports Medicine (Appendix D).

Chapter Five: Research article two titled Post-concussion return-to-play: Roles, responsibilities and implementation among amateur club rugby role players. This chapter was written in accordance with the author guidelines of the Journal of Science and Medicine in Sport. (Appendix E).
Chapter Six: Summary, limitations and future research.

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# CHAPTER 2

# LITERATURE REVIEW

*Referencing within this chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.*

## Introduction

Rugby is one of the most popular sport codes globally, however, given the physical nature of the game it has some of the highest proportions of injuries compared to soccer and basketball (Williams *et al*., 2013:1049; Tee *et al*., 2017:899; Yeomans *et al*., 2018:838). Then again, the rate of injuries are comparable to the likes of ice hockey, Australian Football League and National Rugby League (Yeomans *et al*., 2018). Within professional Australian rugby, head injuries to players, (including concussion), were found to be the most frequently (25%) (Bathgate *et al*., 2002; Kaux *et al*., 2015). Therefore, because of the nature of rugby, players are likely to sustain numerous concussions over a season, as well as throughout their career (Baker *et al*., 2013). For both recreational and professional sport, concussion has been found to be a major health concern (Lebrun *et al*., 2013). Media coverage as of late has placed much needed attention on the consequences of repeated concussions and the possible link to long-term health impairments like neurocognitive disorders (Mckee *et al.*, 2009; Prien *et al*., 2018), which encompass cognitive and behavioural problems (Kurowski *et al*., 2014).

The unsafe attitude and lack of knowledge towards concussion have been found to be a determining factor in the under reporting of concussion symptoms (Register-Mihalik *et al*., 2013). Of critical importance is also how concussion is managed after it has been identified and symptoms have been resolved. After symptoms have been resolved, the adherence to a post-concussion return-to-play (RTP) protocol[1] is required under the supervision of medical professionals (Gardner *et al*., 2014; Wallace *et al*., 2016). The post-concussion RTP protocol, as outlined by the Berlin consensus statement, consists of stepwise increases in physical demands to ensure players are asymptomatic before returning to sport (McCrory *et al*., 2013; McCrory *et al*., 2017). Fraas and Burchiel (2016) in a systematic review, stated that the proper identification of symptoms, concussion management and post-concussion RTP procedure are made increasingly challenging because of the lack of knowledge by different role players such as players, parents, coaches, referees and medical staff. The post-concussion RTP protocol is still a growing challenge and the RTP-facilitator (including

[1] *The stepwise/graduated/graded return-to-play following a concussion will for the purpose of this literature review only be referred to as RTP or post-concussion RTP.

role players such as the coach, clinician, trainer or health care professional), have the goal of ensuring a fast return without risking re-injury (Wallace *et al*., 2016).

Although educational programs/resources provide definitions, consensus statements and clinical evidence on the matter, as well as the application of concussion guidelines are still a major concern (Sabini *et al*., 2014). Finch *et al*. (2013) and White *et al*. (2014) expressed concern specifically regarding the translation of concussion guidelines to non-elite and community sport populations. Ensuring that information reaches target audiences through implementing the preferred method of learning of each role player is referred to as knowledge transfer. Provvidenza *et al*. (2013) applied the knowledge transfer principles to sport-related concussion and the various end-users (role players) then demonstrated a variety of individualized learning strategies (Provvidenza *et al.*, 2009). Clacy *et al*. (2017) suggested that there was a greater concussion knowledge transfer through inter-role communication (e.g. RTP decisions between the club, medical staff and players), in contrast to formal concussion guidelines. This can be attributed to not all role players in community sport having access to, or understanding the guidelines (Clacy *et al*., 2017) and consequently individualized strategies should be considered. However, before this can be done, surveying the existing knowledge (of concussion and post-concussion RTP), as well as the roles and responsibilities of those involved in concussion management, should be investigated first. As the incidence of concussion in rugby has grown, multiple preventative programmes worldwide were designed and implemented (Sewry *et al*., 2017). National prevention programs such as New Zealand's RugbySmart©, Australia's SmartRugby© and South Africa's BokSmart© have been met with some success in decreasing the rate of catastrophic head, neck and spinal cord injuries (Brown *et al*., 2013; Suzuki *et al.*, 2019). Although these programmes have proven helpful, numerous barriers still exist, which is why additional educational strategies are required to target specific role players (Brown *et al*., 2016).

The aim of this chapter was to give context to rugby, specifically in South Africa within the Western Cape Province and to summarize existing literature pertaining to concussion and post-concussion RTP knowledge, roles and responsibilities of the role players.

## Rugby

### Background

Rugby is a team sport with over 7.7 million participants in 129 countries (Hume *et al*., 2017) and growing in popularity especially at an amateur level (Hollis *et al*., 2009). Men and women in various categories, for example play the sport, on junior, amateur and professional levels (Brooks & Kemp, 2008). Professional referred to as elite, can be defined as playing at national or international level, whereas amateurs or community players play for clubs (Hume *et al*., 2017).

The game has multiple modified variations for different competitions such as Tag Rugby and Rugby Sevens, however, rugby union is the most popular (King *et al*., 2012, Yeomans *et al.*, 2018). The game consists of two teams of 15 players, played over 80 minutes (Hume *et al*., 2017). The primary method of progressing play within a match is by running forward with the ball, whilst the opposition attempts to prevent this by tackling the ball carrier (MacQueen & Dexter, 2010). Players, therefore, require numerous physical attributes and skills in order to be successful in a match (Basson *et al*., 2018). Within a match, numerous physical skills are performed (Hendricks *et al.*, 2017), all of which could play a role in determining the match outcome.

Rugby, like many team-contact sports is characterized by multiple collisions (Hendricks *et al.*, 2017; Roberts *et al.*, 2017) with other players, as well with the ground (Fuller *et al*., 2010). In the Super Rugby competition, it was found that loose forwards, specifically the open side (7) flankers were involved in the highest collision rate of up to 50 in an 80-minute match (Schoeman & Schall, 2019). In comparison, King *et al.* (2014) investigated amateur rugby and found that players were involved in an average of 77 collision events per match. Although not directly comparable, the above-mentioned statistics can give us an indication of the contact nature of the game. These contact events throughout the matches are interspersed with high running demands of varying intensities (Yeomans *et al*., 2018). Rugby matches involve physical contact activities, such as tackling, rucking and mauling (Quarrie *et al.*, 2013) interspersed with periods of lower intensity activity such as jogging (Roberts *et al.*, 2013). The demands of rugby matches have increased over time, which entails that players now participate in more frequent contact events of greater intensity (Van Rooyen *et al*.,

2008; Owen *et al.*, 2015). Regarding playing positions, forwards and backs have different demands, which need to be considered (Vaz *et al.*, 2015). Forwards, for example, are more frequently involved in rucks and tackles in comparison to backs (Lindsay *et al*., 2015). In contrast, backs are subjected to complete more accelerations and decelerations of varying intensity (Owen *et al*., 2015).

Factors such as law changes and amendments to the game have also resulted in increased ball in play time across some levels, as well as greater physical contact events (Kraak *et al.,* 2015). Kraak *et al*. (2015) investigated experimental law variations in Super Rugby between 2008 and 2013 and found an increase in the number of ball carries (an increase from 166 to 206). The greater number of carriers in the competition led to an increase in the number of tackles (an increase from 196 to 217) (Kraak *et al*., 2015). In hostel rugby (played by university students) the tackle, was the event leading to most injuries (Mathewson & Grobbelaar, 2015). In a 3-year surveillance study on an international team, the tackle was also identified as the contact event in which 31% of all injuries were sustained (Moore *et al*., 2015). Tackles have accordingly been deemed as the event in which most injuries occur across all levels of competition (Bleakley *et al.*, 2011; Williams *et al.*, 2013). The tackle has been found to lead to specific head injuries for both ball carrier and tackler (Hendricks, 2010; Davidow *et al.*, 2018). Proper contact technique during the tackle has, therefore, been shown to be a defining risk factor regarding injury prevention (Burger *et al*., 2016).

**South Africa and the Western Province**

South Africa has one of the highest rugby participation bases with over 600 000 registered players nationwide. Most of these players represent the amateur population (Viljoen *et al.*, 2017; World Rugby, 2017). Rugby within South Africa is overseen by the South African Rugby Union (SARU), which is responsible for managing the game in all 14 provinces (Basson *et al*., 2018). At junior level, the unions compete within the Craven Week, which ranges from the under-13 to the under-18 level. Starling *et al*. (2018) investigated the 2018 Craven Week competition and found that head and neck injuries had the highest prevalence (48%). South African Rugby also boasts an annual provincial under-20, as well as under-21 competition and a under-20 National team (SA Rugby, 2019) The local competition for professional players within South Africa,

between the various unions is known as the Currie Cup competition. Starling *et al*., (2019) analysed data from the Currie Cup competition, which was recorded since 2014 to 2017 to determine the occurrence and extent of injuries. The results of the above-mentioned study yielded that the WPRU had the lowest incidence of injury burdens but demonstrated the second highest injury severity of all the unions in the Currie Cup competition. When specifying anatomical regions effected, the head was found to be the most frequently injured during the 2017 Currie Cup competition. When investigating the most common injuries over the four-year period, concussions were the most frequently diagnosed in three out of the four years (Starling *et al*., 2019).

The WPRU oversees the annual club league competitions within the Western Cape Province. This league is subdivided into two main categories, namely the Super League clubs and the Regional league clubs. Although previous research (Starling *et al*., 2019) has documented the youth, as well as the professional level, limited research has been done on the incidence of injuries such as concussion on community/amateur level. At community/amateur club level the responsibility of improved player safety and injury prevention falls on the shoulders of coaches and other support staff (Hollis *et al*., 2012) because of inadequate medical support at this level (Viljoen *et al*., 2017). The Super league clubs are sub-divided into Super league A (15 clubs), Super League B (15 clubs), Super league C (15 clubs). The minimum requirement for a club to compete within the Super League is that it should have no less than 90 registered players. The regional league has six subdivisions namely City league (12 clubs), Northern league (11 clubs), Southern league (11 clubs), Paarl Region (11 Clubs), Simonsberg region (11 clubs) and Sunday league (10 Clubs) (Painczyk, 2018).

**Epidemiology of injuries in rugby**

The value of epidemiologic injury studies has been demonstrated in the identification of injury risks and the extent of injuries within sport (Bleakley *et al*., 2011; Hislop *et al*., 2017). The knowledge pertaining to the nature of injuries can be used to implement effective preventative strategies to decrease the occurrence of injuries (Barrett, 2015).

A multitude of factors play a role in injuries and injury risk in rugby, thus making it difficult to identify causality (Viljoen *et al*., 2009; Starling *et al*., 2018). Factors such as psychological stressors, competition calendar, travel load and overtraining regarding

workload may all play a role in injury risk (Soligard *et al*., 2016). Williams *et al*. (2013) stated that because of the differences in laws and gameplay, the incidence and nature of injuries vary. Williams *et al*. (2013) noted a higher incidence of injuries at a higher level of play, which can be attributed to greater size, strength and speed of players (Williams *et al.*, 2013; Vaz *et al.*, 2015). In Australian studies, however, concluded that the injury rate for amateur rugby players was 52.3 per 1000 match hours (Swain *et al*., 2016). Rafferty *et al*. (2018) also concluded that amateur (club level) rugby had a lower incidence of injuries compared to the professional level. In lower competitive levels, such as adult community (amateur club) levels, the injury rates have been reported at 21.7 injuries per 1000 match hours (Roberts *et al.*, 2013; Cruz-Ferreira *et al.*, 2018). Roberts *et al.* (2017) confirmed the above statement that overall injuries rates were higher at a professional level, however, found greater time-loss injuries because of head injuries at amateur compared to semi-professional levels. Injuries where players miss the subsequent game is referred to as time-loss injuries (Gissane *et al*., 2012), but others have also defined time-loss injuries as any injury sustained during a match resulting in an absence from participation in match play for one week or more (Roberts *et al*., 2013). As will be explained later in this chapter, the different defining criteria for time-loss injuries have resulted in inconsistencies.

Because of law changes the frequency of contact events have increased. Vahed *et al*., (2014) who investigated the Currie Cup competition from 2007 to 2013, found that through law changes, the frequency of players contributions (e.g. tackles, rucks, etc.) during the games increased, whereas game stoppages decreased. Viviers *et al*. (2018) stated that matches have developed regarding law changes to better the safety of players and to attempt to increase ball in playtime. Viviers *et al*. (2018) concluded that injury differences do exist between training and matches, age groups, level of participation and sex. Their research found men's rugby having the greatest injury incidences, whereas the rates decreased with lower levels of play (Viviers *et al.*, 2018). In addition, at the men's community level, injury rates could be underestimated because high standard methodological studies are lacking. Age differences also demonstrate that a higher proportion of injuries occurred between under-12 to under-17 levels (34.2 per 1000 match hours), compared to under-9 to under-12 (11.9 per 1000 match hours) (Haseler *et al.*, 2010). Regarding age variations, young players

had a high occurrence of concussions, making up 20% of all match injuries (Viviers *et al*., 2018).

Previously, there were inconsistencies in classifying injuries because they were categorised according to matches missed without distinguishing between time-loss and non-time loss injuries (King *et al*., 2010). The injuries within contact sport can of late be classified according to various methods, namely time-loss injuries, medical attention injuries or non-fatal catastrophic injuries (Bleakley *et al*., 2011; Viviers *et al*., 2018). Per definition medical attention injuries are any injuries that result in players receiving medical attention, whereas time-loss injuries result in players not taking further part in training sessions or matches (Fuller *et al*., 2007). The argument has also been made for team sport to only record match time-loss injuries in contrast to evaluating both match and training incidences (Orchard *et al*., 2007). The most widely accepted method of injury classification has been the use of time-loss injuries (days absent from both training sessions and matches), which has various classifications according to frequency of days missed (Fuller *et al.*, 2007). Categorizing injuries according to time-loss have proven useful to provide insight into the severity of injuries (Viviers *et al*., 2018). Severity of injuries according to time-loss can be grouped as slight (zero-one day), minimal (two-three days), mild (four-seven days), moderate (eight-24 days), severe (>28 days) or career ending and non-fatal catastrophic (Fuller *et al*., 2007). The adaption of similar definitions for injuries by World Rugby (WR) (formerly the International Rugby Board), since 2007 has also vastly increased the quality of data collected (Kaux *et al.*, 2015). In some instances, injuries can be attended to when a player leaves the field for a ‘blood-injury’ and then return to the match later. In a similar fashion, concussion is assessed by medical staff (typically at elite level) and if concussion is ruled out, players can also return to match, which can cause confusion regarding reporting (Viviers *et al*., 2018). In instances where concussions are correctly identified and players removed from play, this is classified as a ‘time-loss’ injury. At a community level, Roberts *et al*. (2013) reported that up to 12% of the season injuries were time-loss injuries resulting from concussion. In the context of a professional competition, Starling *et al*. (2018) reported 25% of the injuries were resolved in either 9 days or less and another 25% were reported to be resolved

in 17 days or more. The above-mentioned competition revealed a time-loss injury rate of 81 per 1000 match hours (Starling *et al.*, 2018).

As stated previously, because of the collision nature of rugby, the players are exposed to a higher risk of injuries (Tee *et al.*, 2017) compared to other sports (Williams *et al.*, 2013; Carter, 2015; Davidow *et al.*, 2018). Repeated successful engagement contact situations, such as tackles and rucks, have shown to be linked with team success, however, these contact situations also attribute to almost 75% of all injuries (Williams *et al.*, 2013). An injury surveillance of the 2017 South African Currie Cup competition reflected, that there was a high incidence of time-loss injuries in the domestic competition, with 81 injuries per 1000 match hours (Starling *et al.*, 2018). Table 2.1 indicates that multiple authors have also previously investigated incidences of injuries in rugby on various levels, as well as the epidemiology of these injuries.

Roberts *et al*. (2014) investigated injuries in English community club level rugby, assessing medical attendance injuries (which may or may not result in time-loss injuries). In the study of Roberts and co-workers in 2014 added medical attendance as a category of quantifying injuries, as opposed to only medical assistance (non-time loss) and time-loss injuries. Because of the classification system, the incidence was as high as 229 medical attendance injuries per 1000 match hours within his population. Although the incidence was higher due to the broad criteria in the definition in comparison to time-loss injuries, the location of injuries remains relevant. Roberts *et al*. (2014) and Barrett (2015) found similar proportions of injuries to the head (24%), as well as shoulder injuries at 10 and 13% of all injuries, respectively. An increase in rugby players in the United States (US), led to investigations in rugby injuries from 2004 to 2013. The most commonly reported sites of injury in the study were the head (17%), followed by the shoulder (15%) and the ankle (10%) (Sabesan *et al*., 2016). Swain *et al*. (2016) investigated amateur Australian club level rugby and found similar popular sites of injuries in the head/face, shoulder and knee. Worth noting was that all these sites had similar incidences recording around 18 injuries per 1000 match hours.

*TABLE 2.1*. **SUMMARY OF THE INCIDENCE OF RUGBY INJURIES PER 1000 MATCH HOURS ACROSS VARIOUS LEVELS OF PLAY**.

| Year | Author(s) | Time frame | Aim of study | Population | Anatomical location (%) | | Total injuries (%) | Overall incidence |
|---|---|---|---|---|---|---|---|---|
| 2014 | Roberts, Trewartha, England, Goodison & Stokes | 3 years (2009-2012) | Investigate epidemiology of head injuries | English Community rugby players | Head:<br>Shoulder:<br>Knee: | 55<br>23<br>22 | 24%<br>10%<br>10% | 229 |
| 2015 | Barrett | 3 years (2011-2013 | Investigate epidemiology of rugby injuries on university level | University Hostel rugby players | Head:<br>Face:<br>Shoulder: | NR | 24%<br>23%<br>13% | 12 |
| 2015 | Moore, Ranson & Mathema, | 3 years (2011-2014) | Investigate injury severity, incidence, nature and cause in international tournaments | A single professional international rugby team | Shoulder:<br>Head:<br>Thigh: | 34<br>32<br>30 | NR | 263 |
| 2015 | Mathewson & Grobbelaar | 2 years (2012-2013) | Determine tackle related injury rate and who is more susceptible to injury | University Hostel rugby players | Head:<br>Face:<br>Shoulder: | 3<br>3<br>2 | NR | 19 |
| 2016 | Swain, Lystad, Henschke, Maher, Kamper | 1 year (2012) | Describe health related quality of life and determine incidence and severity of match injuries | Australian amateur club rugby team season | Head & Face<br>Shoulder<br>Knee | 18<br>18<br>18 | NR | 52 |
| 2017 | Leung, Franettovich Smith, Brown, Rahmann, Mendis, Hides | 1 year | Determine the frequency and nature of injuries sustained | School level rugby in Australia | Lower body<br>Upper body<br>Concussion | 6<br>6<br>4 | NR | 24 |

*Note: *Incidence is expressed as the number of match injuries per 1000 match hours; NR: Not reported*

Moore *et al*. (2015) investigated a professional rugby team's data over three years and compared their respective tournament injury data. The match injury definition used for the surveillance was adapted from Fuller *et al*. (2013). The above-mentioned research demonstrated the three most common sites of injury to be the shoulder (33.8 per 1000 match hours), head (32.0 per 1000 match hours) and thigh (30.0 per 1000 match hours). In the study by Moore *et al*. (2015), almost 80% of all the head injuries were classified as concussions with a severity ranging from 6 to 26 days. This increased incidence of concussion, compared to previous studies, could be because of the implementation of World Rugby's in-match Head Injury Assessment (Moore *et al*., 2015). The head injury assessment as introduced by World Rugby in 2012 has increased the recognition of concussion (Rafferty *et al*., 2018). Overall in the United States, the proportion of head and face injuries increased by 10% over a decade, which should warrant some concern (Sabesan *et al.*, 2016). Barrett (2015) and Mathewson and Grobbelaar (2015) investigated the injury rates in hostel rugby, however, they focused on tackle events leading to injury. Mathewson and Grobbelaar (2015) found similar results in that the head and face were the most injured locations; however, no clear definition was given to distinguish head and face injuries.

The type of injuries in the study by Mathewson and Grobbelaar (2015) indicate that lacerations, joint sprains and concussion were the three most prevalent in university hostel rugby players. This was consistent with all the epidemiologic studies cited in Table1, which indicate that concussions is among the top three types of injuries. Kaux *et al*. (2015) found similar results in a review of rugby injuries and specified that a quarter of all professional rugby players' injuries were to the head.

## Concussion

### Background

According to the Berlin consensus statement *"…sports related concussion is a traumatic brain injury, induced by biomechanical forces."* (McCrory *et al.*, 2017:389). The consensus continues to and provides several common features, which can be used in defining the nature of the injury (McCrory *et al.*, 2017). Often, sport related concussion is used interchangeably with mild traumatic brain injuries as their

definitions overlap and are both subsets of traumatic brain injuries (Giza *et al.*, 2013; King *et al.*, 2013; McCrory *et al.*, 2013).

Sport related concussions lead to a disruption in brain functioning, which could manifest in a wide range of signs and symptoms (Delahunty *et al.*, 2015). Symptoms could manifest as either cognitive, emotional or somatic and if any of these symptoms are present, it requires the immediate removal of a player from play (McCrory *et al.*, 2017). Previously, the loss of consciousness was used as a trademark identification sign, but studies revealed it only occurs in up to nine percent of all concussions (Guskiewicz *et al.*, 2003; Mullally, 2017).

On average, the concussion symptoms resolve between seven to 10 days (McCrory *et al.*, 2012; Harmon *et al.*, 2013) although various factors play a role in injury severity and recovery. Age, sex, level of competition, as well as previous concussions could all be determining factors in the severity of the concussion (Melander & Moen, 2014). If a succeeding concussion occurs before the initial injury has healed it may lead to adverse long-term complications (Harmon *et al.*, 2013; Kroshus *et al.*, 2014). The consequences of multiple previous concussions can manifest as random symptoms, ranging from personality changes to cognitive impairments correlating with dementia (Guskiewics *et al*., 2005; Smith *et al.*, 2013). A player with a history of concussion has a two to 5.8 times higher risk of sustaining another concussion (Guskiewics *et al*., 2007; Hollis *et al*., 2007). Players sustaining a second concussion could have a longer recovery time. A study on soccer players found that the players missed on average 27 days, which is indicative of a subsequent concussion (Hägglund *et al*. 2009). This longer than usual recovery time could reveal that a first concussion went unrecognized and that the player is recovering from a second concussion (Williams *et al*., 2013). Research by Nordstom and Nordstom (2018), found that previously concussed soccer players were more susceptible to any other injuries in the following year. Cross *et al*. (2016) also identified a similar tendency in professional rugby players. Cross and co-workers found that professional rugby players had a 60% greater chance of any injury following a concussion in a season. Although education programmes on concussion exist, numerous myths and false information regarding concussions and its diagnosis is still present (Kissick & Johnston, 2005).

