CONCUSSION KNOWLEDGE AND PRACTICE AMONG ROLE PLAYERS IN PRIMARY SCHOOL RUGBY IN THE NORTH WEST PROVINCE

by

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DECLARATION

I, Magrietha Jansen van Rensburg, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work or any part of it has been, is being, or has to be submitted for another degree at this or any other University.

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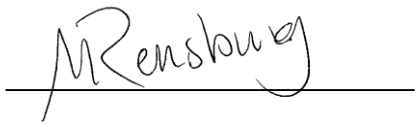

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LIST OF ABBREVIATIONS AND ACRONYMS

AAN	American Academy of Neurology
AEA	Ambulance Emergency Assistants
ACSM	American College of Sports Medicine
ADHD	Attention deficit hyperactivity disorder
ANAM	Automated Neurocognitive Assessment Metrics
BAA	Basic Ambulance Assistants
BESS	Balance Error Scoring System
CCA	Critical Care Assistants
CDC	Centres for Disease Control and Prevention
CME	Continuous Medical Education
CSF	Cerebrospinal fluid
CT	Computer tomography
CTE	Chronic Traumatic Encephalopathy
DAI	Diffuse axonal injury
DCS	Diffuse cerebral swelling
DTI	Diffusion tensor imaging
fMRI	Functional magnetic resonance imaging
H-MRS	Proton magnetic resonance spectroscopy
IRB	International Rugby Board
ImPACT	Immediate Post-concussion Assessment and Cognitive Testing
IPA	Independent Practitioners Association
KOSH	Klerksdorp, Orkney, Stilfontein and Hartbeesfontein
LD	Learning disabilities
LOC	Loss of consciousness
MRI	Magnetic resonance imagery
mTBI	Mild traumatic brain injury
NATA	National Athletic Trainers' Association
NP testing	Neuropsychological testing
PCS	Post-concussion syndromes
PSCA	Pitch Side Concussion Assessment
RTP	Return-to-play
SAC	Standardised Assessment of Concussion
SARU	South African Rugby Union
SCAT2	Sports Concussion Assessment Tool 2

SCOAT	Sports Concussion Office Assessment Tool
SIS	Second impact syndrome
TBI	Traumatic brain injury
USA	United States of America

ABSTRACT

Background: Concussion is a common medical problem which can have devastating complications, particularly in young adults and children. Due to the nature of rugby, concussions are frequently sustained by the players engaging in this contact sport. Since children are more susceptible to sustain a concussion, medical personnel such as doctors or paramedics should theoretically be the role players responsible for medical decision making next to the school rugby field. Coaches, who are often teachers, are often the primary source of medical support next to school sports field. Since failure to recognise or mismanagement of a concussion may lead to serious medical complications and delayed recovery, all role players involved with a potentially concussed child should be knowledgeable on the factors influencing medical decision making. These factors include knowledge on the prevention, recognition and management of a concussion, knowledge on the consequences of a sustained concussion and when to clear a child to Return to Play (RTP).

Aims: This study aimed to report on the general and essential knowledge to be able to recognise a concussion of role players potentially involved with a concussed primary school rugby player and knowledge of role players regarding the prevention and consequences of concussion. In addition, knowledge and practices of role players regarding the management of a suspected or confirmed concussion, as well as knowledge and practices of role players regarding Return to Play (RTP) decision making following a concussion were assessed.

Methods: A self-administered questionnaire was developed according to guidelines from literature to assess the child-specific concussion knowledge and practices of role players. These questionnaires were completed by primary school rugby coaches (n=51), paramedics (n = 39) and doctors (n = 20) in the Klerksdorp, Orkney, Stilfontein and Hartbeesfontein (KOSH) area in the North West Province. The outcome measures consisted of scores (out of a potential 100% if all the correct answers were given) on the prevention, management, recognition, RTP and consequences of a concussion. In addition, the knowledge regarded by literature as being essential to the safe practice of doctors were also assessed among all role players.

Results: It was found that coaches and paramedics were generally the most senior persons responsible for medical decision making next to the rugby field. A substantial proportion of coaches (60.8%) were not *BokSmart* certified at the time of data collection and therefore not adhering to this requirement set out by SA Rugby. There was no relationship between the time since the coaches received their last concussion-related information and their concussion knowledge. There was also no relationship between the coaches' concussion knowledge and whether they attended a recognised concussion training programme such as *BokSmart*. The only variable to show a relationship ($p = 0.001$) with the coaches' overall essential knowledge needed for safe practice was the amount of years they have been coaching rugby. The coaches, who were also teachers, displayed a general lack in knowledge on the effect of a concussion on a child's school work and the need for cognitive rest following a concussion. The paramedics displayed a widespread weakness in their knowledge pertaining to the cognitive aspects associated with a concussion. There was general consensus that the decision to clear a child to Return to Play (RTP) should rest with a doctor. However, the results from this study indicates that a considerable proportion of doctors (30.0%) were unaware of the fact that a child should be free from concussion symptoms not only during physical activity, but also at rest, which may result in premature RTP. The role players displayed a less than adequate knowledge on sport-related concussion with the coaches scoring 71.44 ± 12.03%, the paramedics scoring 67.01 ± 12.29% and the doctors scoring 76.67 ± 6.56% on the overall essential knowledge needed for safe practice