## Legislation

Sport related concussion recommendations and management guidelines were established through an international consensus statement, which are held every four years. This consensus conference has most recently been hosted in Berlin in 2016. It elaborates on previous documentation and expands the understanding of the injury (McCrory *et al*., 2016). Various management strategies post-concussion have been advocated in the past, although the cornerstone thereof has always been physical and cognitive rest, followed by the implementation of post-concussion RTP protocols. These concussion consensus statements are aimed at disseminating information, the standardizing of concussion protocols and have been embraced by the sporting bodies (Viljoen & Patricios, 2012).

Regarding the grading of concussion, up to 16 different classifications of grading scales were used in the past (King, 2014). At the first consensus conference, no grading scales were recommended because there were no scientifically valid scales available. During the second consensus conference, concussions were graded as “simple” or “complex”, with the “simple” not needing any testing and resolved within seven to 10 days, whereas “complex” demonstrated prolonged symptoms and needed neurocognitive computerized testing (Covassin *et al.*, 2009). The third conference, however, rejected the simple or complex grading, because it was not able to predict injury severity (King, 2014).

Regarding rugby, World Rugby (WR) previously had a mandatory stand-down period of three weeks after sustaining a concussion in which players were suspended from play (Marshall & Spencer, 2001) (Table 2.2). The mandatory three-week stand-down period was thereafter updated to an individualized pre-season and post-injury assessment with the use of neurocognitive/neuropsychological computerized testing programs (Shuttleworth-Edwards *et al.*, 2008). Table 2.2 outlines the numerous post-concussion RTP guidelines as recommended by WR (Roberts *et al*., 2017). Computerized neurocognitive tests are recommended as baseline tests and then compared to corresponding tests post-concussion. The use of baseline tests could help determine whether the player is ready to return to strenuous exercise (Ashare, 2009; Van Kampen *et al*., 2006). The use of neurocognitive tests, although having

moderate sensitivity to cognitive deficiencies, have been promoted as tools in monitoring recovery, following injury (McCrory *et al.*, 2009).

Educational programmes such as BokSmart follow a coach-targeted approach and was found to be an effective tool to disseminate information to players (Sewry *et al.*, 2017). A pilot study on players' post-concussion RTP behaviour was, however, found to be not positively received by coaches in the South African Rugby Union Youth week (Brown *et al.*, 2016). In 2012, WR introduces a three-point assessment protocol for head injuries, which is aligned with the Berlin consensus statement. Since the induction of the head injuries assessment there has been a decrease in the frequency of players that remain on the field after sustaining a concussion.

Because of the heterogeneous nature in which the symptoms manifest, testing across various domains is required (McCrory *et al.*, 2013). Major developments have been made of late regarding concussion management because of the concussion consensus statements (McCrory *et al.*, 2009). After the third concussion consensus, concussed players were advised to rest until asymptomatic, and thereafter, follow a graduated RTP program of increasing intensity and contact through which they should have reported as asymptomatic to be allowed to RTP (Leddy *et al.*, 2011). The current guidelines are specific regarding game-day management of concussions, which include recognition followed by permanent removal and then referral to a licenced health care professional (Kroshus *et al*., 2017).

Although introduced worldwide, these educational initiatives have been met with mixed results. The South African BokSmart initiative is a collaborative effort between the SARU and Chris Burger/Petro Jackson fund with the goal of prevention of catastrophic head, neck and spinal injuries (Viljoen & Patricios, 2012). The program includes a biennial compulsory safety workshop for active coaches and referees, first aid training for underprivileged rugby communities, toll free injury hotline and online educational resources (Fraas & Burchiel, 2016). The BokSmart program has been associated with a reduction in serious injuries in junior players, however, showed an increase in senior players although not statistically significant (Brown *et al.*, 2014). The before mentioned can partially be attributed to more experienced coaches resistance to the implementation of a safety program. As of 2019, referees have an additional tool in

the form of a blue card, which can be used in the event of a suspected concussion. The blue card is used to recognize and remove a player from the field and is the first steps in the management of concussion (SA Rugby, 2019).

*TABLE 2.2*: **POST-CONCUSSION RETURN-TO-PLAY GUIDELINES (Roberts *et al*., 2017)**

| Date | Description |
|---|---|
| Until 2010 | The International Rugby Board recommended a 3-week stand down period |
| 2010 to Match 2014 | The International Rugby Board did not prescribe a stand down period and every case was judged on its own merits with graduated RTP started once the player was symptom free. Therefore, a player could return within six days. |
| Match 2014 to present | Any player outside of the enhanced care setting (accounting for the vast majority of community level players) could not RTP in less than 19 days |

*Note: RTP: Return-to-play*

**Field-side management**

Understanding the nature and cause of injuries, assists in the field-side injury management in contact team sports such as rugby (Roberts *et al*., 2014). Effective and early field-side management of injuries can ensure limited pain, promoting healing and shortening of recovery time (Thomas *et al*., 2015). Role players who provide coverage of matches need to be prepared to make diagnosis and/or provide initial treatment to the injury (Wascher & Bulthuis, 2014). The role players can range from players themselves and encompass coaches, medical staff (including physiotherapists, first aiders and doctors), administrative staff and referees. The role players mentioned above can form part of numerous levels, such as intrapersonal (improves players' knowledge and attitude), interpersonal (improve knowledge and attitude of coaches, teammates and parents), community (improve administrative communication) and legislation (enforce policies) (Register-Mihalik, 2017). Clacy *et al*. (2017) investigated community rugby and found that 93% of the role players (including players, coaches, medical staff, administrative staff and referees), reported being able

to identify concussion. The above-mentioned study also yielded that only 16% of the players, 13% of the coaches, 19% of the parents and 47% of the medical staff reported being involved in treating concussion (Clacy *et al*., 2017). Although numerous role players in community sport believed that they could assist in identification of concussion, the perceived responsibility to do so is lacking (Clacy *et al*., 2017). The perceived responsibility to identify concussion was lacking as only 29% of managers/administrators and 16% of players felt it was their duty (Clacy *et al*., 2017).

Tee *et al*. (2018) found that injuries in rugby can be reduced by sharing the roles and through incorporating all parties involved. Donaldson and colleagues (2012) mentioned that at club-level the role players responsible for injury prevention included coaches and club administrators. In a professional sport system, players have access to management guidelines and medical assistance, whereas at a amateur club level players might not have access to this assistance (Borich *et al*., 2013; Makdissi *et al*., 2013). Community sport often rely on volunteers because medical staff and consequently their attendance may be lacking (Clacy *et al*., 2017). Complications in rugby injuries could arise because of medical staff not being present (Tajima *et al.*, 2014) or not being sufficiently qualified (Melander & Moen, 2014). Unlike other injuries that are physically limiting, concussion could manifest, and players can resume matches unknowingly (Brown *et al*., 2014). The responsibility and ownership regarding concussive injuries should be shared across various role players and professions (Fraas *et al*., 2015; Tee *et al*., 2017). Delahunty *et al*. (2015) concluded that one of the reasons for under-diagnosis of concussion could be a lack of professional medical support, therefore, re-emphasizing shared responsibility.

Macqueen and Dexter (2010) state that the field-side staff need to consider a whole host of factors, such as playing position that could influence the players' risk of injury. Field-side injury management in rugby encompasses not only trained staff but also field conditions, medical care systems and match day doctors (Tajima *et al.*, 2014). Various tools have been developed for the use of side-line assessment of concussion, i.e. the Sports Concussion Assessment Tool (SCAT), for example, was conceded after the first consensus conference in 2004 (King *et al*., 2012). In 2012, the SCAT was updated to a SCAT 2/3 along with a child-SCAT 3 (King *et al*., 2014). During the 2016 concussion consensus conference, the SCAT 5 was released, which is useful

according to expert opinion in differentiating between concussed and non-concussed participants (McCrory *et al*., 2017). These updated SCAT versions take approximately 20 minutes to complete, thus moving away from a sideline assessment tool and more towards an off-field assessment (Kutcher & Eckner, 2010).

In 2013, Baker and co-workers investigated junior (under-20) rugby and found that these players would rather report symptoms of a concussion to their coaches than physiotherapists. According to Almquist *et al.* (2008) the same tendency applies to high schools. The coaches' role can create a team culture of safety and reinforce an adherence to prescribed rehabilitation processes, such as following a RTP protocol (Echlin *et al*., 2010; Kroshus *et al*., 2015). However, in a previous study it was reported that most coaches could not pass a first aid and concussion knowledge examination, which warrants some concern (King *et al.*, 2010). The pressure placed on coaches and trainers to do pitch-side concussion assessment is significant; however, the knowledge to accurately diagnose players may be lacking (Lovell *et al*., 2004, Kissick & Johnston, 2005). In the American football league and National Rugby League, coaches are not required to attend concussion education workshops; however, the education is incorporated in the coaching accreditation (Newton *et al.*, 2014). In the context of South Africa, when investigating youth week rugby, the most common barrier for not seeking medical clearance was "not thinking it was necessary". The role players that were also most likely to make this decision of not being evaluated were the players themselves and their parents (Brown *et al*., 2016:44).

Physicians are often required to provide a clearance to RTP; thus, it is crucial that the steps are provided for the player to be able to safely RTP (Kissick & Johnston, 2005). When investigating physicians' judgement of concussion, nearly 40% of the physicians reported they were not confident with the diagnosis of concussion. The main objective for medical staff should be the prevention of a subsequent concussion, which can be achieved by improved recognition and management (Miyashita *et al*., 2013).

**Sport-related concussion in rugby**

Sport related concussions, also referred to as head injuries or mild traumatic brain injury, have been documented by some authors as the most reported injury within rugby (Kohler, 2003; Kemp *et al*., 2008; Hollis *et al*., 2009; Kaux *et al*., 2015). Similarly,

concussion has been found to be the most pressing medical concern in all contact sports across all levels (Benson, 2013). The reported rates of concussion within the sport of rugby differ due to the variance in injury definition (Gardner *et al*., 2014), study design (Hollis *et al*., 2009) and reporting measures (Hollis *et al*., 2009; Haseler *et al*., 2010).

When investigating reporting rates, Fraas *et al*. (2014) found that 45% of rugby players sustained at least one concussion during the season, but only 47% of the cases are reported to medical staff (Fraas *et al*., 2014). Rafferty *et al*. (2018) investigated professional rugby players and discovered an incidence increase from 7.9 per 1000 match hours to 21.5 per 1000 match hours after 4 seasons (Table 2.3). The increase in incidence can be attributed to the ability of role players to identify concussion, which was previously overlooked, or the increase in match frequency that presents a higher risk of sustaining concussion (Ashare, 2009; Rafferty *et al*., 2018).

Regarding concussion incidences across the various levels in rugby there have been major contradictions. Gardner *et al.* (2014) reported that amateur levels have the highest concussion incidences (2.08 per 1000 match hours) in contrast to professional players (1.2 per 1000 match hours). In 2017, Roberts *et al*. found higher incidences of time-loss head injury rates in English amateur rugby (2.8 concussions per 1000 match hours) in comparison to semi-professional matches (2.2 concussions per 1000 match hours). Between 2015 and 2016, Rafferty *et al*. (2018) found a minimal difference between amateur rugby players (21.4 concussions per 1000 match hours), whereas at professional level the incidences were 22.2 per 1000 match hours.

The reasoning for the higher incidence in concussion could be attributed to the lower amount of training activities, as well as skill levels at the amateur level (King *et al*., 2017). Specific positions in rugby have also been found to be predisposed to sustaining a concussion, namely scrumhalves (12%) and flankers (11%) were more susceptible (Fraas *et al*., 2014). In research on professional rugby, Tucker *et al.* (2016) found backline players to be more susceptible to concussion than forwards during a tackle. Thus, different playing positions may differ regarding concussion incidences. Concussions can, therefore, have varying incidences per position, as well as severity across all positions. However, research in this regard is not clear. Although

concussions are not new to contact sport, the identification processes and management of concussion are challenging to all parties involved (Cranton & Leslie, 2014; Mathema *et al*., 2016). Understanding of the mechanisms and events, leading up to concussion in rugby is of critical importance (Hendricks *et al*., 2015). Hendricks *et al*. (2015) investigated personality traits and attitude towards tackling and highlighted tackle training as a form of injury prevention.

The fast-paced nature of rugby often leads to complications regarding field-side identification of concussion symptoms and as a result leads to obscured incidence rates (Clacy *et al*., 2017; Gardner *et al*., 2017). To further challenge clinicians, a high proportion of sports-related concussions (90%) occur without loss of consciousness (McCrory *et al*., 2013). Furthermore, a perfect diagnostic tests have not yet been developed (McCrory *et al*., 2017). The assessment and management of concussion should be a multimodal process, which should include clinical interviews accompanied by clinical, cognitive and motor assessments (Register-Mihalik *et al*., 2017). Barriers regarding the identification of concussion usually include players' tendency to under-report symptoms of concussion (Williams *et al*., 2013) in anticipation of a quicker RTP (McCrea, 2004; Shuttleworth-Edwards *et al*., 2008). The severity of the injury is also downplayed by use of colloquial terms such as "dings" or "having one's bell rung" (King *et al*., 2014; Lin *et al*., 2015). Coaches have been found to be guilty in attempting to shorten the period of RTP by putting pressure on clinicians and players (Partridge, 2014). The use of headgear, as well as mouth guards are believed by players to prevent rugby-related concussion, but inconclusive evidence regarding this, exists (Mcintosh *et al.,* 2010)

*TABLE 2.3*: **CONCUSSION INCIDENCE IN RUGBY ACROSS VARIOUS LEVELS OF RUGBY**

| Year | Author(s) | Time frame | Population | Sample size | Incidence |
|---|---|---|---|---|---|
| 2009 | Hollis, Stevenson, McIntosh, Shores.Collins &Taylor. | 3 years (2005-2007) | Non-professional male rugby players<br>Mean age 22.7 | 313 | 8.0 per 1000 match hours |
| 2014 | Fraas, Coughlan, Hart, McCarthy | 1 year (2010-2011) | Professional male rugby players<br>Mean age: 25.0 | 172 | 44,9% of players reported sustaining at least one concussion |
| 2016 | Cross, Kemp, Smith, Trewartha & Stokes. | 2 year (2012-2014) | Professional rugby players | 366 | 8.9 per 100 match hours |
| 2016 | Lopez, Ma, Weinstein, Cantu, Myers, Nadkar, Victoria & Allen | 4 years (2010- 2013) | Amateur to international rugby 7s male and female players | 67 | Elite males: 18.3/1000 per 1000 match hours<br>Elite Females: 8.1 per 1000 match hours |
| 2017 | Roberts, Trewartha, England, Goodison, & Stokes | 6 years (2009-2015) | Community rugby players subdivided into 3 levels (mean age, 24.6, 24.9 and 25.6 years respectively) | 46 (2009-2010),67 (2010-2011), 76 (2011-2012), 50 (2012-2013), 67 (2013-2014), and 58 (2014-2015) | 2.4 injuries per 1000 match hours |
| 2018 | Rafferty, Ranson, Oatley, Mostafa, Mathema Crick &Moore | 4 years (2012-2013 & 2015-2016) | Senior professional male rugby players | 367 | Increased from 7.9 per 1000 match hours (2012/2013) to 21.5 per 1000 |
| 2018 | Starling, Readhead, Viljoen, Brown, Sewry, & Lambert | 4 years (2014-2017) | Senior professional male rugby players | 154 | 82 (74-95) per 1000 match hours |

Reporting symptoms of concussion within contact sport is a major concern, because of players "not knowing the injury was a concussion" and "not thinking it was serious enough" (Hollis *et al*., 2012:738; Kerr *et al*., 2014:1014; Fraas *et al*., 2014:137). It is, thus, important for players to have knowledge regarding signs, symptoms, mechanisms of injury, as well as management strategies (O'Connell & Molloy, 2016). Players' knowledge of concussion could result in them better understanding why they are being withheld from playing (Miyashita *et al*., 2013).

**Knowledge of the role players**

Prevention of head injuries, through development of effective strategies is of critical importance to all rugby role players (Hendricks *et al.*, 2018). The lack of knowledge regarding concussion could lead to non-reporting of symptoms, incorrect post-concussion RTP protocol(s) or subsequent concussions (McCrory *et al*., 2012). In soccer, it was identified that players are more susceptible to physical injury of any type (not only subsequent concussion), after sustaining an initial concussion (Nordstom *et al.*, 2014; Cross, 2016).

The specific concussion knowledge areas that have been targeted in educational tools are symptom identification, prevention, recognition and the response by role players (Provvidenza, 2013). The identification of concussive symptoms requires knowledge, which plays a role in injury prevention. Boffano *et al*. (2011) found that as many as 38% of players had not been informed on the symptoms of concussions and as a result would RTP immediately.

Concussion knowledge have been found to form attitudes and beliefs regarding concussion risk management (Kroshus *et al*., 2015). Clacy *et al*. (2015) investigated community rugby and found that more than half of the participants stated that they were involved in the prevention of concussions. The above-mentioned study investigated different role players, such as players, parents, coaches, management, medical staff, administrative staff and referees. Regarding the prevention of concussion, 82% of the coaches believed they could prevent concussion, whereas only 34% of the players believed they could prevent concussion (Clacy *et al*., 2015). However, the question is whether the correct preventative measures are being followed and whether these measures are reaching the players. This is generally

known as the knowledge transfer principle, which can be applied to sport related concussion

In the instance that educational material and current guidelines are reaching end-users, this knowledge does not necessarily equate to behavioural change (Register-Mihalik *et al*., 2017). Behavioural change regarding concussion is a process that has multiple barriers because sport is multifaceted in nature (Mrazik *et al*., 2015). The wide arrange of factors that must be taken into account relate to the various role players including players, coaches and administrators (Mrazik *et al*., 2015). A framework known as the Socio-ecological Framework can be implemented. This framework incorporates interaction at various social levels, such as within amateur rugby systems. The outer layer of the framework is targeted at “society and policies”, followed by “community”, “interpersonal” and lastly “intrapersonal” (Register-Mihalik *et al*., 2017:196). This specific framework is useful in pinpointing which areas regarding sport related concussion have not been targeted. As with community sport, such as within the Western Province Rugby Union club rugby, the framework can be applicable to see which level of the framework is lacking regarding the responsibility of concussion and post-concussion RTP.

With the increase in awareness surrounding concussion, educational initiatives were launched to decrease injury and re-injury rates. Concussion education has been aimed at increasing players concussion knowledge and attitudes, as well as reporting rates (Chapman *et al*., 2018). These educational strategies have three main foci. Firstly, to explain what constitutes as a concussion, secondly to describe how a concussion manifest itself and, thirdly, it states the long-term effects thereof (Kroshus *et al*., 2014).

Regarding the previous research on concussion knowledge, Table 2.4 highlights various knowledge deficits. Griffin *et al*. (2017) investigated Welsh amateur rugby coaches, as well as referees’ concussion knowledge and previous experiences. When looking at concussion advice, almost 20% of the coaches and 68% of the referees have previously been asked by players for advice (Griffin *et al.*, 2017). The coaches and referees, although demonstrating sufficient knowledge in recognition of symptoms, tested poorly in both consequences of concussion and RTP protocols (Griffin *et al*., 2017).

*TABLE 2.4*: **CONCUSSION KNOWLEDGE OF VARIOUS ROLE PLAYERS IN RUGBY**

| Year | Author(s) | Assessment instrument | Major findings |
|---|---|---|---|
| 2011 | Boffano, Boffano, Gallesio, Roccia, Cignetti & Piana | Four amateur rugby teams in Northwest Italy completed questionnaire on knowledge and beliefs of concussion. | 39% had not been informed about symptoms of concussion. |
| 2013 | White, Newton, Makdissi, Sullivan, Davis, McCrory, Donaldson, Ewing & Finch | An online knowledge survey was conducted in 2012 across Australia. 15 questions were selected by a literature review to assess general concussion knowledge (GCK) on a 5-point Likert scale,<br>A 24-item checklist was created to assess concussion signs and symptoms (CSS), scored on dichotomous yes (1) and no (0) scale. | >90% correctly identified 5 out of 8 symptoms of concussion.<br>55% of the coaches and trainers did not know that there is an increased risk of concussion after sustaining a first concussion. |
| 2015 | Fraas, Coughlan, Hart & McCarthy | Surveys sent out to 11 coaches and 12 medical staff of 4 professional rugby clubs in Ireland (2010/2011). | 66% of the coaches correctly indicated that previous concussion increases the risk of a second concussion. |
| 2016 | O'Connell & Molloy | Questionnaire was compiled from Cusimano (2009) assessed 79 male and female rugby players | 75% of the players would continue playing if concussed. |
| 2017 | Viljoen, Schoeman, Brandt, Patricios & Van Rooyen | A descriptive cross-sectional study was used assessing Junior Amateur High School (JAMS) and Senior Amateur Club (SAC) in South Africa using modified RoCKAS-ST. | JAHS (62%) and SAC (60%) in CKI. JAHS and SAC identified 66% and 63% of the symptoms correctly.<br>CAI was 66% and 67% for JAHS and SAC respectively. |
| 2017 | Martin, Hrubeniuk, Christopher, MacDonald & Leiter | A cross sectional survey on all Canadian senior level rugby players using a modified Leiter questionnaire. | 49% would be less likely to present symptoms during playoff games.<br>29% would continue playing while symptomatic. |
| 2018 | Kraak, Coetzee, Gouws, Loubser & Van Vuuren | University hostel rugby players using RoCkAS-ST. | 75% Concussion Knowledge Index<br>81%-Concussion Attitude Index |
| 2019 | Kraak, Coetzee, Kruger, Sterwart & Van Vuuren | Western Province Club Rugby players using RoCKAS-ST. | 67%-Concussion Knowledge Index<br>62%-Concussion Attitude Index |

*Note: CSS: Concussion signs and symptoms; GCK: General concussion knowledge; RoCKAS-ST: Rosenbaum Concussion Knowledge and Attitudes Survey - Student. Version; JAHS: Junior amateur High school; SAC: Senior Amateur Club; CKI: Concussion Knowledge Index; CAI: Concussion Attitude Index*

Regarding coaches as role players, Broglio *et al*. (2010) found that more than 60% of concussions were unreported and coaches were unable to identify concussion related symptoms (Broglio *et al*., 2010). White (2014) also investigated coaches and athletic trainers' concussion knowledge in both Australian Football and Rugby League. The most common misconception in over 50% of the coaches, was regarding players having an increased risk of subsequent concussion after sustaining an initial concussion. A study by Fraas *et al*. (2015) reported better knowledge regarding to the same question in that 66% of the coaches were able to identify that a previous concussion could put players at risk for a subsequent concussion. As mentioned previously, a lack of concussion knowledge found jeopardised diagnosis and increased the risk for other injuries in players (Fedor & Gunstad, 2015). Kroshus *et al*. (2014) found that the rate of under reporting of concussions by players correlated with a lack of symptom focussed knowledge. Players need to have knowledge of concussion and be able to recognize symptoms in order to report the injury to the coach or healthcare professional (Williams *et al*., 2013).

Numerous factors could play a role in players not reporting their symptoms or not removed from play. O'Connell and Molloy (2016) reported that 75% of the participants answered that they would likely to very likely continue to play if concussed. In this instance match importance was a determining factor when making decisions regarding RTP whilst concussed (O'Connel & Molloy, 2016). Martin *et al*. (2017), however, found a lesser proportion of players (29%) that would play if symptomatic from concussion. From a South African context, Viljoen *et al*. (2017) investigated amateur players and coaches' knowledge of concussion. The junior amateur participants scored marginally higher regarding concussion knowledge (62%), in comparison to the senior amateurs (60%). Although no notable difference was found in this instance between the two groups, the attitude toward concussion still warranted improvement (Viljoen *et al.*, 2017). Kraak *et al*. (2018) found that university hostel rugby players achieved a fair score of 75% regarding the concussion knowledge index (CKI) section and a slightly higher score of 81% for the concussion attitude index (CAI). The players and coaches have been the most documented role players regarding concussion knowledge. However, the fact that research is only focussed on these role players warrants concern.

## Return-to-play

### Background

Moore *et al*. (2015) stated that increasing knowledge of injuries can assist in understanding injury prevention, rehabilitation and RTP. Research regarding RTP knowledge focussed on players, coaches or referees (Griffin *et al*., 2017), however, the RTP process can be influenced by numerous other role players. No previous research conducted on post-concussion RTP roles and responsibilities of various role players in amateur rugby could be found. Notably, RTP is a multifactorial process with the end goal of returning a player back to competition (Menta & D'Angelo, 2016). The decision regarding RTP is most commonly the responsibility of the medical and support staff and is based on clinical assessments or field tests (Menta *&* D'Angelo, 2016).

After a concussion has been sustained the consensus guidelines advise a thorough physical and cognitive assessment by a clinician, as well as guiding a player through an RTP protocol (Sabini *et al*., 2014). Concussion have, however, been problematic to assess by clinicians because it relies heavily on subjective self-reporting of symptoms (King *et al*., 2014).

The assessment of concussion and timing of RTP protocol can be assisted by comparing post-concussion scores to baseline assessments. The multimodal approach, which should be followed with the assessment of concussions, has various sub-categories, such as clinical, cognitive, symptom and motor assessments (Henry et al., 2015). The clinical interview provides a historical context regarding the player's injury history. The symptom assessment can be executed within the same session. The cognitive assessment is usually done via the use of computerized neurocognitive testing, which test for memory, processing speed, reaction time and attention. The King-Devick test was found by Patricios *et al*. (2017) to have relatively good sensitivity and specificity. Leddy *et al*. (2018) found the Buffulo concussion treadmill test to be an individualized aerobic treatment option post-concussion. The motor assessment is most common in the form of balance scoring and coordination (Register-Mihalik *et al*., 2017). The clinicians' decision on when to begin the RTP protocol should not be based solely on this assessment even though it can be useful in identifying subtle

impairments in individuals (Kutcher & Eckner, 2010). The RTP protocol, however, is reliant also on providing the medical doctor, coach or athletic trainer with accurate information on concussion history and symptoms (Cusimano *et al*., 2017), as well as up to date motor re-assessments protocols (since some assessments may have a practise effect especially in younger populations) (Valovich *et al*., 2003).

The RTP protocol for concussion is a stepwise progression in which activities of increasing physical nature must be completed throughout the process. The goal is to be asymptomatic before, as well as after each stage (Meier *et al*., 2015). Each stage of the RTP protocol should be 24 hours, thus making the programme six days, not including the rest phases. If any symptoms of concussion reoccur, the player should revert to resting for 24 hours and restart the protocol at the previous asymptomatic stage (Harmon *et al*., 2013; McCrory *et al*., 2013). Under legal and medical guidelines, no suspected concussion may RTP on the same day as occurrence of injury (Delahunty *et al*., 2015). The implementation of such guidelines and protocols should follow an individualized approach to protect players because not all symptoms will present in the same manner in various players (Melander & Moen, 2014).

**Procedure of return-to-play post-concussion**

Brown *et al*. (2015) stated that the 6-stage RTP protocol is to be followed to ensure the player is ready for the physical demands of the game without reoccurrence of symptoms. In the RTP protocol, the most crucial decision is when to commence with the physical activities of the protocol and the duration of the process (McCrory *et al*., 2013; Brown *et al.*, 2015). Makdissi *et al*. (2013) stated that children and adolescence be advised to have longer stand down rest periods than senior players, which is also embraced by South African Rugby (see Table 2.5).

Previously, the post-concussion RTP protocols were conflicting because of the variance in stand down time (Table 2.2), as well as how to return to full match readiness (Brown *et al*., 2016). The current guidelines advocate an individualized approach; however, the applicability of a universal RTP protocol is still questionable (Sabini *et al*., 2014). Tommasone and McLeod (2006) stated that a preventative measure could be altering the RTP progressions for sport with higher concussion incidences such as rugby. The various concussion-grading scales that were previously

implemented had proven to be unreliable (Patricios *et al*., 2010) because the injury could manifest in a variety of symptoms and RTP protocols because these gradings were inconsistent. The presence of delayed onset signs and symptoms of concussion is a factor that also needs to be considered (McCrory *et al*., 2017).

*TABLE 2.5*: **THE POST-CONCUSSION RTP STAND DOWN TIMES AS REQUIRED BY WORLD RUGBY**

| Age group | Minimum asymptomatic rest period from day of injury (days) | Minimum asymptomatic time between RTP steps | Minimum days missed |
|---|---|---|---|
| Children & adolescents (<19 years) | 14 | 1(x5) | 19 |
| Adults (>19 years) | 7 | 1(x5) | 12 |

*Note: Specific age groups are context specific for South African Rugby. Children and adolescents are players younger than 19 years of age. Adults are players 19 years and older*.

WR's guidelines regarding post-concussion state that any player displaying signs of concussion should be immediately and permanently removed from play (Mathema *et al*., 2016). World Rugby (2014) advocate the use of neuropsychological testing, an examination by a health care professional and memory and balance tests. The biggest factor now remains the reliance on objective, self-reported symptom recognition from players, which rests on behaviour (Hendricks *et al*., 2012), as well as knowledge of the injury (Meier *et al*., 2015; Cusimano *et al*., 2017). Hollis *et al*. (2012) investigated junior and senior teams and their compliance to stand down periods following a concussion. In latter study, it was found that 100% of the players were non-compliant with the given stand down period. The effect of RTP prematurely could lead to a following concussion, which could have devastating effects such as short and long-tern neurocognitive deficits (McCrory *et al*., 2013). Brown *et al*. (2016) notes that medical doctors need to guide players through the RTP protocol and involve the players, coaches, parents and employers to ensure adherence to the protocol.

**Role players in post-concussion return-to-play**

The role players' main focus has always been to return players to play in the shortest timeframe, without re-occurring symptoms or further injury (Wallace *et al*., 2016). The adherence to concussion legislation and RTP guidelines is, however, met with numerous barriers and misconceptions by all parties involved, which effects the RTP decision (Mrazik *et al*., 2015). It is because of the statement above that we have to take into account that the different role players have various optimal learning strategies, which need to be targeted to transfer knowledge (Provvidenza *et al*., 2013).

The role players are the players themselves, parents, coaches, sports trainers, general practitioners (doctors) and sporting bodies. Finch and White (2017) made the case that the players and parents should be seen as the end-users of guidelines and knowledge should be disseminated accordingly. The coaches and sport trainers are the personnel who will be responsible for recognition and initial support, as well as support regarding RTP guidance (Finch & White, 2017). Melander and Moen (2014) also believes that the identification and assessment of players suffering from concussion is commonly the shared responsibility of coaches, registered health care professionals and referees. Patricios *et al*. (2017) stated that at levels of lower competition a principle of recognize and remove should be followed. It is also recommended that players manifesting clear on-field signs, such as postural deficiencies or loss of consciousness should be directly removed from participation. The suspected players can, however, be requested to perform side-line testing and clinical evaluation (Patricios *et al.*, 2016).

Although RTP protocols have various barriers to overcome without a standardized protocol for RTP post-concussion, clinicians, coaches, players and parents would be confused regarding implementation (Brown *et al*., 2015). Finch and White (2017) stated that the publishing of guidelines in medical journals are only reaching a particular target group; consequently, coaches and other role players are being overlooked. The RTP protocol alone is not sufficient, after completion and graduation from the RTP, clinicians have the responsibility to educate players and parents. Delahunty *et al*. (2015) reported that regulatory bodies, coaches and parents should ensure that RTP is implemented as prior experiences of concussion did not dictate safer subsequent behaviour. Referees and coaches have the authority to remove players from the field of play and should share in the responsibility (Delahunty *et al*.,

2015). When investigating parents in sport, Lin (2015) found that neither previous concussion nor sport participation increased scores of concussion knowledge or attitudes (Lin *et al*., 2015).

**Post-concussion return-to-play knowledge of the role players**

Although knowledge regarding concussion has been found to be satisfactory in numerous role players (Griffin *et al.*, 2017), this does not necessarily translate to RTP attitudes (Kurowski *et al*., 2016). Strategies must be aimed at increasing knowledge, as well as creating positive behaviour changes in targeted attitudes (Kroshus *et al*., 2015; Griffin *et al.*, 2017). Kurowski *et al*. (2016) investigated the benefits of educational pre-season lectures and found a minimal effect because 25% of the players that were diagnosed with concussion still returned to play while symptomatic. This study found that the effects of educational resources, such as lectures showed a decline over the length of a season. Numerous other studies have also investigated the willingness of players to continue play even if symptomatic and found similar results (O'Connel & Molloy, 2016; Kraak *et al*., 2018).

Mrazik *et al*. (2016) concluded that interventions have improved short-term knowledge but did not affect long-term knowledge on concussion behaviour. Griffin *et al*. (2017) found that the RTP knowledge scores were low for amateur coaches and referees in that they were only able to answer one out of six questions correctly. This indicates that the low RTP attitudes in these role players are merely a result of an educational initiative not reaching the amateur level. In contrast to this Kemp *et al*. (2016) assessed Rugby league and the American football league and found that coaches had higher attitudes towards guidelines after using the guidelines of the preceding season (Kemp *et al*., 2016). This practical method of ensuring coaches and trainers use the RTP guidelines and experience the benefits could hold some merit above solely handing out guidelines and protocols. A possible cause for the misconceptions and attitudes towards concussion could be online news articles variability in reporting of concussion (Ahmed & Hall, 2017).

**Summary**

The literature indicates that following a concussion a player might demonstrate non-specific and/or delayed symptoms, ranging from mild to severe (McMillan *et al*., 2017). With the current level of concussion and RTP knowledge of players, as well as other role players in rugby (coaches, specialist-coaches, medical staff, referees, administrators), concussions can go unnoticed and unreported (Gardner *et al*., 2014). Knowledge of concussion by players can be a determining factor in the management of concussion and the road to recovery (Viljoen *et al*., 2017). It is imperative that the role players understand the motivational factor behind reporting symptoms to increase accurate concussion management (Kroshus *et al.*, 2014). BokSmart has made headway in decreasing catastrophic injuries in South African in junior rugby from 2010 to 2014 (Brown *et al*., 2016). Considering that the majority of rugby is played at the amateur level where medical assistance might not always be available, a more holistic approach is required to ensure that the same standard of concussion management is applied across all levels (Fischer *et al*., 2017).

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# CHAPTER 3

# METHODOLOGY

*Referencing within this chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.*

## 3.1. Introduction

## 3.2 Research design

## 3.3 Study design

## 3.4 Participants

## 3.5 Data collection procedure

## 3.6 Limitations and assumptions

## 3.7 Statistical analysis

## 3.8 Ethical aspects

## 3.9 References

## Introduction

Despite gaining much needed awareness on concussion in rugby (Clacy *et al*., 2015), concussion management have reported less than optimal at community level (Finch *et al*., 2013). Insufficient knowledge and the dissemination thereof to relevant role players in community sport create confusion regarding the identification and management of concussion (Lebrun *et al*., 2013). Although numerous education programs exist and BokSmart was established as the South African Rugby Union's (SARU) safety initiative (Viljoen & Patricios, 2012), the extent to which these guidelines are disseminated to amateur levels are unknown. At professional level, systems have improved to effectively manage concussion and post-concussion return-to-play (RTP), however, at lower levels of competition these systems are lacking (Chinn & Porter, 2013). The identification of symptoms, correct management and comprehensive post-concussion RTP protocol could prevent long-term negative consequences and prolonged recovery for players (Guskiewicz *et al*., 2005). It is imperative that rugby players understand the mechanisms of injury, as well as the complications thereof (O'Connell & Molloy, 2016). Previous studies have indicated that knowledge of concussion and adherence to post-concussion RTP on amateur levels in South Africa were insufficient (Walker, 2015; Viljoen *et al*., 2017). Within the context of community rugby, it has been found that various role players understand that they have a responsibility in concussion management; however, these perceived responsibilities have been known to differ (Clacy *et al*., ,2015).

## Research design

The research design of the current study could be classified as quantitative as it made use of multiple sources of data (Creswel, 2009) in a attempt to generalize the findings to a population. The design made use of surveys as to 'measure the characteristics of a population with statistical precision' (Sukamolson, 2007). The primary aim of the current study was to determine concussion knowledge and attitudes (Research Article one), as well as post-concussion RTP roles, responsibilities and implementation (Research Article two), among Western Province Rugby Union (WPRU) club rugby role players. One of the advantages of survey research is that it allows researchers to understand aspects of behaviour within a specific population (Sukamolson, 2007).

## Study design

The current study followed a descriptive observational cross-sectional study design and consisted of two distinct phases. The clubs that were approached were all affiliated with the WPRU. Data was collected during the 2018 to 2019 WPRU club rugby season using the previously mentioned instruments (RoCKAS-ST and post-concussion RTP implementation). The RoCKAS-ST was previously used by Viljoen *et al*. (2017), as well as Kraak *et al*. (2018), to investigate senior amateur clubs and university hostel rugby players respectively.

In Phase 1 (research article one) concussion knowledge, risk-and- precaution-taking attitudes among amateur club rugby role players were determined.

The first phase of the study utilized a previously established questionnaire known as the modified Rosenbaum Concussion knowledge and attitude survey – student version (RoCKAS-ST) (Appendix B), to measure Concussion Knowledge (CKI) and Concussion Attitude (CAI) (Rosenbaum & Arnett, 2010). Section one of the survey have 14 true/false questions and section two have three true/false questions. Section three and four contains 15 questions in the format of a five-point Likert scale. Five out of the 15 questions were basic opinion questions and the remaining 10 were applied opinion questions. If the responses for the before mentioned questions were deemed “safe” responses, the participants would answer by selecting a four or five on the Likert scale. The last section was a 16-item symptom checklist with eight legitimate symptoms and eight distractor items. The CKI was, therefore, determined by tallying sections one, two and five’s legitimate questions, yielding a possible score ranging from zero-25.

Regarding post-concussion return-to-play, the roles, responsibilities and implementation among amateur club rugby role players, were investigated in *Phase 2* (research article two).

The second phase utilized the post-concussion RTP implementation questionnaire, which was designed by the primary researcher and Dr Wilbur Kraak (Appendix C) to measure the post-concussion RTP roles, responsibilities and implementation of the role players (players, coaches, medical staff, administration staff and referees). The post-concussion RTP questionnaire is based on previous literature of post-concussion

RTP and scrutinized by experts in the field of concussion in rugby. The questions were predominantly multiple choice with the exception of question 13. The population investigated were WPRU amateur club rugby role players who had to complete both questionnaires (however, referees were excluded from the post-concussion RTP questionnaire because they are not directly involved with post-concussion RTP).

**Participants**

Participants in the current study were male and female role players from amateur rugby clubs registered within the WPRU. These clubs could have senior players (aged 20 and older), as well as junior player (younger than 20), however, not all open clubs facilitated junior players. The participants were: players, coaches, medical staff and administrative staff within the applicable rugby organization. The referees affiliated with the WPRU referee society were also assessed in research article one, because they could play a huge role on field and follow-up concussion reporting. All informed consents forms that had to be completed were attached to the questionnaire and explained by the primary researcher before the completion of the forms. Inclusion and exclusion criteria for the participants are presented in Table 3.1.

Permission for clubs to participate were requested from the WPRU. Phases one and two of the study investigated the knowledge and roles of role players in amateur clubs. Referees (affiliated with WPRU) were also assessed by only completing phase 1 (RoCKAS-ST questionnaire only) of the study. The researchers, after having obtained ethical clearance, began to correspond with the WPRU. The union put the primary researcher into contact with a chairperson or secretary of each rugby club in the WPRU. The primary researcher corresponded telephonically with the contact person of each club and determined whether hard copies or electronic questionnaires best suited them. To promote a better response rate the researcher followed up with the contact person of each club.

The snowball sampling method was used in which the WPRU was contacted and asked to connect the primary researcher with the different clubs in order for them to agree to participate. The different clubs were then asked to provide the details of the different role players within their respected organizations. Each organisation had to provide a contact person; this contact person had direct contact with the primary

researcher regarding data collection. The contact person arranged the dates and time for the researcher to meet with the participants and collect data. At this time, the primary researcher informed the participants on the scope of the project and any questions were answered. During this time the participants completed the informed consent form (Appendix A), and data collection commenced. The contact person at each club was not involved in the data collection.

*TABLE 3.1*: **INCLUSION AND EXCLUSION CRITERIA**

| Inclusion | Exclusion |
|---|---|
| Male and female role players (players, coaches, medical staff, administrative staff and referees) from WPRU club rugby. | Different formats of rugby other than 15-a-side and seven-a-side teams or organisations. |
| Players who are not currently playing due to injury or other circumstances but were registered with a club since the beginning of 2019. | Amateur clubs that did not comply with the request from WPRU and did not complete the questionnaires. |
| Participants who signed an informed consent form. | Amateur clubs outside the borders of the WPRU. |
| | Clubs who did not at the time participate in an annual league. |
| | Referees were excluded from part two (post-concussion RTP implementation questionnaire) of the current study. |

**Data collection procedure**

In phase one (Research Article one) the concussion knowledge, risk- and precaution-taking attitudes among WPRU club rugby role players were investigated.

The first phase of the study used a questionnaire to investigate the concussion knowledge and attitudes among WPRU club rugby role players. The questionnaire was a modified Rosenbaum Concussion Knowledge and Attitudes questionnaire for

students (RoCKAS-ST). This collection of data was conducted in person for the respected participants in each club.

This questionnaire was previously evaluated by a panel of psychologists and neuropsychologists, as well as through published research and were found to be reliable and valid (Rosembaum & Arnett, 2010). The limitations and assumptions can be viewed in Table 3.2. This part of the study focused more on the individual response in each category of the different role players.

Post-concussion RTP roles, responsibilities and implementation among the WPRU club rugby role players were investigated for phase two (Research Article 2).

Phase two of the current study was to determine what the respected role players' implementation, roles and responsibilities were regarding post-concussion RTP. The data of the second phase of the study was collected on the same day as Phase 1.

***Pilot study***

A pilot study to test the validity of the questionnaire was conducted to determine whether any questions were misleading or could be misconstrued by participants. The questionnaire was emailed to 15 rugby role player who were the not registered with the Western Province Rugby Union. The questionnaire was only available in English and participants of the pilot study could email and ask for clarity if a language barrier(s) arose. The questions assessed whether the post-concussion RTP questionnaire was aligned with the aims of the current study. The pre-set questions' responses were assessed and relevant changes were made to the questionnaire.

***Main study***

After the necessary changes were made to the post-concussion RTP questionnaire, both questionnaires could be disseminated. Phases one and two were completed in-person by role players in the Western Province Rugby Union club rugby. Times were arranged in which the participants could complete the questionnaires. If the participants were limited due to the language of the questionnaire, they could at any time ask the researcher for clarity on questions.

*TABLE 3.2*: **LIMITATIONS AND ASSUMPTIONS**

| Limitation | Assumptions |
|---|---|
| Role players within a club could have more than one role. | All players that receive concussion will have followed a RTP protocol. |
| Concussion management is outsourced and not dealt with internally | All clubs will have at least one role player who manages concussed players. |
| Language barriers because the questionnaires will only be available in Afrikaans and English. | Players and coaches did not use any material to help in answering of questionnaire. |
| Medical and administrative staff might not be at the venue when the questionnaires were completed. | |
| The successful recruitment of participants is dependent on the first wave of participants (individuals) | |

## Statistical analysis

*Research article one and two*

The data was analysed using descriptive statistics (standard deviations, means, frequencies and percentages). Cronbach's Alpha was used to determine the reliability, whereas ANOVA's were used for continuous variables between groups. For Post-hoc analysis, Fisher least significant difference was done. Pearson was used to determine the relationship between continuous variables. Whereas for comparisons of categorical variables, cross tabulation with the Fisher exact test were done.

## Ethical aspects

The protocol for the study was submitted to the Departmental Ethics Screening Committee (DESC) at Sport Science, as well as the Human Research Ethics committee (HREC). Ethical clearance was obtained (REC 050411-032) from the Human Research Ethics Committee (Humanities) at Stellenbosch University. The anonymity of participants was created by using numbering systems (rather than personal information) to help the researcher keep track of the specific issues of

questionnaires. All the data sets will be secured by a password protected laptop where all the hard copies will be scanned and also added to the digital database. The hard copies of the questionnaires and consent forms will all be stored in a secure cabinet in the storeroom at the Department of Sport Science, Stellenbosch University. The data collected will be kept for 5 years and thereafter destroyed. The data was electronically captured by the primary researcher and stored on a password protected laptop. The hard copies of the data was filed and is stored in a secured cabinet in the storeroom at the Department of Sport Science, Stellenbosch University.

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# CHAPTER 4

# RESEARCH ARTICLE 1

# CONCUSSION KNOWLEDGE, RISK- AND PRECAUTION-TAKING ATTITUDES AMONG AMATEUR CLUB RUGBY ROLE PLAYERS

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*This article will be submitted to the International Journal of Sports Medicine (Appendix D). This article is included herewith in accordance with the guidelines for authors of this journal. To provide a neat product for the thesis, this article has been edited to represent an actual published article as it would appear in the abovementioned journal. This does not imply that the article has been accepted or will be accepted in said journal. As a result, the referencing style may differ as the from other chapters of the thesis.*

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**Title page**

**Abstract**

**Introduction**

**Methodology**

**Results**

**Discussion**

**Conclusion**

**References**

**Addendum**

# Title page

## Title

Concussion knowledge, risk-and precaution-taking attitudes among amateur club rugby role players

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***Abstract***

Concussion in rugby is a frequent occurrence because of the contact nature of the game and can go undetected by different role players. Knowledge regarding identification of symptoms, management and prevention of re-injury is crucial for the welfare of players. The aim of the study was to determine the knowledge and attitudes among amateur club rugby role players. The study gathered quantitative information by utilizing the Rosenbaum Concussion Knowledge and Attitude survey-Student Version (RoCKAS-ST). The participants (N=434) medical staff (79 ± 0.10%) provided the highest CKI scores followed by referees (78 ± 0.08%), coaches (74% ± 0.11) and players (66 ± 0.13%) scoring the lowest. Although the role players scored 76% ± 5.84% for the Concussion Attitude Index (CAI) the internal consistency was poor (α = 0.44). Consequently, the CAI was subdivided according to an exploratory factor analysis, into risk- and precaution-taking factors. Players demonstrated the highest risk-taking score (1.8 ± 0.74) compared to coaches (1.4 ± 0.5) and referees (1.2 ± 0.42) ($p<0.01$). Referees presented the greatest precaution-taking score (4.5 ± 0.61) compared to players (4.2 ± 0.72) and medical staff (3.8 ±1.09). It was also found that across various concussion-related scenarios the different participants believed themselves to have safer attitudes compared to that of others within their team. Only two out of eight legitimate symptoms, headaches and dizziness, were correctly identified by 80% or more of participants, which warrants concern that identification of symptoms could be lacking on this level.

**Keywords**: Rugby union; club level; mild traumatic brain injury; head injuries; concussion knowledge.

## 1. Introduction

Concussions are a frequent occurrence in rugby union (hereafter referred to as rugby)[1-3], which is the worlds' most popular team contact sport[4-5]. Initial and subsequent concussions have been found to be associated with cognitive, behavioural and physical impairments for affected players[6]. Completely preventing concussions are highly unlikely; however, through knowledge dissemination, correct symptom recognition and management of consequences, the prevention of re-injury is possible[7-8]. Concussion management should be a shared responsibility across various role players[9]. Nevertheless, the concussion knowledge of these

role players specifically players [10-11], medical staff [12], coaches [13] as well as referees [14] have been found to be lacking.

Inadequate knowledge regarding symptoms and/or to intentionally hide subjective symptoms for the purpose of continuing playing may be the rationale for not disclosing concussions symptoms[15,16]. Investigations have found that players did also not believe the symptoms were serious enough[17,18]. The under-reporting of concussions in rugby is not isolated to players only, because it has been linked to the lack in symptom-focussed knowledge in all role players [19,20]. A previous study[9] indicated that coaches, out of all the role players (players, coaches, parents, team management, medical staff, administrative staff and referees), perceived themselves to have the greatest responsibility in concussion education. At various levels of play, coaches are responsible of concussion management because of inadequate on-site healthcare personnel[21]. When role players have greater knowledge regarding the consequences of concussion it increases the adherence to post-concussion return-to-play (RTP) protocols[10]. Likewise, concussion attitudes relate to the willingness of players to report symptoms and adhere to the RTP protocol[22]. Attitudes towards concussion has also been found to be influenced by numerous factors such as parents, teammates and perceived match importance[16].

In the South African context amateur (i.e. adult community) players constitute the majority of the playing population and at this level medical assistance could be lacking[10]. Kraak and colleagues [23] investigated the abovementioned population and found that players scored 67% for concussion knowledge and 62% for concussion attitude. Previous research indicated that, 65 to 70% was deemed a moderate level of knowledge and attitude, whereas above 75% was considered sufficient [24,10]. Because of the challenges at this level, all the role players within the structure have a part to play in the prevention of concussion[9]. Surprisingly, coaches were among the participants found to have the lowest concussion knowledge in comparison to players, medical staff and referees[12,13]. If symptoms like these go unreported and unnoticed the best medical practice for this injury may not be implemented[25]. Walker *et al*.[11] also found that as many as 79% professional rugby players were not aware that they needed to be cleared by a doctor before returning to play post-concussion.

Education on the symptoms and potential risks to recognize a concussion and to allow for accurate reporting are needed [7]. When looking at concussion education initiatives, many programs have been introduced nationwide; but have been met with challenges and mixed results[11]. The purpose of these programs are to reduce the quantity and severity of injuries in community sport[26]. World Rugby's Rugby Ready, New Zealand's RugbySmart, Australia's

SmartRugby and South Africa's BokSmart are all examples of nationwide rugby education initiatives[13]. The aim of the BokSmart National Rugby Safety Programme is to provide rugby coaches and referees with the correct knowledge and technical skills to ensure that safety and best practice principles (including concussion management) are incorporated into all aspects of the game.

Numerous tools have been developed to measure the concussion knowledge of role players within sport. One of these measures is the Rosembaum Concussion Knowledge and Attitude Survey-Student Version (RoCKAS-ST) designed by Rosenbaum and Arnett[27]. The questionnaire is a psychometrically sound scale for measuring concussion knowledge and attitude in high school sport persons. In 2018, Chapman and colleagues[29] investigated the RoCKAS-ST in collegiate (above 18) participants and found that the Concussion Knowledge Index (CKI) was valid and reliable, however. the Concussion Attitude Index (CAI) indicated a poor correlation between items in this population. In 2013, Williams *et al*.[25] used the same measurement to assess adult football players' (age: 23.4 ± 4.5) concussion knowledge and found they scored on average 66% (16.4 ± 2.9). The same study by Williams *et al.*[25] regarding concussion attitude yielded a score of 79.47% on average (60 ± 8.). In 2016, Eagles *et al.*[27] utilized the RoCKAS-ST, with minor adaptations; to measure the effects of an education program on youth hockey players[27]. The baseline scores were on average 74.58% for concussion knowledge and 81.08% for concussion attitude. Kraak *et al.*[24] assessed hostel rugby players at Stellenbosch University using the RoCKAS-ST and found that in four out of the eight questions relating to concussion knowledge players scored less than 50%, indicating apparent misconceptions[24]. The players scored 75% for the knowledge section and 81% for the attitude section. As mentioned previously, Kraak *et al*.[23] also investigated concussion knowledge and attitudes in Western Province Rugby Union (WPRU) clubs. However, the researchers only included players into their investigation. Therefore, the aim of the current study was to determine the knowledge and attitudes among amateur club rugby role players across the 2018 to 2019 seasons.

## 2. Methodology

This cross-sectional study design made use of a questionnaire to collect information on concussion knowledge and attitudes of various amateur club rugby role players, i.e. players, coaches, administrative staff, medical staff and referees. The current study included all male and female role players from WPRU club rugby who participated within the annual league. Ethical approval (REC 050411-032) was obtained from the Research Ethics Committee: Human Research at Stellenbosch University.

457 participants agreed to participate in the study, however, only 434 returned completed questionnaires. A general response rate for each role player was established for clubs in Super League A, B and C, where 90 registered players are required, whereas clubs in the remaining zones only require 80 registered players. The response rate for players was 5% (346 out of 7560 players). For coaches, it is estimated that within each club there are on average 10 coaches, as well as an additional 10 administrative staff. The response rate of coaches and administrators were 4% and 2% respectively. Referees had a response rate of 18% and medical staff could not be accurately determined as a high proportion are volunteers and only available on match days. Out of the possible 89 clubs within WPRU club rugby structure, 16 clubs responded to the request to participate in the study, yielding a club response rate of 18%. The data was collected during the 2018 and 2019 club rugby season. The aim, purpose and data collection procedures of the study were explained to the participants by the primary researcher. Those who agreed to participate in the study completed an informed consent form, demographic information survey and the RoCKAS-ST questionnaire. Club representative arranged a time and date, which would suite club participants to complete a questionnaire. The participant completed the questionnaires in person (paper based) enabling them to ask questions or electronically. In both cases they could withdraw from the study at any time during the data collection process.

The RoCKAS-ST questionnaire content and subsections was previously described by Rosenbaum and Arnett[27] Legitimate questions answered correctly in Section one and two received one point, whereas incorrect answered received no points. Eight out of the 16 symptoms were classified as legitimate and made up a portion of the CKI. The participant with a higher score in the CKI (ranging between 0 and 25), revealed a higher level of concussion knowledge [26]

The Concussion Attitude Index (CAI) was used to determine the views of the participants regarding concussion situations. The range of the answers were between 15 to 75; with a higher tally representing a safer attitude towards concussion[27,28]. Chapman *et al*.[29] investigated the reliability of the RoCKAS-ST questionnaire in collegiate sport persons (over 18 years of age) and found the CKI section to be valid and reliable, however, the attitude section was not found to be a sound measure. For the above-mentioned reason an exploratory factor, analysis was conducted. Section 3 was subdivided into concussion risk-taking and precaution taking. Concussion risk-taking questions included questions 1, 5, 6 and 8 of section three. The precaution-taking factor was made up of the remaining questions from section three namely, questions 2, 3, 4 and 7. Questions 4 and 8, although being part of each factor, was not included in the scoring because both were neutral index items. Section 4 was also divided

into 2 separate categories namely ‘self’ and ‘others’. The ‘self’ score (SS) related to questions as perceived by the participant themselves, whereas ‘other’ score (OS) was identical questions and asked the participant how they believed a teammate would answer the question. All the uneven question numbers (1,3,5,7,9) in section four related to scenarios of participants themselves, whereas the even numbers (2,4,6,8,10) related to how the participants perceived others to react. This concept enables researchers to determine the variation between how the participant would answer and how he/she would perceive others to answer the same question. Finally, section 5 reports on the concussion symptom checklist.

Regarding statistical analysis, reliability was determined using Chronbach’’s Alpha, whereas ANOVA’s were used for continuous variables between groups. The Post-hoc analysis utilized Fischer least significant difference. Pearson correlation was used to determine the relationship between two variables. The scores for the sections were summarized using descriptive statistics such as mean, frequency and standard deviation. Statistica (Version 13.5)(Del Inc, Tulsa, OK, USA) and Excel (Microsoft Corporation, Redmond, WA, USA) was used to analyse the data

## 3. Results

### *3.3.1. Demographic information*

The participants were on average 27.1 ± 11.1 years old, with 11.7 ± 7.5 years’ experience in their respective roles. The majority 98% (n=425) of the participants were male, 65% reported involvement at senior level, whereas 21% were at junior level and the remainder were unreported. Out of the 434 participants, 80% (n=346) were players, 8% (n=37) coaches, 3% (n=15) administrative staff and 2% (n=8) medical staff and 6% (n=28) referees. 457 participants in total completed the informed consent, 6 players were excluded due to incomplete questionnaires and 17 participants failed to indicate their primary role within the club.

### *3.3.2. Preliminary data analysis*

The CAI was determined to have low reliability (α=0.44); the combined average CAI score for role players were 76 ± 5.8%. The low reliability of the CAI could be due to the poor correlation between items suggesting they may not be measuring the same underlying construct; an acceptable value would be above α- value of above 0.70[30].

### *3.3.3. Concussion Knowledge Index (CKI)*

The results on each individual question of the RoCKAS-ST is presented in Addendum A. Table 4.1 presents the mean CKI score for all the role players. There was a statistically significant difference overall between the CKI scores of the role players ($p<0.01$). Post-hoc analysis indicated that players demonstrated significantly lower concussion knowledge compared to coaches ($p<0.01$), referees ($p<0.01$) and medical staff ($p=0.01$). Administrative staff demonstrated the second lowest concussion knowledge score, reporting significant differences in comparison to referees ($p=0.01$), as well as medical staff ($p=0.04$).

Table 4.1: Concussion knowledge index (CKI; %) of the different role players

| Role players | n | M ± SD | Range |
|---|---|---|---|
| **Players** | 346 | 67± 0.13%* | 24 - 92 |
| **Coaches** | 37 | 74 ± 0.11%* | 40 - 88 |
| **Administrative staff** | 15 | 67 ± 0.14%* | 40 - 92 |
| **Medical staff** | 8 | 79 ± 0.10% | 56 - 88 |
| **Referees** | 28 | 78 ± 0.08%* | 60 - 96 |
| **Combined** | 433 | 73 ± 0.11% | 24 - 96 |

*Note: n – number of observations; M-mean; SD-Standard Deviation; *p < 0.05*

Interestingly, in section 1, question 7, '*Being knocked unconscious always causes permanent damage to the brain*', coaches reported unsafe responses in scoring only 62%, which was the lowest of all role players. While only 38% of both coaches and medical staff correctly answered question 17 in section 1, '*An athlete who gets knocked out after getting a concussion is experiencing a coma'.* Question 13 in section 1, '*After 10 days, symptoms of a concussion are usually completely gone*', was reported the lowest by administrative staff (27%).

### *3.3.4. Concussion Knowledge Index (CKI) versus years of experience*

Pearson correlation was used to determine whether years of experience of either players or any of the other role players correlated with the determined concussion knowledge (CKI) score. For players the correlation was $r= -0.54$ ($p<0.01$), whereas for staff the correlation was $r=-0.38$ ($p<0.01$). There was an inverse relationship between years of experience and concussion knowledge.

### *3.3.5. Concussion attitudes: Risk- and precaution-taking*

Table 4.2 summarises concussion risk-taking and precaution-taking factors from the exploratory factor analysis. The players demonstrated the highest proportion (36%) of risk-taking, whereas the referees had the lowest score of risk-taking (25%) ($p<0.01$). Coaches (28%) also demonstrated safer scores compared to players (36%) for risk-taking ($p<0.01$).

More specifically, referees (28%) demonstrated safer risk-taking attitudes compared to players (38%) (p=0.02) for section 3, question 1, '*I would continue playing sport while also having a headache that resulted from a minor concussion*' (Addendum A). Coaches also presented lower and hence safer risk-taking scores compared to players in both, section 3, question 5 (25% versus 35% respectively), '*I feel that concussions are less important than other injuries*' (p<0.01) and for section 3, question 6 (25% versus 34% respectively) '*I feel that an athlete has a responsibility to return to a game even if it means playing while still experiencing symptoms of a concussion*' (p<0.01). The referees also presented safer risk-taking compared to players for both the above-mentioned section 3 question 5 (21% versus 25% respectively) (p<0.01) and questions 6 (25% versus 34% respectively) (P=0.02).

Table 4.2: Risk-taking and precaution-taking score per role player and combined

| | Risk-taking | | Precaution-taking | |
|---|---|---|---|---|
| **Role player** | **N** | **M ± SD** | **n** | **M ± SD** |
| **Player** | 342 | 1.8 ± 0.74* | 342 | 4.2 ± 0.72* |
| **Coach** | 37 | 1.4 ± 0.50* | 37 | 4.4 ± 0.66* |
| **Admin staff** | 15 | 1.5 ± 0.62* | 15 | 4.4 ± 0.47* |
| **Medical staff** | 8 | 1.4 ± 0.66* | 8 | 3.8 ± 1.09* |
| **Referee** | 28 | 1.2 ± 0.42* | 28 | 4.5 ± 0.61* |
| **Combined** | 430 | 1.5 ±0.59 | 430 | 4.3 ± 0.71 |

*Note: n-number of observations, M – mean, SD – Standard deviation, *p < 0.05*

Regarding precaution-taking, referees demonstrated a superior score (90%), whereas medical staff demonstrated the lowest relative score (76%). Section 3, question 2, '*I feel that coaches need to be extremely cautious when determining whether an athlete should return to play*' indicated that medical staff (70%) had the lowest precaution-taking in scoring less than players (87%), coaches (94%), administrative staff (93%) and referees (92%) (p<0.01). (83%).

### *3.3.6. Concussion attitudes: Self versus others attitude*

When comparing the concussion attitude, self to others scores within the same role player, players yielded significant differences (p<0.01) in all four scenarios. For coaches, significant differences (p<0.05) were found in all scenarios with the exception of Scenario 3, whereas administrative staff only reported a significant difference in Scenario 3. The medical staff were found to have a statistically significant difference between self and other score for Scenario 1 and 2.

When comparing the SS versus OS between the different role players, Section 4 of the questionnaire reported significant differences in scenario 1 for the others-score (OS) between both referees and administrative staff ($p<0.01$), as well as between referees and players ($p<0.01$). Scenario 2 yielded significant differences for both the SS ($p<0.01$) and OS ($p=0.04$). For scenario 2, the role players that demonstrated significant difference for SS were between players and coaches ($p<0.01$) and between players and referees ($p<0.01$). The OS for scenario 2 was, however, only found to be significant between players and administrative staff ($p=0.03$), medical staff and coaches ($p=0.02$), as well as administrative staff and medical staff ($p=0.01$).

Table 4.3: Concussion attitude for self and others for scenario 1 and 2.

| **Scenario 1** | | | | | | |
|---|---|---|---|---|---|---|
| Player R suffers a concussion during a game. Coach A decides to keep player R out of the game. Players R's team loses the game. | | | | | | |
| I feel that coach A made the right decision to keep player R out of the game. | | | | Most players would feel that coach A made the right decision to keep player R out of the game. | | |
| | **Self** | | | **Other** | | |
| **Role players** | **n** | **M ± SD** | **Range** | **n** | **M ± SD** | **Range** |
| **Player** | 345 | 4.5 ± 0.90 | 1 - 5 | 343 | 3.9 ± 1.09 | 1 – 5 |
| **Coach** | 37 | 4.7 ± 0.53 | 3 – 5 | 35 | 3.7 ± 1.10 | 1 – 5 |
| **Admin staff** | 16 | 4.3 ± 0.97 | 1 – 5 | 16 | 4.0 ± 0.71 | 2 – 5 |
| **Medical staff** | 8 | 4.7 ± 0.48 | 4 – 5 | 8 | 3.0 ± 1.32 | 1 – 5 |
| **Referee** | 28 | 4.6 ± 1.08 | 1 – 5 | 28 | 3.2 ± 1.15 | 1 – 5 |
| **Combined** | 434 | 4.5 ± 0.79 | 1 – 5 | 430 | 3.6 ± 1.07 | 1 - 5 |
| **Scenario 2** | | | | | | |
| Player M suffered a concussion during the first game of the season. Player O suffered a concussion of the same severity during the semi-final playoff game. Both players had persisting symptoms. | | | | | | |
| I feel that player M should have returned to playing during the first game of the season (the same game of the injury). I feel that player O should have returned to play during the semi-final playoff game. | | | | Most players would feel that player M should have returned to play during first game of season (the same game of injury). Most players feel that player O should have returned to play during the semi-final playoff game. | | |
| | **Self** | | | **Other** | | |
| **Role Players** | **n** | **M ± SD** | **Range** | **n** | **M ± SD** | **Range** |
| **Player** | 343 | 2 ± 1.00 | 1 – 5 | 339 | 2.3 ± 1.12 | 1 - 5 |
| **Coach** | 37 | 1.5 ± 0.84 | 1 – 5 | 37 | 2 ± 1.07 | 1 – 5 |
| **Admin staff** | 16 | 1.7 ± 0.85 | 1 – 4 | 16 | 1.8 ± 0.84 | 1 – 4 |
| **Medical staff** | 8 | 1.7 ± 0.74 | 1 – 4 | 8 | 2.8 ± 0.86 | 1 – 4 |
| **Referee** | 28 | 1.3 ± 0.59 | 1 – 4 | 28 | 2.3 ± 1.11 | 1 – 5 |
| **Combined** | 432 | 1.7 ± 0.80 | 1 – 4 | 428 | 2.2 ± 1.00 | 1 – 5 |

*Note: n – number of observations, M – mean, SD – Standard deviation*

Significant differences for the SS was reported in scenario 3. The coaches reported the highest score and significant differences were reported between both coaches and players (p=0.02), as well as between coaches and medical staff (p=0.02). Scenario 4 investigated whether players should disclose symptoms of a concussion to coaches regardless of being withdraw from participating. Scenario 4 (Table 4), presented significant differences for both the SS (p=0.05) and OS (p=0.02). The significant differences were found in the SS between players and referees (p<0.01), coaches and referees (p<0.01), as well as between administrative staff and referees (p=0.04). The OS reported significant differences between players and medical staff (p=0.01) with the medical staff reporting the lowest score.

Table 4.4: Concussion attitude for self and others for scenario 3 and 4

| **Scenario 3** | | | | | | |
|---|---|---|---|---|---|---|
| Player R suffered a concussion. Player R's team has a physiotherapist on staff. | | | | | | |
| I feel that the physiotherapist rather than player R should make the decision about player R returning to play. | | | | Most players would feel that the physiotherapist rather than player R should make the decision about returning player R to play. | | |
| | **Self** | | | **Others** | | |
| **Role players** | **n** | **M ± SD** | **Range** | **n** | **M ± SD** | **Range** |
| **Player** | 343 | 3.9 ± 1.25 | 1 – 5 | 343 | 3.6 ± 1.22 | 1 – 5 |
| **Coach** | 37 | 4.3 ± 0.87 | 1 – 5 | 37 | 3.8 ± 1.09 | 1 – 5 |
| **Admin staff** | 16 | 4.1 ± 0.90 | 2 – 5 | 16 | 3.4 ± 0.93 | 2 – 5 |
| **Medical staff** | 8 | 2.9 ± 1.36 | 2 – 4 | 8 | 3.0 ± 1.12 | 1 – 4 |
| **Referee** | 28 | 4.0 ± 1.24 | 1 – 5 | 28 | 3.5 ± 1.24 | 1 – 5 |
| **Combined** | 437 | 4 ± 1.22 | 1 - 5 | 437 | 3.6 ± 1.21 | 1 – 5 |
| **Scenario 4** | | | | | | |
| Player H suffered a concussion and has a game in two hours. He/she is still experiencing symptoms of a concussion. However, player H knows that if he tells his/her coach about the symptoms, his/her coach will keep him/her out of the game | | | | | | |
| I feel that player H should tell the coach about the symptoms | | | | Most players would feel that player H should tell the coach about the symptoms | | |
| | **Self** | | | **Other** | | |
| **Role players** | **n** | **M ± SD** | **Range** | **n** | **M ± SD** | **Range** |
| **Player** | 346 | 4.4 ± 0.97 | 1 – 5 | 346 | 4.1 ± 1.03 | 1 – 5 |
| **Coach** | 37 | 4.3 ± 1.01 | 1 – 5 | 37 | 3.8 ± 1.01 | 1 – 5 |
| **Admin staff** | 16 | 4.4 ± 0.99 | 1 – 5 | 16 | 4.1 ± 0.97 | 2 – 5 |
| **Medical staff** | 8 | 4.4 ± 1.32 | 1 – 5 | 8 | 3.0 ± 1.12 | 1 – 5 |
| **Referee** | 28 | 4.9 ± 0.26 | 4 – 5 | 28 | 3.7 ± 1.19 | 1 – 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Combined** | 437 | 4.4 ± 0.95 | 1 – 5 | 437 | 4 ± 1.05 | 1 – 5 |

*Note: n – number of observations, M – mean, SD – Standard deviation*

*3.3.7. Concussion symptom checklist*

By viewing the concussion symptom checklist of section 5 in isolation, the results indicated that headaches (93%), dizziness (86%) and difficulty remembering (72%) were the most commonly selected. A low proportion of participants selected weight gain (3%), hair loss (2%) and arthritis (2%) as possible symptoms. The above-mentioned items were categorized as distractor items, however, some participants still selected them. Difficulty speaking ($p<0.01$), sensitivity to light ($p=0.01$), difficulty remembering ($p<0.01$), drowsiness ($p<0.01$), feeling in a 'fog' ($p=0.02$), difficulty concentrating ($p<0.01$) and dizziness were found to be statistically significant symptoms among the various role players.

Table 4.5: Concussion symptom checklist for role player.

| **Symptoms** | **P** | **C** | **AS** | **R** | **MS** | **Combined** |
|---|---|---|---|---|---|---|
| | **n (%)** | **n (%)** | **n (%)** | **n (%)** | **n (%)** | **n (%)** |
| **Hives** | 21 (6) | 3 (8) | 1 (7) | 1 (4) | 1(13) | 27 (6) |
| **Headache** | 331 (94) | 36 (97) | 13 (87) | 27 (96) | 8 (100) | 415 (95) |
| **Difficulty speaking** | 159 (45) | 24 (65) | 10 (67) | 23 (82) | 7 (88) | 223 (51) |
| **Arthritis** | 5 (1) | 0 (0) | 0 (0) | 1 (4) | 1 (13) | 7 (2) |
| **Sensitivity to light** | 190 (54) | 22 (59) | 6 (40) | 22 (79) | 7 (88) | 247 (56) |
| **Difficulty remembering** | 247 (70) | 28 (76) | 10 (67) | 26 (93) | 8 (100) | 319 (73) |
| **Panic attack** | 48 (14) | 5 (14) | 0 (0) | 5 (18) | 2 (25) | 60 (14) |
| **Drowsiness** | 233 (66) | 33 (89) | 10 (67) | 26 (93) | 8 (100) | 310 (71) |
| **Feeling in a fog** | 146 (42) | 14 (38) | 8 (53) | 17 (61) | 7 (88) | 192 (44) |
| **Weight gain** | 8 (2) | 2 (5) | 1 (7) | 0 (0) | 1 (13) | 12 (3) |
| **Feeling slowed down** | 220 (63) | 26 (70) | 9 (60) | 19 (68) | 8 (100) | 282 (64) |
| **Reduced breathing** | 78 (22) | 10 (27) | 4 (27) | 10 (36) | 5 (63) | 107 (24) |
| **Excessive studying** | 17 (5) | 2 (5) | 0 (0) | 2 (7) | 0 (0) | 21 (5) |
| **Difficulty concentrating** | 234 (67) | 29 (78) | 10 (67) | 26 (93) | 7 (88) | 306 (70) |
| **Dizziness** | 300 (85) | 36 (97) | 12 (80) | 27 (96) | 7 (88) | 382 (87) |
| **Hair loss** | 7 (2) | 1 (3) | 0 (0) | 0 (0) | 0 (0) | 8 (2) |

*Note: n – number of observations, M – mean, SD – Standard deviation, % - Percentage, P – Players, C – Coaches, AS – Administration staff, R – Referee, MS – Medical staff*

## 4. Discussion

The aim of the study was to determine the concussion knowledge and attitude among amateur club rugby role players. The main findings of the study were that players demonstrated the lowest concussion knowledge and the greatest risk-taking attitude in comparison to referees who demonstrated the highest concussion knowledge scores and most cautious attitude towards concussion. Regarding concussion risk-taking, coaches and referees had significantly lower scores compared to players, which could indicate the value of BokSmart. The administrative staff demonstrated the second lowest concussion knowledge index (CKI) scores, which warrants concern as they could play a vital role in player welfare. The CKI was higher for senior amateur players than previously reported by Viljoen *et al.*[10] and similar to research performed by Kraak *et al*.[23]

### *4.4.1. Concussion Knowledge Index (CKI)*

On average the players scored 67% in the CKI, which was the lowest compared to the other role players. This was deemed insufficient because only scores above 75% have previously been considered sufficient[25,10] for concussion knowledge. The players scored lower compared to previous research done by Kraak *et al*.[25] and Olutende *et al.*[31] who investigated university hostel rugby and sub-elite rugby players, respectively. The results were however, higher compared to a similar population of South African amateur players investigated by Viljoen *et al*.[10.]In the study by Viljoen and co-workers' senior players scored 60% which was thought to lead to unsafe behaviour regarding concussion. Coaches (73.94%) were found to scored significantly higher than players ($p<0.01$) for concussion knowledge. Although still insufficient the relative higher score obtained by coaches could be a result of the compulsory bi-annual BokSmart education workshops.

Referees presented sufficient knowledge scores of 78%, while coaches were ranked third highest by scoring 74%. In community rugby, coaches are often left with the responsibility of concussion detection and the removal of concussed players because medical support might be lacking[10]. Chinn and Porter[32] also highlighted the coaches' role in community college rugby in that coaches played an important role in implementing the concussion management protocol. According to Griffin *et al*.[14] 85% of the referees in their study stated they had the final say regarding to whether a player should leave the field. In the current study the referees yielding the highest concussion knowledge scores, which indicated a positive sign. Recently SA Rugby introduced a Blue Card by which referees' or medical staff can order a player with suspected concussion to leave the playing field. This recent change will establish the role referees play alongside medical staff in concussion management during match-

play[33].Misconceptions were still identified within the roles of respective role players, which should be considered for future research initiatives (Addendum A).

Scoring poorly in question 13 from section 1 was a concern because administrative staff previously considered themselves to play a vital role in injury prevention [34]. However, only half of the administrative staff identified that there was long-term health and well-being risks from multiple concussions. Administrative staff can, thus, enforce the prescribed rest period, as well as implement regular screening[9] and thereby prevent subsequent concussions.

*4.4.2. Concussion Knowledge Index versus years of experience*

When investigating possible correlations between years of experience in respective roles players and concussion knowledge, the CKI scores indicated an inverse correlation in the current study. Research regarding the relationship between concussion knowledge and years of experience within specific role players in rugby are however limited.

*4.4.3. Concussion Attitude Index: Risk- and precaution-taking*

An overall average CAI of 76% was reported by the role players in the current study, which was higher than that previously reported by Viljoen *et al.*[10], as well as Kraak *et al.*[24]. Because of the unreliability of the CAI, further exploratory factor analysis identified '*concussion risk-taking'* and '*concussion precaution-taking'* attitudes instead. An important consideration is that behaviour adjustments by investigating risk-taking to prevent concussion could lead to increases in other injuries[35]. The referees in the current study reported the lowest risk-taking and higher precaution-taking behaviour, compared to players and medical staff. A possible explanation for the above-mentioned finding could be that referees have a greater responsibility with the initial identification of potential concussion, whereas medical staff predominantly have a post-concussion responsibility. Clacy and colleagues[36], support this finding that referees indicated they have a prevention responsibility (i.e. "*running a safe game*", "*enforcing the laws of the game*") to "*make sure that any dangerous play is stopped immediately to prevent any injuries*", "*facilitate safe play*" and "*follow formal guidelines about safe play*". However, medical staff stated that their responsibilities included concussion risk identification and creating a safe environment[9]. This should warrant concern as medical staff ultimately have the authority to remove concussed players, where after they should be assessed[33]. Numerous factors could, however, play a role in concussion risk-taking, such as perceived pressure to continue playing either from themselves, team members[37] or coaches[38]. For instance, Griffin *et al.*[14] found that 40% of referees reported seeing coaches' pressure potentially concussed players to continue playing[14].

*4.4.4. Concussion attitudes: Self versus others*

Scenario 1 from section 4 related to the perceptions of others, when coaches withhold a concussed player from playing a game. Medical staff scored the lowest regarding the opinion of others, compared to referees ($p<0.01$) and administrative staff ($p<0.01$). The low perceived safety reported by referees regarding the opinion of others, could likely be because of prior experiences on club rugby level, however, no research has been conducted on referees at this level. Regarding scenario 2, significant differences were found for the self-score in which players had the highest score, demonstrating the most unsafe behaviour towards match importance determining the RTP. Players, therefore, scored significantly higher than both coaches ($p<0.01$) and referees ($p<0.01$), which should warrant concern. Similar responses have previously been found among soccer players indicating that 96% would allow match importance to influence reporting of concussion and RTP[25].

*4.4.5. Concussion symptom checklist*

The only symptoms identified by more than 80% of all the players were headaches (93%) and dizziness (86%). This is consistent with previous research in which the recognized symptoms were also only 2 out of 8[23]. The other symptoms, which were often selected, were dizziness (86%), difficulty remembering (72%) and drowsiness (70%). Significant differences were found between the role players for the following symptoms: difficulty speaking ($p<0.01$); sensitivity to light ($p=0.01$); difficulty remembering ($p<0.01$); drowsiness ($p<0.01$); feeling in a fog ($p=.0.02$); difficulty concentrating ($p=0.01$); and dizziness ($p=0.01$). Administrative staff reported the lowest score for 5 out of the 8 above-mentioned symptoms. Clacy *et al*.[36] report that there is a great reliance on medical staff to identify symptoms, although at community level medical staff may not be present at training sessions and/or matches. Cussimano *et al*.[8] stated that recognition of symptoms leads to decision making regarding diagnosis, treatment, as well as prevention. As these symptoms could be challenging to test, the need for concussion protocols at community level is highlighted.

## 4.5. Conclusion

In conclusion, the results of the study indicated that less than half of the role players at amateur club rugby level had sufficient knowledge regarding concussion with players and administrative staff demonstrating the lowest levels of concussion knowledge. Regarding risk- and precaution-taking attitudes towards concussion, the players proved to have the highest risk-taking attitude and the medical staff demonstrated the lowest precaution-taking attitudes. Referees, however, demonstrated the safest attitudes toward concussion by having the lowest

risk-taking and highest precaution-taking scores while reporting safe attitudes towards concussion scenarios. Understanding the knowledge and attitudes towards concussion at community club rugby level might assist in identifying which areas are to be further targeted by SARU[33]. Limitations of the study could include the sample size of the medical staff, as well as the variance in the type of medical staff, which can be specified in future studies. The low response rate by club role players also inhibit the generalization of results to the entire union's club rugby population. For future studies the focus should be placed on all levels of competition, as concussion occurs at all levels of participation.

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## 4.7. Addendum A

Section 1 and 2 Concussion Knowledge Index responses by WPRU club rugby role players

| 1.1 | There is a possible risk of death if a second concussion occurs before the first one has healed | % Correct |
|---|---|---|
| | Player | 90.46 |
| | Coach | 91.81 |
| | Admin staff | 93.33 |
| | Medical staff | 100.00 |
| | Referee | 96.42 |
| | Combined | 94.40 |
| 1.2 | Running everyday does little to improve cardiovascular health | |
| | Player | 53.75 |
| | Coach | 72.97 |
| | Admin staff | 66.67 |
| | Medical staff | 87.50 |
| | Referee | 75.00 |
| | Combined | |
| 1.3 | People who had one concussion are more likely to have another concussion | |
| | Player | 73.12 |
| | Coach | 86.48 |
| | Admin staff | 93.33 |
| | Medical staff | 62.50 |
| | Referee | 92.85 |
| | Combined | 81.66 |
| 1.4 | Studs help player's feet grip the playing surface | |
| | Player | 91.04 |
| | Coach | 97.29 |
| | Admin staff | 100.00 |
| | Referee | 100.00 |
| | Medical staff | 92.86 |
| | Combined | |
| 1.5 | In order to be diagnosed with a concussion, you have to be knocked out | |
| | Player | 77.45 |
| | Coach | 86.48 |
| | Admin staff | 86.67 |
| | Medical staff | 75.00 |

| | | |
|---|---|---|
| | Referee | 96.42 |
| | Combined | 84.40 |
| 1.6 | A concussion can only occur if there is a direct hit to head | |
| | Player | 42.77 |
| | Coach | 64.86 |
| | Admin staff | 40.00 |
| | Medical staff | 62.50 |
| | Referee | 71.42 |
| | Combined | 56.31 |
| 1.7 | Being knocked unconscious always causes permanent damage to the brain | |
| | Player | 70.80 |
| | Coach | 62.16 |
| | Admin staff | 86.67 |
| | Medical staff | 75.00 |
| | Referee | 89.28 |
| | Combined | 76.78 |
| 1.8 | Symptoms of a concussion can last several weeks | |
| | Player | 86.70 |
| | Coach | 97.29 |
| | Admin staff | 100.00 |
| | Medical staff | 87.50 |
| | Referee | 96.42 |
| | Combined | 93.58 |
| 1.9 | Sometimes a second concussion can help a person remember things that were forgotten after the first concussion | |
| | Player | 78.32 |
| | Coach | 86.48 |
| | Admin staff | 80.00 |
| | Medical staff | 100.00 |
| | Referee | 85.71 |
| | Combined | 86.10 |
| 1.10 | Weightlifting helps to tone and/or build muscle | |
| | Player | 95.95 |
| | Coach | 94.59 |
| | Admin staff | 100.00 |
| | Medical staff | 100.00 |
| | Referee | 96.43 |
| | Combined | |

| | | |
|---|---|---|
| 1.11 | After a concussion occurs, brain imaging (CAT scan, MRI, X-rays etc.), typically shows visible physical damage (bruise, blood clot) to the brain | |
| | Player | 18.49 |
| | Coach | 13.51 |
| | Admin staff | 20.00 |
| | Medical staff | 50.00 |
| | Referee | 21.42 |
| | Combined | 24.69 |
| 1.12 | If you receive one concussion and you have never had a concussion before, you will become less intelligent | |
| | Player | 94.79 |
| | Coach | 94.59 |
| | Admin staff | 86.67 |
| | Medical staff | 100.00 |
| | Referee | 96.42 |
| | Combined | 94.49 |
| 1.13 | After 10 days, symptoms of a concussion are usually completely gone | |
| | Player | 38.75 |
| | Coach | 37.83 |
| | Admin staff | 26.67 |
| | Medical staff | 37.50 |
| | Referee | 53.57 |
| | Combined | 38.86 |
| 1.14 | After a concussion, people can forget who they are and not recognize others but be perfect in every other way | |
| | Player | 34.10 |
| | Coach | 54.05 |
| | Admin staff | 13.33 |
| | Medical staff | 25.00 |
| | Referee | 17.85 |
| | Combined | 28.87 |
| 1.15 | Grade eight high school students and first year university students tend to be the same age | |
| | Player | 87.86 |
| | Coach | 89.19 |
| | Admin staff | 93.33 |
| | Medical staff | 100.00 |
| | Referee | 92.86 |
| | Combined | |
| 1.16 | Concussions can sometimes lead to emotional disruptions | |
| | Player | 72.83 |
| | Coach | 83.78 |

| | | |
|---|---|---|
| | Admin staff | 80.00 |
| | Medical staff | 100.00 |
| | Referee | 100.00 |
| | Combined | 87.32 |
| 1.17 | A player who gets knocked out after getting a concussion is experiencing a coma | |
| | Player | 39.88 |
| | Coach | 37.83 |
| | Admin staff | 40.00 |
| | Medical staff | 37.50 |
| | Referee | 46.42 |
| | Combined | 40.33 |
| 1.18 | There are rarely a risk to long-term health and well-being from multiple concussions | |
| | Player | 54.62 |
| | Coach | 67.56 |
| | Admin staff | 46.67 |
| | Medical staff | 75.00 |
| | Referee | 75.00 |
| | Combined | 63.77 |
| While playing in a game player Q and player X collide with each other and each suffer a concussion. Player Q has never had a concussion in the past. Player X has had 4 concussions in the past | | |
| 2.1 | Is it likely that player Q's concussion will affect his long term health and well being | |
| | Player | 72.25 |
| | Coach | 64.86 |
| | Admin staff | 66.67 |
| | Medical staff | 37.50 |
| | Referee | 64.28 |
| | Combined | 61.11 |
| 2.2 | It is likely that player X's concussion will affect his long term health and well being | |
| | Player | 91.04 |
| | Coach | 91.89 |
| | Admin staff | 93.33 |
| | Medical staff | 87.50 |
| | Referee | 85.71 |
| | Combined | 89.89 |
| Player F suffered a concussion in a game. He continued to play in the game despite the fact that he continued to feel the effects of the concussion. | | |
| 2.3 | Is it likely that player Q's concussion will affect his long term health and well being | |
| | Player | 81.21 |
| | Coach | 91.89 |
| | Admin staff | 73.33 |
| | Medical staff | 100.00 |

| | |
|---|---|
| Referee | 85.71 |
| Combined | 86.25 |

Section 3 Concussion Attitude Index and role player responses

| | | P | C | AS | MS | R |
|---|---|---|---|---|---|---|
| 1 | I would continue playing a sport while having a headache that results from a concussion | 38% | 32% | 35% | 25% | 28% |
| 2 | I feel that coaches need to be extremely cautious when determining whether a player should Return-to-Play | 87% | 94% | 93% | 70% | 92% |
| 3 | I feel mouth guards protect teeth from being damaged or knocked out | 83% | 77% | 80% | 75% | 84% |
| 4 | I feel that professional players are more skilled at their sport than high school players | 82% | 82% | 83% | 85% | 90% |
| 5 | I feel that concussions are less important than other injuries | 35% | 25% | 31% | 28% | 21% |
| 6 | I feel that players have the responsibility to return to a game if it means playing while still experiencing symptoms of concussion | 34% | 25% | 29% | 33% | 25% |
| 7 | I feel that a player who is knocked unconscious should be taken to the emergency room | 85% | 92% | 90% | 83% | 94% |
| 8 | I feel most high school players will play professional sports in the future | 55% | 49% | 61% | 48% | 51% |

Note: P-Players, C-Coach, AS-Administrative staff, MS-Medical staff, R-Referee

# CHAPTER 5

# RESEARCH ARTICLE 2

# POST-CONCUSSION RETURN-TO-PLAY: ROLES, RESPONSIBILITIES AND IMPLEMENTATION AMONG AMATEUR CLUB RUGBY ROLE PLAYERS

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*This article will be submitted to the Journal of Science and Medicine in Sport (Appendix E). This article is included herewith in accordance with the guidelines for authors of this journal. To provide a neat product for the thesis, this article has been edited to represent an actual published article as it would appear in the abovementioned journal. This does not imply that the article has been accepted or will be accepted in said journal. As a result, the referencing style may differ as the from other chapters of the thesis.*

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## Title page

### Title

Post-concussion return-to-play: Roles, responsibilities and implementation among amateur club rugby role players

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# Post-concussion return-to-play: Roles, responsibilities and implementation among amateur club rugby role players

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***Abstract***

**Objectives**: Concussions are an inherent part of contact sport, however, subsequent concussions can be decreased by following the appropriate post-concussion return-to-play (RTP) protocol. The aim of the study was to investigate the post-concussion roles, responsibilities and implementation in amateur club rugby role players.

**Design**: A descriptive cross-sectional study design.

**Methods**: A custom designed post-concussion RTP implementation questionnaire was implemented to determine the roles and responsibilities in amateur club rugby role players.

**Results**: The 6-stage RTP protocol was preferred by almost a third of the players and administrative staff, as well as two thirds of 64% of the coaches ($p<0.01$). When asked to identify the correct order of activities of the 6-stage RTP protocol less than half (40%) of the medical staff and 37% of the coaches were able to successfully do so. Regarding the roles and responsibilities; the majority of coaches (88%), administrative staff (79%) and medical staff (100%) all believed coaches should have knowledge of post-concussion RTP guidelines. Coaches were also selected by 71% of the players and 88% of the coaches to be responsible for monitoring training sessions and matches for injuries.

**Conclusions**: Although coaches were selected by the role players in the current study to have the greatest responsibility regarding post-concussion RTP, their implementation of RTP protocols were found lacking. Concussion education should focus on practical implementation of post-concussion RTP protocols.

**Key words**: Rugby union; mild traumatic brain injury; club level; return-to-play.

## 5.1. Introduction

Rugby Union (hereafter referred to as rugby), has a high occurrence of injuries because of the physical demands and the frequent contact between opposing players[1-3]. Of the numerous amounts of the injuries that occur in rugby, up to 30% involve the head, neck and spine, and therefore, players are at high risk for concussions[4,5]. After sustaining a concussion, players need to complete a return-to-play (RTP) protocol, which encompass that they be asymptomatic at rest and throughout activities, which gradually increases in intensity[6]. Previously concussed players are more susceptible to sustaining a secondary concussion with aggravated symptoms and longer recovery time[7,8,9]. The above-mentioned subsequent concussion could also be a result of premature return-to-play (RTP) and indicate that complete

clinical recovery was not achieved[10]. Given the high proportion of concussion, more emphasis should be placed on post-concussion RTP implementation[11]. The implementation of post-concussion RTP is dependent on role player behaviour, of which the intention to perform said behaviour has been found a predicting factor. The misunderstanding and incorrect implementation of RTP guidelines can lead to the questionable management of players throughout the process[10]. A shared responsibility among role players has been advocated by previous literature to ensure the safe RTP of players[12] although differences in perceptions have been reported throughout the club structure.

Since 2012, the RTP guidelines (adopted by the International Rugby Board, now World Rugby) stipulate an individualized approach to concussion management[13]. This management, which includes implementing a post-concussion RTP protocol has, however, proven to be a challenging issue for clinicians. Although the exercises prescribed at the correct timeframe has proven beneficial[14,15] the prescribed level of exercise has been deemed vague[16]. If implemented correctly, the players should not report concussion symptoms after any stages of the RTP protocol and if symptoms were to re-occur, revert back to step one[17]. After the RTP protocol has been adhered to fully, the players should be evaluated and cleared by a medical doctor or licensed health care professional[18].

Although the amount of concussion educational programs and resources have increased, there have been little measurable improvements in concussion related knowledge, attitudes[19] and behavioural changes[20]. Of concern is that only 21% of club players are aware of the general RTP guidelines[19] and only 18% of medical staff used formal measures to identify concussion[12]. Regarding coaches, it has been reported that there have been misunderstandings on when it is safe for players to RTP[22]. When coaches were asked under which circumstance the players can RTP on the same day, 97% of coaches and trainers indicated, "*when the player says he/she is symptom free and ready to play*".

Players have been known to previously underreported symptoms to RTP, which warrants concern as players should not RTP in the same day of a game or practise[23]. Research by Mathema *et al*. [23] investigated adult rugby and found that 80% of the medical staff reported feeling pressured to allow the players to continue playing regardless of concussion symptoms. It is for this reason that medical doctors or licensed health care professionals should engage the players' family and most of all the coaches on how to manage the RTP post-concussion[18].

A multidisciplinary team of role players should be responsible for identification of symptoms, initial management and RTP protocol implementation[24]. Paddack *et al.* [25] investigated the state of policies in community colleges and found that only half (47%) of the trainers had concussion

policies in place, which included the management of concussion and RTP protocols. Chinn and Porter[26] investigated student athletes and found an inverse relationship between the years of experience and use of baseline concussion testing. The less experience these role players had, the more likely they were to implement a concussion baseline test[26]. The above-mentioned indicate that experience in a specific role was not necessarily a prerequisite for implementation of baseline testing. The aim of this study was to investigate the post-concussion RTP roles, responsibilities and implementation among amateur club rugby role players.

## 5.2. Methodology

The study utilized a quantitative cross-sectional study design in which a paper-based questionnaire was completed. The post-concussion RTP implementation questionnaire (Appendix C) was designed by the primary researcher and the study leader and was based on available literature on post-concussion RTP (henceforth referred to as RTP), general RTP and suggestions from rugby experts in the field of concussion and rugby. Ethical approval (REC 050411-032) was obtained from the Human Research Ethics Committee at Stellenbosch University.

All of the 89 rugby clubs registered with the WPRU were contacted to participate in the study. Regarding the players, there were roughly 7560 registered players, 890 coaches and administrative staff, respectively and an undisclosed number of medical staff. The study yielded a response rate of 4%. The inclusion criteria entailed that the role players must be associated with WPRU club rugby and should be male or female. The post-concussion RTP implementation questionnaire aimed to determine the post-concussion RTP implementation and the roles and responsibilities of the different role players in amateur club rugby.

Prior to the main study, a pilot study was conducted with the aim of determining whether any questions could be misunderstood or misinterpreted. The feedback from the pilot study was screened to determine whether any technical aspects needed to be addressed or whether questions had to be added or removed. 15 participants in the field of rugby completed the pilot study. The participants of the pilot study were role players (players, coaches, medical staff and administrative staff) from amateur club rugby who did not form part of the current study. After completion of the questionnaire, pre-set questions were administered to the participants, which inquired about the general interpretation of questions in the questionnaire.

The club representatives were contacted and a date and time for each data collection was determined. The purpose of the study was explained to the participants before commencing with the data collection. Hereafter, demographic information, informed consent, as well as the

questionnaire itself was completed. All questionnaires were formulated in English however the participants could ask for clarity on the questions any time during the data collection. The post-concussion RTP questionnaire (Appendix C) aimed to investigate two themes namely, "*implementation of post-concussion RTP - (questions 1 to 8)"* and "*post-concussion RTP roles and responsibilities - (questions 9 to 17)*".

Descriptive statistics, such as the mean, frequency and standard deviation were used. The data was expressed as percentages and frequencies to summarize the score of each question. One-way ANOVA's were conducted as with the first question which was a Likert-scale question (question 1) to compared between the groups with post-hoc testing using Fischer least significant difference (LSD) test. The other questions were compared between the groups using cross tabulation and generalized Fischer exact test. Statistica version 13.5 (Dell Inc, Tulsa, OK, USA) and Excel (Microsoft® Corporation, Redmond, WA, USA) was utilized to analyse the data.

### 5.3. Results

In Table 5.1, statistically significant differences were found in role players throughout questions 2, 3, 4, 7 and 8 ($p<0.05$). Question 1 – *'Do you believe you have the ability to assist a concussed player on when it is safe to RTP'* indicated that medical staff scored the highest compared to players ($p<0.01$) and coaches ($p=0.03$).Collectively, 27% disagreed, 24% indicated they were neutral and 25% agreed with the abovementioned question.

Question 2 assessed whether baseline testing was being implemented at the club - '*Do you know whether the organization that you belong to, perform any preseason screening such as computerized brain function testing or measuring of baseline symptoms for concussion'* ($p<0.01$). A high proportion of administrative staff (79%) and coaches (61%) responded that '*no'* concussion baseline testing was conducted for players (Table 5.1).

All the medical staff responded '*yes*' to question 3 – '*Do you have knowledge of any concussion tools, which can be used in the assessment of an injured player'* in contrast to only half of both the coaches (49%) and administrative staff (43%) ($p<0.05$) (Table 5.1).

However, significant differences in responses by the role players were reported for question 4 '*Are any of the following side-line concussion assessments/test currently being implemented within your club',* because the SCAT 3/5 ($p=0.01$), as well as physical signs ($p=0.01$) were conveyed by the role players. Medical staff reported that in assessing concussion they relied predominantly on physical signs (75%) and SCAT 3/5 (50%), whereas only a third (35.12%)

of coaches preferred physical signs and very few coaches (5.88%) preferred using the SCAT 3/5 (Table 5.1).

Table 5.1: Implementation of post-concussion RTP role player responses (Question 2 - 8)

| Questions | Response(s) | P *f*(%) | C *f*(%) | AS *f*(%) | MS *f*(%) |
|---|---|---|---|---|---|
| Question 2: Do you know whether the organization (club) you belong to, perform any preseason screening such as computerized brain function testing or measuring of baseline symptoms for concussion? | Not sure | 152 (42) | 6(16) | 3(21) | 2(25) |
| | Yes | 154(46) | 8(22) | 0(0) | 4(50) |
| | No | 41(12) | 22(61) | 11(79) | 2(25) |
| Question 3: Do you have knowledge of any concussion tools, which can be used in the assessment of an injured player? | Not sure | 74(22) | 8(23) | 3(21) | 0(0) |
| | Yes | 132(38) | 17(49) | 6(43) | 8(100) |
| | No | 137(40) | 10(28) | 5(36) | 0(0) |
| Question 4: Are any of the following immediate (sideline) concussion assessments/ test currently being implemented within your club? (you may mark more than one) | Not sure | 126(38) | 12(35) | 5(35) | 4(50) |
| | Physical signs | 106(32) | 12(35) | 8(57) | 6(75) |
| | Balance assessments | 79(34) | 11(32) | 5(36) | 4(50) |
| | None | 59(18) | 6(18) | 2(14) | 0(0) |
| | SCAT3/5 | 27(8) | 2(6) | 1(7) | 4(50) |
| | Computerized brain function test | 13(4) | 1(3) | 1(7) | 2(25) |
| Question 5: Following a concussion, is there a mandatory period of time a player should rest? | Not Sure | 50(14) | 3(8) | 1(7) | 0(0) |
| | Yes | 271(79) | 31(86) | 12(86) | 8(100) |
| | No | 21(6) | 2(6) | 1(7) | 0(0) |
| Question 6: Does the organization you belong to have records of player medical history/injury history? | Not sure | 155(45) | 13(36) | 2(14) | 2(25) |
| | Yes | 107(31) | 12(33) | 6(43) | 5(63) |
| | No | 80(23) | 11(31) | 6(43) | 1(12) |
| Question 6.1: If you answered yes, do you know whether the organisation uses the medical history information in the event of a suspected concussion? | Not sure | 93(52) | 9(39) | 3(30) | 3(38) |
| | Yes | 55(31) | 7(30) | 5(40) | 4(40) |
| | No | 30(17) | 7(30) | 3(30) | 1(12) |
| Question 7: Are any of the following concussion return-to-play guidelines implemented at your club/team? | None | 53(16) | 6(17) | 3(21) | 0(0) |
| | Not sure | 179 (53) | 7(19) | 6(43) | 2(25) |
| | 6 Stage | 99(30) | 23(64) | 5(36) | 6(75) |
| | Buffalo Treadmill | 6(2) | 0(0) | 0(0) | 0(0) |
| Question 8: Which grading system of concussion is currently implemented at your club/team? | None | 60 (18) | 12(33) | 6(43) | 1(13) |
| | Not sure | 253(75) | 20(56) | 4(29) | 3(38) |
| | Colorado | 4(1) | 0(0) | 0(0) | 0(0) |
| | Case-by-case | 17(5) | 4(11) | 4(29) | 1(13) |
| | Glasgow coma scale | 2(1) | 0(0) | 0(0) | 3(38) |

*P – Players, C – Coaches, AS – Administrative staff, MS – Medical staff, f – frequency, % - percentage*

Table 5.2: Roles and responsibilities in the post-concussion RTP process role player responses (Question 9 - 17)

| Questions | Response(s) | P *f*(%) | C *f*(%) | AS *f*(%) | MS *f*(%) |
|---|---|---|---|---|---|
| Question 9: Within your organisation, what category does the medical team fall into? | Not sure | 142(42) | 11(31) | 5(36) | 0(0) |
| | Designated | 154(46) | 17(47) | 7(50) | 7(88) |
| | Assigned | 41(12) | 8(22) | 2(14) | 1(13) |
| Question 10: In your opinion, should a concussed player be assessed by either a medical doctor or registered healthcare professional (Biokineticist/ Physiotherapist/First aid) before returning to full contact? | Not sure | 44(13) | 0(0) | 1(7) | 0(0) |
| | Yes | 296(87) | 35(97) | 13(93) | 8(100) |
| | No | 1(0) | 1(3) | 0(0) | 0(0) |
| Question 11: Within your organization, are players assessed by either a medical doctor or registered healthcare professional (Biokineticist/ Physiotherapist/First aid) before returning to full contact? | Not sure | 108(33) | 3(8) | 5(36) | 1(13) |
| | Yes | 189(57) | 27(75) | 8(57) | 7(88) |
| | No | 34(10) | 6(17) | 1(7) | 0(0) |
| Question 12: Who within your organization, do you believe should have knowledge of return-to-play guidelines? (can mark more than one) | Player | 168(50) | 22(61) | 6(43) | 6(75) |
| | Coach | 249(74) | 32(88) | 11(79) | 8(100) |
| | Specialist coach | 163(49) | 21(58) | 4(29) | 6(75) |
| | Medic | 253(76) | 29(81) | 9(64) | 8(100) |
| | Physiotherapist | 205(61) | 23(64) | 7(50) | 7(88) |
| | Biokineticist | 149(44) | 16(44) | 3(21) | 6(75) |
| | Doctor | 254(73) | 24(67) | 7(50) | 7(88) |
| | Administrative staff | 63(19) | 19(53) | 7(50) | 2(25) |
| | Referee | 121(36) | 11(31) | 7(50) | 6(75) |
| Question 13: Player A is diagnosed with a concussion, please rank (from 1 to 6) the following activities in the order that you believe they should be performed before returning to play? | Correct | 50(22) | 10(37) | 2(29) | 2(40) |
| | Incorrect | 177(78) | 17(63) | 5(71) | 3(60) |
| Question 14: Have you participated in the BokSmart educational training program within the last 5 years? | Yes | 116(35) | 33(92) | 13(93) | 4(50) |
| | No | 218(65) | 3(8) | 1(7) | 4(50) |

(cont.)

Table 5.2: Roles and responsibilities in the post-concussion RTP process role player responses (Question 9 - 17)

| Questions | Response(s) | P f(%) | C f(%) | AS f(%) | MS f(%) |
|---|---|---|---|---|---|
| Question 15: Have you attended any other educational seminars or training programs? | First aid | 100(69) | 19(68) | 5(63) | 4(67) |
| | BokSmart Medic | 45(31) | 10(36) | 5(63) | 2(33) |
| | Cardiopulmonary-resuscitation | 18(13) | 2(7) | 2(25) | 0(0) |
| | Paramedics | 10(7) | 0(0) | 1(13) | 0(0) |
| | Basic Life Support | 26(18) | 3(11) | 2(25) | 1(17) |
| Question 16: Which role player in your organization, ensures that the concussed player is ready to return-to-Play? | Player | 71(22) | 4(11) | 2(16) | 0(0) |
| | Coach | 173(53) | 20(56) | 7(54) | 0(0) |
| | Specialist coach | 86(26) | 4(11) | 1(8) | 0(0) |
| | Medic | 166(50) | 13(36) | 3(23) | 3(38) |
| | Physiotherapist | 130(40) | 14(39) | 4(31) | 2(25) |
| | Biokineticist | 89(27) | 6(17) | 0(0) | 0(0) |
| | Doctor | 182(55) | 21(58) | 6(46) | 6(75) |
| | Administrative staff | 22(7) | 4(11) | 2(15) | 0(0) |
| | Referee | 38(12) | 1(3) | 1(8) | 1(13) |
| Question 17: Who within your organization is responsible for monitoring matches and practises for injuries and possible concussions? | Player | 61(18) | 1(3) | 1(7) | 0(0) |
| | Coach | 233(71) | 28(80) | 9(64) | 4(50) |
| | Specialist coach | 131(40) | 13(37) | 2(14) | 2(25) |
| | Medic | 157(48) | 15(43) | 6(43) | 5(63) |
| | physiotherapist | 128(39) | 14(40) | 5(36) | 6(75) |
| | Biokineticist | 71(22) | 10(29) | 1(7) | 1(13) |
| | Doctor | 113(34) | 11(31) | 2(14) | 2(25) |
| | Administrative staff | 53(16) | 17(49) | 6(43) | 0(0) |
| | Referee | 40(12) | 2(6) | 0(0) | 1(13) |

*P – Players, C – Coaches, AS – Administrative staff, MS – Medical staff, f – frequency, % - percentage*

Although there were no significant differences reported in the responses for Questions 5, 6, 6.1 and 10, the remainder of questions were deemed statistically significant ($p<0.05$). Question 7 '*Are any of the following concussion RTP guidelines implemented at your club/team'* also indicated differences among the role players. Decisions on which RTP protocol should be followed, more specifically with the use of the 6-stage RTP protocol ($p<0.01$), as well as players reporting '*unsure*' ($p<0.01$) proved significant. Only 30% of the players, 64% of the coaches and 36% of the administrative staff indicated they would implement the 6-stage RTP protocol (Table 5.1).

Regarding Question 8 – '*Which grading system of concussion is currently implemented at your club/team'* a majority of the players (75%) followed by (56%) of the coaches and 38% of the medical staff indicated they were '*not sure'* ($p<0.05$) (Table 5.1).

In Table 5.2 Question 9 states – '*Within your organization, what category does your medical team fall into'* shows 88% of the medical staff and 50% of the administrative staff, 47% of the coaches and 46% of the players indicated that the medical staff belonged to the clubs ($p<0.05$).

Question 11 states - '*Within your organization, are players assessed by either a medical doctor or registered healthcare professional*'. The medical staff (88%) predominantly indicated 'yes' in contrast to 57% of the administrative staff and 57% of the players ($p=0.02$) (Table 5.2).

Regarding Question 12, '*Who within the organization, do you believe should have knowledge of return-to-play guidelines'* only the administrative staff differed as their role proved to be statistically significant. The highest reported was 53% of the coaches and 50% of the administrative staff themselves indicated that 'administrative staff' should have knowledge of the guidelines. The players, however, indicated that it was not necessary because 81% of the players did not select the administrative staff ($p<0.01$) (Table 5.2).

Question 16 – '*Which role player in your organization, ensures that the concussed player is ready to RTP'* yielded that coaches ($p<0.01$), specialist-coaches ($p<0.01$) and Biokineticists were significant role players. For this question, coaches were selected by 53% of the players, by 56% of the coaches (56%) and by 54% of the administrative staff (54%) but unselected by 100% of the medical staff. Specialist-coaches ($p=0.01$) and Biokineticist ($p<0.01$) were, however only selected by a quarter of all players (26 and 27% respectively) but unselected by the rest of the role players (Table 5.2).

Regarding question 17 – '*Who within the organization is responsible for monitoring matches and practises for injuries and possible concussions',* 18% of the players ($p=0.01$) indicated

themselves, whereas the highest proportion (48%) of the administrative staff ($p<0.01$) indicated the coaches were responsible (Table 5.2).

## 5.4. Discussion

The main finding of the study was that although coaches were perceived as the role players with the greatest responsibility of post-concussion RTP, their implementation of RTP was found lacking. Less than two-thirds of coaches selected the six stage RTP protocol and only one third were able to rank these activities in the correct order.

Medical staff displayed the highest perceived ability to assist a concussed player on when to safely RTP. Patricios *et al*. [27] stated that 'when' to RTP post-concussion is a challenge faced by all medical staff. A high proportion of the administrative staff indicated that baseline screening was not implemented at the clubs. There was, however, a great variance in the responses by various role players to the above-mentioned question pertaining to baseline screening, which warrants concern as baseline screening has been defined as a 'cornerstone' in the management of concussions[28].Chinn and Porter[26] indicate similar findings in their study where 71% of the participants were not exposed to baseline testing.

Regarding the implementation of assessments medical staff indicated the highest knowledge of concussion tools followed by the coaches and administrative staff who could assess a concussed player. This could imply that coaches and administrative staff lack knowledge of assessment, which should warrant some concern because the responsibility of assessment could shift to them.

When asked to specify the concussion assessments, 'physical signs' were reported as the most common assessment by medical and administrative staff, as well as coaches. 50% of the medical staff selected the SCAT 3/5 as another assessment method. The above-mentioned percentage was, however, higher than that reported by Clacy *et al*. [29] they found that as little as 18% of the medical staff would use formal measures such as the SCAT to assess concussion.

Mandatory post-concussion rest periods were advocated by all of the medical staff who on average advised 21 days of rest. Similarly, the majority of coaches and administrative staff also believed mandatory rest periods should be implemented and advocated an average of 12 to 13 days of rest, respectively. The medical staff were, therefore, more conservative regarding stand-down periods in comparison to the coaches and administrative staff. This could also imply that coaches and administrative staff, who are directly involved at clubs, place a greater emphasis on match outcomes and player attendance than safety, or are not as

conservative as medical staff. Regarding the above-mentioned, Brown *et al*.[18] advised that medical staff and coaches should consider educating players on the dangers of premature RTP.

When asked in the current study, which of the post-concussion RTP protocols should be followed; 50% of the players and slightly less of the administration staff reported being unsure. 64% of the coaches, however, selected the 6-stage (BokSmart) RTP protocol. Previous research by Brown *et al*.[18] found that the 6-stage RTP protocol was the safest measure. What warrants serious concern is that coaches attend a compulsory BokSmart workshop, which covers the post-concussion RTP protocol to be followed in the event of a concussion. Thus the transference of the correct RTP protocol to coaches can be improved.

When investigating the category into which the medical staff at the organization fall into, there was quite divided responses. A majority of the medical staff and less than half of the players indicated they were the clubs' own medical staff. This discrepancy could be a determining factor when injured players are searching for follow-up advice from medical staff. It is stated that players must be assessed by medical staff to commence with the RTP protocol, as well as before returning to full contact training[18].

The following questions assessed whether the participants believed concussed players *should* be cleared (question 10), in contrast to if concussed players *are* in fact cleared (question 11) by medical staff before returning to play. The majority of role players indicated that they believe concussed players should be cleared, whereas in question 11 only 50% of the participants reported that players were in fact cleared. This abovementioned phenomenon could be due to socio-economic barriers in club players not having the access to health care professionals. This is similar to previous research done by Brown *et al*.[18]. They found that only 50% of youth week players sought out medical clearance before RTP.

The role players who were thought to have knowledge of RTP guidelines (Question 12), were investigated. The players predominantly believed that 'medical staff', as well as 'coaches*'* had the knowledge, whereas the coaches, administrative staff and medical staff all essentially identified the 'coaches' as the role players they believed should have knowledge of RTP guidelines. Hollis *et al*.[11] similarly stated that coaches and medical staff were the most relied upon role players regarding RTP decisions. Within the context of America, the National Collegiate Athletics Association (NCAA) reported that athletic coaches (73%) were identified as authority RTP decision-making. Medical staff were the second most selected option; however, the presence of medical staff at amateur level have in some instances previously been deemed inadequate[27].

When asked to arrange the 6-stage post-concussion RTP protocol in the correct order (Question 13), only a third of the coaches and slightly more medical staff could do so successfully. These findings warrants concern because the 6-stage RTP protocol is recommended by BokSmart and WR to be implemented in the event of a concussion. Although being identified by coaches as most used protocol (Question 7), the implementation is lacking.

The current study indicated that coaches in community rugby have the highest perceived responsibility to uphold post-concussion RTP. Half of the players, coaches and administrative staff identified 'coaches' as responsible in the assessment of whether a player is ready to RTP. Coaches were the most identified role player responsible for monitoring matches and training for injuries and concussions.

## 5.5. Conclusion

In conclusion, coaches were deemed as the most responsible role player in post-concussion RTP. However, results regarding the implementation of RTP concluded that coaches and administrative staff demonstrated relatively low willingness to assist others on when it was safe to RTP. Coaches were identified by the majority of participants (71% of the players and 80% of the coaches, respectively) to be responsible for monitoring matches and training sessions for concussion, as well as having knowledge of RTP guidelines. However, only two thirds of the coaches and a third of the administrative staff indicated implementing the 6-stage RTP protocol, which is the advocated protocol by BokSmart and WR. Furthermore, the correct 6-stage protocol was identified by less than half of medical staff and 37% of the coaches, which indicates a low level of implementation. Although 92% of the coaches and 93% of the administrative staff had participated in BokSmart within the last 5 years, the participants demonstrated inadequate knowledge to be able to implement RTP protocols. Limitations to the current study included a low response rate from the role players, which makes generalizations to the club rugby population problematic. Future research should focus on assessing the practical application of RTP guidelines by the role players.

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# CHAPTER 6

# SUMMARY, CONCLUSION, LIMITATIONS AND FUTURE RESEARCH

*Referencing within this chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.*

## 6.1 Summary

## 6.2. Conclusion

## 6.3. Limitations

## 6.4. Future research

## 6.5 Practical application

## 6.1 Summary

Although research has recently been conducted regarding concussion knowledge in a variety of sports, little is known about the various role players' concussion knowledge at amateur club rugby level in the Western Province Rugby Union. The same hold true for the role player's post-concussion return-to-rugby (RTP) roles, responsibilities and implementation in amateur club rugby. The research conducted could shed light on various role players concussion and RTP knowledge and responsibilities from low socio-economic status areas such as in some amateur club rugby situations. Globally unions have a rugby safety initiative, the research can help identify role players who are perceived to have knowledge of concussion.

The primary objective was to investigate concussion and RTP knowledge, roles and responsibilities of amateur club rugby role players. The current study was based on two specific aims. The first aim was to determine the concussion knowledge and attitudes of amateur club rugby role players, which was done by using the RoCKAS-ST questionnaire. Secondly, the aim was to investigate the post-concussion RTP roles and responsibilities of amateur club rugby role players, as well as the implementation of post-concussion RTP. This was done by implementing a custom designed post-concussion RTP questionnaire.

The study was presented in five sections, which consisted of the introduction and problem statement (Chapter 1), the literature review (Chapter 2), methodology (Chapter 3), Research article 1 (Chapter 4) and Research article 2 (Chapter 5). The article format was approved by the senate of Stellenbosch University and the two research articles were presented in accordance with the specific journal guidelines.

Chapter 1 of the current study introduced the problem, stated the specific objectives, as well as a further motivating the study. The literature review (Chapter 2) aimed to give background on rugby in South Africa and the Western Province. Chapter 2 also gave insight into concussion and post-concussion RTP knowledge, roles and responsibilities. The literature focussed on role players, such as players, coaches, administrative staff, medical staff and referees. The chapter emphasized that a holistic approach regarding concussion management is required in community sport to ensure

the safety of players. The literature showed the need for concussion knowledge and post-concussion RTP implementation at club level.

Chapter 3 included the methodology of the current study in which the research design, participants and data collection procedures were described.

Chapter 4 was written as a research article titled: *'Concussion knowledge, risk- and precaution-taking attitude among amateur club rugby role players'*. The results indicated that overall, the participants scored 73% for concussion knowledge, with the players scoring 66%, referees 78% and medical staff 79%. Regarding the risk- and precaution taking attitudes towards concussion, players (36%) demonstrated the highest risk-taking score in contrast to referees (90%), who demonstrated the greatest precaution taking score. Medical staff (76%), however, demonstrated the lowest precaution taking score of all role players. The findings demonstrated the superior concussion knowledge and the safe attitudes of referees and highlighted their importance regarding player's safety.

Chapter 5 is a research article titled: *'Post-concussion and return-to-play; roles, responsibilities and implementation among amateur club rugby role players'.* The results indicated that 74% of the players perceived that coaches should have knowledge of RTP guidelines and 71% indicated that coaches were responsible for monitoring training sessions and matches for injuries. 80% of the coaches themselves indicated that they were responsible for monitoring matches and training sessions, and 88% stated that they should have knowledge of RTP guidelines. The correct order to the 6-stage RTP protocol was successfully identified by only 40% of the medical staff and 37% of coaches, which warrants concern as this protocol was selected to be implemented in the event of a concussion.

To summarize, within the WPRU club rugby, referees demonstrated superior knowledge and low risk-taking attitudes with towards concussion. Regarding the roles and responsibilities, coaches were deemed as primary role players responsible for post-concussion RTP; however, they presented a low willingness and a lack in implementing the protocol.

## 6.2. Conclusion

The conclusions drawn from this research is presented according to the objectives of Chapter 1.

Research Article 1: *'Knowledge of and attitude towards concussion amateur club rugby role players'.*

The study found that referees and medical staff exhibited greater concussion knowledge in contrast to players and administrative staff. The risk-taking attitude presented highest in players and precaution-taking attitude the highest in referees. Current concussion education through BokSmart is compulsory for coaches and referees; however, the translation of this knowledge is ineffective to players because they reported the lowest knowledge scores and highest risk-taking attitudes.

Research Article 2: '*Post-concussion RTP roles, responsibilities and implementation in amatuer club rugby role players'*.

The results of the current study indicated that although coaches were selected as responsible for RTP, and monitoring training sessions and matches, they did not believe in their ability to assist others on when it would be safe to RTP post-concussion. More than half of all the role players (including coaches), failed to correctly rank the 6-stage RTP protocol although it was selected as the best practice by the majority of participants. Coaches, although being selected as responsible for post-concussion RTP implementation, were found lacking in this respect.

## 6.3. Limitations

- The sample size of the specific role players was not sufficient, which could make it problematic to generalize the findings. Furthermore, the qualification of the medical staff were not recorded.
- The RoCKAS-ST was too long, and participants were rushed to complete it because of training time restrictions.
- The questionnaires were only available in English.

- The Western Cape draught throughout the 2018 season saw numerous clubs implement different training strategies, which made data collection at training sessions problematic.
- The snowball sampling method which was used could be limiting as the first individual could neglect to nominate a second wave of participants thus creating a smaller sample size.

### 6.4. Future research

The results of the current study highlighted interesting focus areas, such as the misconceptions regarding concussion and high risk-taking in the role players affiliated to WPRU club rugby. Future studies should assess the knowledge translation of coaches and referees to players because they are obligated to attend the BokSmart educational workshop.

The coaches were identified as the main role players as perceived by themselves and the other role players to have the responsibility for RTP, therefore, future research should focus on how coaches intend to implement the guidelines within the WPRU club rugby structures.

### 6.5. Practical application

The practical application of the research would be to have workshops, which specifically address concussion and post-concussion RTP for all role players. The workshops should ensure that systems are in place in the event of a concussion, as well as the best-practice protocol when a player returns to play. Pre-season information sessions can also be hosted at various clubs to highlight the importance of reporting concussion symptoms by players and removing a player suspected of having concussion from matches or training. Furthermore, a certification can be created for role players who attend a workshop on concussion, as well as having regular online evaluations, which can be completed to stay up to date. The medical staff can also be held to a higher standard by having a criteria certification (eg. Level 3 first aid), in order to diagnose concussion.

# APPENDIX A:

# INFORMED CONSENT

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

**Stellenbosch University**

**Consent to participate in research**

---

## Concussion and Return-to-Play: Knowledge, Roles and Responsibilities in Western Province Club Rugby

You are hereby requested to participate in a research study conducted by Johannes van Vuuren (MSc Sport Science student), Dr Wilbur Kraak and Dr Karen Welman from the Sport Science department at Stellenbosch University. All the information the participant provides will be subjected towards a research project. You were selected as a possible participant in this study, because the focus of the study is concussion and return-to-play among rugby players, coaches, medical staff, administrative staff and referees (concussion knowledge only) within Western Province Club Rugby.

### 1. Aim of the study

The aim of the study is to investigate concussion and return-to-play knowledge, roles and responsibilities among different role players in Western Province Club Rugby.

### 2. Procedures

If you accept the request to participate in the study, we would ask of you to kindly complete the following:

- It is required from you to complete two questionnaires (modified RoCKAS-ST questionnaire & Return-to-Play implementation questionnaire) that investigates the knowledge and attitude of concussions and return-to-play procedures and responsibilities following a concussion in your organization.

- The questionnaires must be completed individually, and to the best of your abilities. It is required from you as the individual completing these questionnaires not to acquire any information from other resources, but only by means of your own knowledge. If there are any queries regarding the questionnaires, then only are you permitted to ask for assistance, but no correct answer will be provided for the questions.
- To complete the questionnaires will take approximately 30-35 min. After completing of the questionnaires, it is to be submitted manually or electronically to the researcher's database.
- The information from the questionnaires will not be shared towards anyone other than the researchers and supervisors. Prior to filling the questionnaires, the researchers will provide a broad overview of the study and what is expected from you as the individual and the procedure of the questionnaires.

**3. Potential risks and discomforts**

There are no potential risks and discomforts identified in the study towards the participant. However, if the participant does feel sensitive towards the questions provided in the questionnaires, then the participant has the right to discontinue the study.

**4. Potential benefits to subjects and/or society**

The benefit of the study is that it can potentially bring awareness into society, especially towards the rugby community within Western Province in terms of their knowledge and understanding what a concussion constitutes and the correct procedure to follow for a concussed rugby player. Furthermore the implementation of Return-to-Play procedures is of critical importance to ensure the safety of the athletes in any contact sport. The study could potentially shed light on any implementation issues regarding our South African Rugby safety initiative (BokSmart).

**5. Payment for participation**

There is will be no monetary compensation for participants taking part in the study.

**6. Confidentiality**

Any information that is obtained in connection to this study and that can be associated with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of filling in a questionnaire anonymously by the participant. All the completed questionnaires will be collected and kept safely by the study conductors. The information provided by the completed questionnaires will only be accessed by the study conductors for the aim of the study. The publishing of information will be in the form of a generalized population of amateur Western Province Club Rugby players, coaches, administrative staff, medical staff and referees and not as an individual.

**7. Participation and withdrawal**

The individual has the choice whether to participate in this study or to decline any further involvement at any stage. If you choose to participate be in this study, you may withdraw at any time without any form of consequences. You may also refuse to answer any questions that you feel might invade your privacy or rights and still remain part of the study. The investigators do have the right to remove you from this research if circumstances arise which warrant doing so. The participant's involvement in the study may be discontinued if the investigators suspects that the questionnaire is not filled in individually or truthfully.

**8. Identification of investigators**

If you have any questions or concerns about the research, please feel free to contact:

| **Supervisor** | **MSc Student** |
|---|---|
| Wilbur Kraak | Johannes van Vuuren |
| kjw@sun.ac.za | rugbyresearch@sun.ac.za |
| **Co-Supervisor** | |
| Karen Welman | |
| welman@sun.ac.za | |

**9. Rights of research subjects**

You may withdraw your consent at any time and discontinue participation without penalty or consequences. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding

your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

**Signature of research subject or legal representative**

The information above was described to me by the investigators in English and I _____ was in command of the language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study and I have been given a copy of this form.

_____
**Name of Subject/Participant**

_____ _____
**Signature of Subject/Participant or Legal Representative** **Date**

**Signature of investigator**

I declare that I explained the information given in this document to _____ [*participant]* and/or [his/her] representative _____ [*name of the representative]. [H*e/she] was encouraged and given ample time to ask me any questions. This conversation was conducted in [*Afrikaans/*English/*Xhosa/*Other*] and [*no translator was used/this conversation was translated into* _____ by _____].

_____ _____
**Signature of Investigator** **Date**

# APPENDDIX B:
# ROCKAS-ST QUESTIONNAIRE

## Section 1

## Please read the following statements and circle TRUE or FALSE for each question

| | | | |
|---|---|---|---|
| 1 | There is a possible risk of death if a second concussion occurs before the first one has healed | TRUE | FALSE |
| 2 | Running everyday does little to improve cardiovascular health | TRUE | FALSE |
| 3 | People who had one concussion are more likely to have another concussion | TRUE | FALSE |
| 4 | Studs help athlete's feet grip the playing surface | TRUE | FALSE |
| 5 | In order to be diagnosed with a concussion, you have to be knocked out | TRUE | FALSE |
| 6 | A concussion can only occur if there is a direct hit to head | TRUE | FALSE |
| 7 | Being knocked unconscious always causes permanent damage to the brain | TRUE | FALSE |
| 8 | Symptoms of a concussion can last several weeks | TRUE | FALSE |
| 9 | Sometimes a second concussion can help a person remember things that were forgotten after the first concussion | TRUE | FALSE |
| 10 | Weightlifting helps to tone and/or build muscle | TRUE | FALSE |
| 11 | After a concussion occurs, brain imaging (CAT scan, MRI, X-rays etc.) typically shows visible physical damage (bruise, blood clot) to the brain | TRUE | FALSE |
| 12 | If you receive one concussion and you have never had a concussion before, you will become less intelligent | TRUE | FALSE |
| 13 | After 10 days, symptoms of a concussion are usually completely gone | TRUE | FALSE |
| 14 | After a concussion, people can forget who they are and not recognize others but be perfect in every other way | TRUE | FALSE |
| 15 | Grade eight high school students and first year university students tend to be the same age | TRUE | FALSE |
| 16 | Concussions can sometimes lead to emotional disruptions | TRUE | FALSE |
| 17 | An athlete who gets knocked out after getting a concussion is experiencing a coma | TRUE | FALSE |

| | | | |
|---|---|---|---|
| 18 | There are rarely a risk to long-term health and well-being from multiple concussions | TRUE | FALSE |

**Section 2**
**Please read the following statements and circle TRUE or FLASE for each question**

**Scenario 1**

While playing in a game player Q and player X collide with each other and each suffer a concussion. Player Q has never had a concussion in the past. Player X has had 4 concussions in the past

| | | | |
|---|---|---|---|
| 1 | Is it likely that player Q's concussion will affect his long term health and well being | TRUE | FALSE |
| 2 | It is likely that player X's concussion will affect his long term health and well being | TRUE | FALSE |

**Scenario 2**

Player F suffered a concussion in a game. He continued to play in the game despite the fact that he continued to feel the effects of the concussion.

| | | | |
|---|---|---|---|
| 3 | Even though player F is still experiencing the effects of the concussion, his performance will be the same as when he had not suffered a concussion | TRUE | FALSE |

**Section 3**

**For each question, circle the number that best describes how you feel about each statement**

| | | Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|---|
| 1 | I would continue playing a sport while having a headache that results from a concussion | 1 | 2 | 3 | 4 | 5 |
| 2 | I feel that coaches need to be extremely cautious when determining whether an athlete should Return-to-Play | 1 | 2 | 3 | 4 | 5 |
| 3 | I feel that mouth guards protect teeth from being damaged or knocked out | 1 | 2 | 3 | 4 | 5 |
| 4 | I feel that professional athletes are more skilled at their sport than high school athletes | 1 | 2 | 3 | 4 | 5 |
| 5 | I feel that concussions are less important than other injuries | 1 | 2 | 3 | 4 | 5 |
| 6 | I feel that athletes has a responsibility to return to a game even if it means playing while still experiencing symptoms of a concussion | 1 | 2 | 3 | 4 | 5 |
| 7 | I feel that an athlete who is knocked unconscious should be taken to emergency room | 1 | 2 | 3 | 4 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | I feel that most high school athletes will play professional sports in the future | 1 | 2 | 3 | 4 | 5 |

**Section 4**

**For each question, read the scenarios and circle the number that best describes your view (for the questions that ask you what most athletes feel, best your answer on how you think MOST athletes would feel)**

**Scenario 1**

Player R suffers a concussion during a game. Coach A decides to keep player R out of the game. Players R's team loses the game

| | | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|---|
| 1 | I feel that coach A made the right decision to keep player R out of the game | 1 | 2 | 3 | 4 | 5 |
| 2 | Most athletes would feel that coach A made the right decision to keep player R out of the game | 1 | 2 | 3 | 4 | 5 |

**Scenario 2**

Athlete M suffered a concussion during the first game of the season. Athlete O suffered a concussion of the same severity during the semi-final playoff game. Both athletes had persisting symptoms.

| | | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|---|
| 3 | I feel that athlete M should have returned to playing during the first game of the season (the same game of the injury). | 1 | 2 | 3 | 4 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Most athletes would feel that athlete M should have returned play during first game of season (the same game of injury) | 1 | 2 | 3 | 4 | 5 |
| 5 | I feel that athlete O should have returned to play during the semi-final playoff game | 1 | 2 | 3 | 4 | 5 |
| 6 | Most athletes feel that Athlete O should have returned to play during the semi-final playoff game | 1 | 2 | 3 | 4 | 5 |

**Scenario 3**

Athlete R suffered a concussion. Athlete R's team has a physiotherapist on staff

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | I feel that the physiotherapist rather than athlete R should make the decision about athlete R returning to play | 1 | 2 | 3 | 4 | 5 |
| 8 | Most athletes would feel that the physiotherapist rather than athlete R should make the decision about returning athlete R to play | 1 | 2 | 3 | 4 | 5 |

**Scenario 4**

Athlete H suffered a concussion and has a game in two hours. He is still experiencing symptoms of a concussion. However, athlete H knows that if he tells his coach about the symptoms, his coach will keep him out of the game

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | I feel that athlete H should tell coach about the symptoms | 1 | 2 | 3 | 4 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | Most athletes would feel that athlete H should tell coach about the symptoms | 1 | 2 | 3 | 4 | 5 |

**Section 5**

Think about someone who has had a concussion. Check off the following signs and symptoms that you believe someone may be likely to experience AFTER a concussion (mark with x)

| | | | |
|---|---|---|---|
| Hives | | Feeling in a “Fog” | |
| Headache | | Weight Gain | |
| Difficulty speaking | | Feeling slowed down | |
| Arthritis | | Reduced breathing rate | |
| Sensitivity to light | | Excessive Studying | |
| Difficulty remembering | | Difficulty concentrating | |
| Panic attacks | | Dizziness | |
| Drowsiness | | Hair loss | |

## APPENDIX C:

## POST-CONCUSSION RTP IMPLEMENTATION QUESTIONNAIRE

**Please answer the following questions by marking the applicable answer(s) (mark using x). Questions marked with ** should be answered by internal role players only**

1. Do you believe that you have the ability to assist a concussed player on when it is safe to Return-to-Play?

| | |
|---|---|
| Strongly disagree | |
| Disagree | |
| Neutral | |
| Agree | |
| Strongly agree | |

2. Do you know whether the organization (club) you belong to, perform any preseason screening such as computerized brain function testing or measuring of baseline symptoms for concussion**?

| | | | | | |
|---|---|---|---|---|---|
| Not Sure | | Yes | | No | |

3. Do you have knowledge of any concussion tools which can be used in the assessment of an injured player?

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | Yes | | No | |

4. Are any of the following immediate (sideline) concussion assessments/ test currently being implemented within your club? (you may mark more than one)

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | None | | SCAT 3/5 | |
| Balance assessment | | Physical Sign | | Computerised brain function test (Cogstate-sport, ImPACT) | |

5. Following a concussion is there a mandatory period of time a player should rest?

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | Yes | | No | |

5.1. If you answered yes to the above question, what is it?

| | | | | | |
|---|---|---|---|---|---|
| 24-48 hours | | 3 - 5 days | | 5-7 days | |
| 8 -10 days | | 30 days | | More than 30 days | |

6. Does the organization you belong to have records of player medical history/ injury history?

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | Yes | | No | |

6.1. If you answered yes, do you know whether the organisation uses the medical history information in the event of a suspected concussion?

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | Yes | | No | |

7. Are any of the following concussion Return-to-Play guidelines implemented at your club/team?

| | | | | | |
|---|---|---|---|---|---|
| None | | Not sure | | 6 Stage (Boksmart /World Rugby) | |
| Buffalo Treadmill test | | | | | |

8. Which grading system of concussion is currently implemented at your club/team?

| | | | | | |
|---|---|---|---|---|---|
| None | | Not sure | | Cantu | |
| Colorado | | Case-by-case (Individualized | | American Academy of Neurology (AAN) | |
| Glasgow Coma scale | | | | | |

9. Within your organisation, what category does the medical team fall into?

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | Designated (clubs' medic) | | Assigned(eg. ER24) | |

10. In your opinion, should a concussed player be assessed by either a medical doctor or registered healthcare professional (Biokineticist/ Physiotherapist / First aid) before returning to full contact?

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | Yes | | No | |

11. Within your organization, are players assessed by either a medical doctor or registered healthcare professional (Biokineticist/ Physiotherapist/ First aid) before returning to full contact?**

| | | | | | |
|---|---|---|---|---|---|
| Not sure | | Yes | | No | |

12. Who within your organization, do you believe should have knowledge of Return-to-Play guidelines?** (can mark more than one)

| | |
|---|---|
| Player | |
| Coach | |
| Specialist-coach | |
| Medic | |
| Physiotherapist | |
| Biokineticist | |
| Doctor | |
| Administrative staff | |
| Referee | |
| Other (Please specify) | |

13. Player A is diagnosed with a concussion, please rank (from 1 to 6) the following activities in the order that you believe they should be performed before returning to play?

| | |
|---|---|
| Sport specific exercise | |
| Light aerobic exercise | |
| No activity | |
| Non contact training drills | |
| Game play | |
| Full contact practice | |

14. Have you participated in the BokSmart educational training program within the last 5 years? **

| | | | |
|---|---|---|---|
| Yes | | No | |

15. Have you attended any other educational seminars or training programs? (can mark more than one)

| | |
|---|---|
| First Aid | |
| BokSmart Medics | |
| Cardiopulmonary-resuscitation (CPR) | |
| Paramedics | |
| Basic Life support | |
| Other (Please specify) | |

16. Which role player in your organization, ensures that the concussed player is ready to Return-to-Play?** (can mark more than one)

| | |
|---|---|
| Player | |
| Coach | |
| Specialist-coach | |
| Medic | |
| Physiotherapist | |
| Biokineticist | |
| Doctor | |
| Administrative staff | |
| Referee | |
| Other (Please specify) | |

17. Who within your organization is responsible for monitoring matches and practices for injuries and possible concussions?** (can mark more than one)

| | |
|---|---|
| Player | |
| Coach | |
| Specialist-coach | |
| Medic | |
| Physiotherapist | |
| Biokineticist | |
| Doctor | |
| Administrative staff | |
| Referee | |
| Other (Please specify) | |

**Thank you for your participation!**

# APPENDIX D:

# INSTRUCTION FOR AUTHORS: INTERNATIONAL JOURNAL OF SPORT MEDICINE

## Scope of the Journal

The International Journal of Sports Medicine (IJSM) provides a forum for the publication of papers dealing with basic or applied information that will advance the field of sports medicine and exercise science and offer a better understanding of biomedicine. The following sections define the scope of the journal: Training & Testing; Orthopedics & Biomechanics; Clinical Sciences; Nutrition; Behavioural Sciences; Physiology & Biochemistry; Genetics & Molecular Biology.

## General Policy

The journal publishes original papers, reviews, and letters to the editor. Manuscripts submitted to the journal must contain novel data on theoretical or experimental research or on practical applications in the field of sports medicine and exercise science. Purely descriptive studies that lack generalizability to the wider world of sports medicine will be assigned a low priority and may not be entered by a corresponding editor into the peer-review process. Intervention studies which lack a comparator group and/or are very inconsistent with the CONSORT guidelines may also be assigned a low priority and not entered for peer review. Studies that employ data analysis approaches that are obviously inappropriate will also be assigned a low priority and not entered for peer-review, as will studies in which the clinical/practical significance of the findings has not been quantified and/or communicated. The paper must also be written in grammatically correct English, otherwise it may be refused for review. No substantial part of the submission should have been published elsewhere. If a part of the submission has been published or presented at a congress, symposium, national meeting proceeding or master's or doctoral theses, the reference for that publication and/or presentation should be given in the manuscript acknowledgement section. Submitted papers undergo peer reviewing by two independent reviewers. Authors may suggest names and full addresses including telephone and FAX numbers of two reviewers but not from their own institution.

Authors are required to conduct their research ethically according to international standards and as required by the journal as described in Harriss DJ, Macsween A, Atkinson, G. Standards for Ethics in Sport and Exercise Science Research: 2018 Update. Int J Sports Med 2017; 38: 1126-1131 (https://www.thieme-connect.com/products/ejournals/ pdf/10.1055/s-0043-124001.pdf). Authors are expected to clearly state in the Methods section – by citing the aforementioned publication – that the study meets the ethical standards of the journal.

**Categories of articles accepted for review**

Original articles: Theoretical or experimental (basic or applied) research or practical applications. Either original work or the replication of work that better establishes basic principles will be considered. Original articles should not exceed a total of 15000 characters, excluding references. Review articles: Review articles on topics of broad interest are desirable. Authors who wish to submit an unsolicited review article should correspond with the editors-in-chief to determine the timeliness of the proposed review article. The correspondence should include an abstract and a complete outline of the proposed review article, including figures and tables (if possible). Review articles should not exceed 30000 characters, excluding references. Review articles are considered by the editors and expert reviewers before a final decision regarding publication is made.

Letters to the editor are welcome and will be published if appropriate. Letters (maximum length 700 words) relating to material previously published in IJSM should be submitted within 6 months after publication of the material the letter is referring to. Such letters will be sent to the corresponding author for comment within six weeks. The original letter and any reply will be published concurrently. Letters to the editor are excluded from online submission and should be sent to the editorial office at ijsm.editorialoffice@thieme.de

**Submission of manuscripts**

Manuscripts can be submitted exclusively via online submission at http://mc.manuscriptcentral.com/IJSM or via link at www.thieme. de/sportsmed. Hard copy submission and electronic submission via email are not accepted. See below

under “Uploading files on submission” for further information on the online submission process.

**Style:** Manuscripts may be rejected without review on the basis of poor English or lack of conformity to stated standards of style.

**Title**: The title should be concise but informative.

**First page**: Names and addresses of the authors should not appear on the first page or elsewhere in the main document. These data are entered separately in the online submission system.

**Abstract:** The abstract should be informative. It should be self-explanatory without reference to the text of the manuscript. It should include essential significant results that support the conclusion of the work. Three to six key words not used in the title should also be provided (these can be entered during the online submission). Abbreviations should not be used in the abstract.

**Introduction:** Should be comprehensible to the general reader. Give a clear statement of the purpose of the paper and provide relevant context to support the basis for the paper and the significance of the work. Do not exhaustively review the literature.

**Materials & Methods:** Provide sufficient information in the text or by reference to other work to permit the submitted work to be repeated without the need to communicate with the authors. Relevant validity and reliability data should be provided for critical methods. State the type of statistical tests used. Include the number of observations and the statistical findings when appropriate. Parametric and non-parametric statistics must be used as appropriate.

**Results:** Should be presented precisely and should not contain material that is appropriate in the discussion. Units, quantities, and formulas should be expressed according to the Système Internationale (SI units). All measurements should be given in metric units.

**Discussion**: Emphasize the new and important aspects of the study and conclusions from the study. Acknowledgements: Financial support should be stated.

**References**: References should be cited in the text by number and listed in order of their citation in the paper. Authors bear complete responsibility for the accuracy of the references.

**EndnoteStyle:**
https://www.thieme.de/statics/dokumente/thieme/final/de/dokumente/sw_%20autorenlounge/Thieme-German.zip

Only published or “in press” papers or books may be cited in the reference list. Information from manuscripts submitted but not yet accepted should be cited in the text as “unpublished observations” in parentheses. Personal communications should be listed in the text in parentheses. Published abstracts must not be used as references. Use of a large number of abstracts or non peer-reviewed articles in the reference section will be grounds for rejection of the submission without review.

**Examples of references Journal article:** 1 Palmer GS, Dennis SC, Noakes TD et al. Assessment of the reproducibility of performance testing on an air-braked cycle ergometer. Int J Sports Med 1996; 17: 293–298

**Complete book**: 1 Dingle JT (ed). Lysosomes. New York: American Elsevier, 1972: 65

**Chapter of a book:** 1 Zancetti A, Baccelli G, Guazzi M et al. The effect of sleep on experimental hypertension. In: Onesti G, Kim KE, Moyer JH (eds). Hypertension: Mechanisms and Management. New York: Grune & Stratton, 1973: 133–140

**Basic principle of quoting online sources:**
<institution / author(s)><dot><title (where possible, release

date)><dot><“On the internet:”><URL><semicolon><„status:“><date

of online access><doi (if available)>

**Figures:** We cannot accept or store illustrations in which personal data of third parties are included. Please submit images in completely anonymous form, free of personal data only! Such data may not only be directly visible in the image (e.g., a patient name

or a date of birth in an X-ray image); they can also be included in the metadata of the image, which is accessible with the appropriate software. They may also be obscured by a cropping feature (such as Powerpoint or Word), but can be made visible underneath. If you have questions about data protection regulations, please contact us before submitting your manuscript. Figures, illustrations, or half-tones should be used when findings are best visually communicated. The use of photographs or equipment and experimental subjects should be avoided; good line drawings are more informative. Abbreviations used in the figure must be explained in the legend. Reference to the figure should be made in the text. Figures, illustrations or half-tones must be sharp and high-contrast. Uniform typographical setup (font style and size, line thickness) of all figures in a paper is highly desirable. Images should be provided as .tif or .jpg files in a resolution of 300 dpi.

**Tables:** Tables should be used to communicate information that is hard to present visually. Results whose interpretation is more easily comprehended by knowing the means and SEM (or SD) may be presented in a table(s). Tables should be self-explanatory and bear a short title. Table legends should be typed on the same sheet as the table as a header. A footnote to the table should explain all abbreviations used in the table. Tables should be provided either as word or excel files.

**Uploading files on submission**

For submission of all manuscripts, follow the instructions of the online submission system at http://mc.manuscriptcentral.com/IJSM. Before submission, keep ready full metadata of the manuscript (title, full names referenced by Arabic superscripts with affiliation and addresses of all authors, and also, the complete list of references, footnotes, figure legends, and tables). **The author submitting the manuscript will be corresponding author**. Upload as many files as needed for your manuscript. If you have updated a file, please delete the previous version and upload the revised file. If you are submitting a revision, please include only the latest set of files. All files will be combined into a single PDF document for the peer review process. When uploading your manuscript, you are required to select the **File designation**:

**Main document**. The main document should be in Word format. It should not include any figures or tables.

**Figures and tables**. Each one should be uploaded separately. Images should be uploaded as .tif or .jpg files in a resolution of 300 dpi. Tables should be uploaded either as Word or Excel files. When uploading, a form appears requesting the following information:

- File tags: Please enter the figure/table number e. g. Figure 1a, Table 1
- Caption/legend: Please enter the figure/table number plus legend Figure legends should be brief but must contain all the information to make the illustration comprehensible without taking recourse to the text.

Please do not upload PDFs! To designate the order in which your files appear, use the dropdowns in the “order” column.

**Galley proofs and proof-reading** A PDF file of the galley proofs will be sent via e-mail to the corresponding author for proof reading. Proof reading is for typesetting errors only. At this stage the manuscript cannot be changed. The galley proofs should be returned to the appropriate address within 48 hours so the publication of the submission is not delayed.

**Page charge** Together with the galley proofs, if the manuscript is more than three printed pages, the corresponding author will be asked by the publisher to submit a check or purchase order to pay the cost of publication. Up to three printed pages of publication are without charge to the corresponding author. Each printed page beginning with the fourth printed page will carry a page charge of € 160.– (including 19% VAT).

**PDF for personal use:** The corresponding author will receive a PDF of the published article free of charge for personal, non-commercial use only.

## APPENDIX E:

## INSTRUCTION FOR AUTHORS: JOURNAL OF SCIENCE AND MEDICINE IN SPORT

### Preparation of Manuscripts

• Microsoft Word is the preferred software program. Use Arial or Times New Roman font, size eleven (11) point. • Manuscript is double-spaced throughout (including title page, abstract, text, references, tables, and legends). • Margins are 1 inch or 2.5 cm all around • Include page and line numbers for the convenience of the peer reviewers. • Number the pages consecutively, beginning with the title page as page 1 and ending with the Figure legend page. • All headings (including the Title) should be in sentence-case only, not in capital letters. • Sub-headings are generally not accepted. Incorporate into the text if required. • Footnotes are not acceptable. • Keep the use of tables, figures and graphs to a minimum. • See notes on Tables, Figures, Formulae and Scientific Terminology at the end.

**WORD COUNT LIMITS** Original Research papers

• 3000 word count limit (excluding title, abstract, tables/figures, figure legends, Acknowledgements, and References) • Maximum number (combined) of tables and figures is 3 • Long tables should only be included as supplementary material and will be made available on-line only • Maximum number of references is 30 • A structured abstract of less than 250 words (not included in 3000 word count) should be included with the following headings: Objectives, Design, Method, Results, and Conclusions

Review articles

• 4000 word count limit (excluding title, abstract, tables/figures, figure legends, Acknowledgements, and References) • Maximum number (combined) of tables and figures is 3 • Long tables should only be included as supplemental files and will be available online only • Maximum number of references is 60 • A structured abstract of less than 250 words (not included in 4000 word count) should be included sticking as closely as possible to the following headings: Objectives, Design, Method, Results, and Conclusions

**Structure of the Manuscript (in order):**

1. Cover Letter - Every submission, regardless of category must include a letter stating:

• The category of article: Original Research or Review article

-• The sub-discipline: sports medicine, sports injury (including injury epidemiology and injury prevention), physiotherapy, podiatry, physical activity and health, sports science, biomechanics, exercise physiology, motor control and learning, sport and exercise psychology, sports nutrition, public health (as relevant to sport and exercise), rehabilitation and injury management, and others having an interdisciplinary perspective with specific applications to sport and exercise and its interaction with health.

• Sources of outside support for research (including funding, equipment and drugs) must be named.

• Financial support for the project must be acknowledged, or "no external financial support" declared.

• The role of the funding organisation, if any, in the collection of data, their analysis and interpretation, and in the right to approve or disapprove publication of the finished manuscript must be described in the Methods section of the text

• When the proposed publication concerns any commercial product, either directly or indirectly, the author must include a statement (1) indicating that he or she has no financial or other interest in the product or distributor of the product or (2) explaining the nature of any relation between himself or herself and the manufacturer or distributor of the product.

• Other kinds of associations, such as consultancies, stock ownership, or other equity interests or patent-licensing arrangements, also must be disclosed. Note: If, in the Editor's judgment, the information disclosed represents a potential conflict of interest, it may be made available to reviewers and may be published at the Editor's discretion; authors will be informed of the decision before publication.

• The Ethical Guidelines that have been followed must be stated clearly. Provide the Ethics Committee name and approval number obtained for Human investigation.

• Authors must declare that manuscripts submitted to the Journal have not been published elsewhere or are not being considered for publication elsewhere and that

the research reported will not be submitted for publication elsewhere until a final decision has been made as to its acceptability by the Journal.

Permission from the copyright holder (typically the publisher) must be submitted to the Editorial Office for the reproduction of any previously published table(s), illustration(s) or photograph(s). Permission must be valid for reuse in both print and electronic formats. Appropriate consents must also be obtained for any patient images appearing in your manuscript. [OPTIONAL: For Elsevier's patient consent policy, please visit www.elsevier.com/about/company-information/policies/patient-consent.]

**2. Title Page (first page) should contain:**

a. Title. Short and informative

b. Authors. List all authors by first name, all initials and family name

c. Institution and affiliations. List the name and full address of all institutions where the study described was carried out. List departmental affiliations of each author affiliated with that institution after each institutional address. Connect authors to departments using alphabetical superscripts.

d. Corresponding author. Provide the name and e-mail address of the author to whom communications, proofs and requests for reprints should be sent.

e. Word count (excluding abstract and references), the Abstract word count, the number of Tables, the number of Figures.

Appropriate consents must also be obtained for any patient images appearing in your manuscript. [OPTIONAL: For Elsevier's patient consent policy, please visit Patient consent.]

**2. Title Page (first page) should contain:**

a. Title. Short and informative

b. Authors. List all authors by first name, all initials and family name

c. Institution and affiliations. List the name and full address of all institutions where the study described was carried out. List departmental affiliations of each author affiliated with that institution after each institutional address. Connect authors to

departments using alphabetical superscripts.
d. Corresponding author. Provide the name and e-mail address of the author to whom communications, proofs and requests for reprints should be sent.
e. Word count (excluding abstract and references), the Abstract word count, the number of Tables, the number of Figures.

**3. Manuscript (excluding all author details) should contain: (in order)**
a. Abstract - must be structured using the following sub-headings: Objectives, Design, Methods, Results, and Conclusions. Avoid abbreviations and acronyms.
b. Keywords - provide up to 6 keywords, with at least 4 selected via the Index Medicus Medical Subject Headings (MeSH) browser list: Medical Subject Headings.These keywords should not reproduce words used in the paper title. c. Main body of the text.
For Original Research papers, text should be organised as follows:
i. Introduction - describing the (purpose of the study with a brief review of background
ii. Methods - described in detail. Include details of the Ethics Committee approval obtained for Human investigation, and the ethical guidelines followed by the investigators. This section is not called Materials and Methods, and should not include subheadings. Do not use the term "subjects" - use terms such as "participants", "patients" or "athletes", etc.
iii. Results - concisely reported in tables and figures, with brief text descriptions. Do not include subheadings. Use small, non-italicized letter p for p-values with a leading zero, e.g. 0.05; Measurements and weights should be given in standard metric units. Do not replicate material that is in the tables or figures in the text.
iv. Discussion - concise interpretation of results. Cite references, illustrations and tables in numeric order by order of mention in the text. Do not include subheadings.
v. Conclusion
vi. Practical Implications - 3 to 5 dot (bulleted) points summarising the practical findings derived from the study to the real-world setting of sport and exercise - that can be understood by a lay audience. Avoid overly scientific terms and abbreviations. Dot points should not include recommendations for further research.
vii. Acknowledgments - this section is compulsory. Grants, financial support and

technical or other assistance are acknowledged at the end of the text before the references. All financial support for the project must be acknowledged. If there has been no financial assistance with the project, this must be clearly stated.
viii. References - authors are responsible for the accuracy of references.
ix. Tables - may be submitted at the end of the text file, on separate pages, one to each page.
x. Figure Legends - must be submitted as part of the text file and not as illustrations.
4. Figures - must be submitted as one or more separate files that may contain one or more images.
5. Supplementary material (if any) - tables or figures to be viewed online only.

***Peer Review***

The journal receives an ever-increasing number of submissions and unfortunately can only publish a small proportion of manuscripts. The journal's Editorial Board does not enter into negotiations once a decision on a manuscript has been made. The Editor's decision is final. The entire peer-review process will be managed electronically to ensure timely review and publication. Authors can expect an initial decision on their submission within 6 weeks.

***Use of word processing software***

It is important that the file be saved in the native format of the word processor used. The text should be in single-column format. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the word processor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier). Note that source files of figures, tables and text graphics will be required whether or not you embed your figures in the text. See also the section on Electronic artwork.
To avoid unnecessary errors you are strongly advised to use the 'spell-check' and

'grammar-check' functions of your word processor.

## Article structure

### *Introduction*

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

### *Material and methods*

Provide sufficient details to allow the work to be reproduced by an independent researcher. Methods that are already published should be summarized and indicated by a reference. If quoting directly from a previously published method, use quotation marks and also cite the source. Any modifications to existing methods should also be described.

### *Results*

Results should be clear and concise.

### *Discussion*

This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

### *Conclusions*

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

### *Appendices*

If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly, for tables and figures: Table A.1; Fig. A.1, etc.

## Essential title page information

• ***Title.*** Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• ***Author names and affiliations.*** Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. You can add your name between parentheses in your own script behind the English transliteration. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
• ***Corresponding author.*** Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. This responsibility includes answering any future queries about Methodology and Materials. **Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.**
• ***Present/permanent address.*** If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

## Abstract

A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

## Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using British spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

***Abbreviations***

Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

***Acknowledgements***

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

***Formatting of funding sources***

List funding sources in this standard way to facilitate compliance to funder's requirements:

**Funding:** This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, please include the following sentence:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

***Nomenclature and units***

Follow internationally accepted rules and conventions: use the international system of units (SI). If other quantities are mentioned, give their equivalent in SI. You are urged to consult IUPAP: Symbols, Units, Nomenclature and Fundamental Constants in Physics for further information.

***Math formulae***

Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

***Footnotes***

Footnotes should be used sparingly. Number them consecutively throughout the article. Many word processors can build footnotes into the text, and this feature may be used. Otherwise, please indicate the position of footnotes in the text and list the footnotes themselves separately at the end of the article. Do not include footnotes in the Reference list.

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***Electronic artwork***

***General points***

• Make sure you use uniform lettering and sizing of your original artwork.
• Embed the used fonts if the application provides that option.
• Aim to use the following fonts in your illustrations: Arial, Courier, Times New

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• Number the illustrations according to their sequence in the text.

• Use a logical naming convention for your artwork files.

• Provide captions to illustrations separately.

• Size the illustrations close to the desired dimensions of the published version.

• Submit each illustration as a separate file.

A detailed guide on electronic artwork is available.

**You are urged to visit this site; some excerpts from the detailed information are given here.**

*Formats*

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Regardless of the application used other than Microsoft Office, when your electronic artwork is finalized, please 'Save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):

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TIFF (or JPEG): Color or grayscale photographs (halftones), keep to a minimum of 300 dpi.

TIFF (or JPEG): Bitmapped (pure black & white pixels) line drawings, keep to a minimum of 1000 dpi.

TIFF (or JPEG): Combinations bitmapped line/half-tone (color or grayscale), keep to a minimum of 500 dpi.

**Please do not:**

• Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); these typically have a low number of pixels and limited set of colors;

• Supply files that are too low in resolution;

• Submit graphics that are disproportionately large for the content.

***Color artwork***

Please make sure that artwork files are in an acceptable format (TIFF (or JPEG), EPS (or PDF), or MS Office files) and with the correct resolution. If, together with your accepted article, you submit usable color figures then Elsevier will ensure, at no

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If the work involves the use of human subjects, the author should ensure that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals. Authors should include a statement in the manuscript that informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed

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***Figure captions***

Ensure that each illustration has a caption. Supply captions separately, not attached to the figure. A caption should comprise a brief title (**not** on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

**Tables**

Please submit tables as editable text and not as images. Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. Number

tables consecutively in accordance with their appearance in the text and place any table notes below the table body. Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. Please avoid using vertical rules and shading in table cells.

## References

### *Citation in text*

Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

### *Reference links*

Increased discoverability of research and high quality peer review are ensured by online links to the sources cited. In order to allow us to create links to abstracting and indexing services, such as Scopus, CrossRef and PubMed, please ensure that data provided in the references are correct. Please note that incorrect surnames, journal/book titles, publication year and pagination may prevent link creation. When copying references, please be careful as they may already contain errors. Use of the DOI is highly encouraged.

A DOI is guaranteed never to change, so you can use it as a permanent link to any electronic article. An example of a citation using DOI for an article not yet in an issue is: VanDecar J.C., Russo R.M., James D.E., Ambeh W.B., Franke M. (2003). Aseismic continuation of the Lesser Antilles slab beneath northeastern Venezuela. Journal of Geophysical Research, https://doi.org/10.1029/2001JB000884. Please note the format of such citations should be in the same style as all other references in the paper.

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As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

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Please ensure that the words 'this issue' are added to any references in the list (and any citations in the text) to other articles in the same Special Issue.

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• References should be numbered consecutively in un-bracketed superscripts where they occur in the text, tables, etc, and listed numerically (e.g. "1", "2") at the end of the paper under the heading "References".

• For Original Research papers, no more than three references should be used to support a specific point in the text.

• All authors should be listed where there are three or fewer. Where there are more than three, the reference should be to the first three authors followed by the expression "et al".

• Book and journal titles should be in italics.

• Conference and other abstracts should not be used as references. Material referred to by the phrase "personal communication" or "submitted for publication" are not considered full references and should only be placed in parentheses at the appropriate place in the text (e.g., (Hessel 1997 personal communication). References to articles submitted but not yet accepted are not encouraged but, if necessary, should only be referred to in the text as "unpublished data".

• Footnotes are unacceptable.

• Book references:Last name and initials of author, chapter title, chapter number, italicised title of book, edition (if applicable), editor, translator (if applicable), place of publication, publisher, year of publication.Example:Wilk KE, Reinold MM, Andrews JR. Interval sport programs for the shoulder, Chapter 58, in The Athlete's Shoulder, 2nd ed., Philadelphia, Churchill Livingstone, 2009

• Journal references:
Last name and initials of principal author followed by last name(s) and initials of co-author(s), title of article (with first word only starting in capitals), abbreviated and italicised title of journal, year, volume (with issue number in parenthesis if applicable), inclusive pages.
For guidance on abbreviations of journal titles, see Index Medicus at www.nlm.nih.gov/tsd/serials/lji.html.
Example:
Hanna CM, Fulcher ML, Elley CR et al. Normative values of hip strength in adult male association football players assessed by handheld dynamometry. J Sci Med Sport 2010; 13(3):299-303.

• Internet references should be as follows:
Health Care Financing Administration. 1996 statistics at a glance. Available at: http://www.hcfa.gov/stats/stathili.htm. Accessed 2 December 1996.

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***Journal abbreviations source***
Journal names should be abbreviated according to the List of Title Word Abbreviations.

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**Supplementary material**

Supplementary material such as applications, images and sound clips, can be published with your article to enhance it. Submitted supplementary items are published exactly as they are received (Excel or PowerPoint files will appear as such online). Please submit your material together with the article and supply a concise, descriptive caption for each supplementary file. If you wish to make changes to supplementary material during any stage of the process, please make sure to provide an updated file. Do not annotate any corrections on a previous version. Please switch off the 'Track Changes' option in Microsoft Office files as these will appear in the published version.

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This journal encourages and enables you to share data that supports your research publication where appropriate, and enables you to interlink the data with your published articles. Research data refers to the results of observations or experimentation that validate research findings. To facilitate reproducibility and data reuse, this journal also encourages you to share your software, code, models, algorithms, protocols, methods and other useful materials related to the project.

Below are a number of ways in which you can associate data with your article or make a statement about the availability of your data when submitting your manuscript. If you are sharing data in one of these ways, you are encouraged to cite the data in your manuscript and reference list. Please refer to the "References" section for more information about data citation. For more information on depositing,

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***Data linking***

If you have made your research data available in a data repository, you can link your article directly to the dataset. Elsevier collaborates with a number of repositories to link articles on ScienceDirect with relevant repositories, giving readers access to underlying data that gives them a better understanding of the research described.

There are different ways to link your datasets to your article. When available, you can directly link your dataset to your article by providing the relevant information in the submission system. For more information, visit the database linking page.

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# APPENDIX F:

# LANGUAGE EDITOR LETTER

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot·your knowledge partner

07 November 2019

**TO WHOM IT MAY CONCERN**

I, Prof Karel J. van Deventer, hereby declare that I conducted the language and technical editing of an MSc Master thesis titled, *Concussion and return-to-play: Knowledge, roles and responsibilities in the Western Province club rugby role players*, authored by Mr Johannes van Vuuren.

Yours sincerely

KJ van Deventer

(Emeritus Associate Professor [Retired])

Sportwetenskap
Sport Science
STELLENBOSCH

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