Conclusions: Despite the fact that the doctors scored significantly better compared to the coaches and paramedics on their overall essential knowledge score (all of the essential knowledge items combined), very few doctors did not present with considerable gaps in their essential knowledge needed for safe practice when dealing with a concussed child. By implication the findings from this study indicates that children suffering from a concussion may be at risk for receiving inappropriate or insufficient medical care when sustaining a concussion. These findings should be communicated to sport governing bodies such as SA Rugby and further research undertaken to address the lack in knowledge among role players potentially dealing with concussed athletes as a matter of urgency.

CONCUSSION KNOWLEDGE AND PRACTICE AMONG ROLE PLAYERS IN PRIMARY SCHOOL RUGBY IN THE NORTH WEST PROVINCE

CHAPTER 1
INTRODUCTION

1.1 SCOPE OF RESEARCH

Participation in sporting activities and events is often a regular ritual for many children, adolescents and young adults. Collision sports, for example rugby, are by their very nature likely to cause injuries including head injuries such as concussion. Browne & Lam (2006) found that organised sports activity may cause concussion as much as 6 times more often than other activities in children between the ages 6 and 16 years (Browne & Lam, 2006).

To better understand the repercussions of concussion in sport, four international sport consensus conferences on concussion were convened over the past decade. During this time the definition of concussion has evolved with improved understanding of the brain. Concussion is more a functional rather than a structural injury (Herring et al., 2011; Herring et al., 2006; McCrory et al., 2009; McGuire, 2011; Scorza et al., 2012) and frequently affects multiple global functions resulting in various physical signs and symptoms, as well as cognitive deficits (Patel et al., 2005). Usually sports related concussions do not result in macroscopic damage to the brain visible with static neuroimaging techniques, such as computer tomography (CT) or magnetic resonance imagery (MRI) (Atabaki & Stiell, 2008; Herring et al., 2011; Jagoda et al., 2008; McCrory et al., 2009).

In the past concussion was managed by categorising concussion symptoms into different grading scales (Jagoda et al., 2008; Meehan & Bachur, 2009). Individual variables, such as age, severity of current injury and previous history of concussive injury have a substantial influence on the nature, manifestation and outcome of concussive injury. When taking these factors into account, an individualised approach to the management of concussion in sport has been proposed (Herring et al., 2011; Kirkwood et al., 2006; McCrory et al., 2009). One facet of an individualised approach to concussion management in sport entails the use of neuropsychological testing (NP testing). NP testing uses an individualised pre-season neurocognitive profile, which is then used as a standard for comparison

against further neurocognitive scores obtained during the given season, in order to assess for any cognitive change (Harmon et al., 2013; Moser et al., 2007).

Isolated concussions in sports are often self-limiting injuries and concussive symptoms usually resolve within 3 to 7 days (McCrory et al., 2009), with most athletes recovering from concussion within one month (Moser et al., 2007). Most of the common cognitive sequelae of concussion are similar for children and adults; the magnitude of consequences to children remains largely unknown (Field et al., 2003; McCrory et al., 2004). However, the effects of concussions are more severe when the brain is still developing (Daneshvar & Nowinski, 2011; Giza & Hovda, 2001; Giza, 2006). In addition, children often find themselves in learning environments where cognitive stress is greater. As such younger athletes need to be considered as a separate group and more conservative management of concussion in children is often needed (Gioia et al., 2009; Kirkwood et al., 2006; Lovell & Fazio, 2008; McCrory et al., 2009).

As opposed to adults, children acquire and retain new information within an active learning setting. The disruption of learning and memory associated with a concussive injury may have detrimental effects on the student athlete's education (Kirkwood et al., 2006; McCrory et al., 2004; McGrath, 2010). School children who had a concussive injury may experience problems at school and are unable to concentrate for extended periods (McGrath, 2010; Moser & Schatz, 2002). Moreover, cognitive demands may exacerbate the child's symptoms. It is therefore important that the student athlete, just as in the case of return to play, return to cognitive activity in a graduated manner (i.e., return to school activities). School performance should return to a normal level before implementing a physical return to play programme (McLeod & Gioia, 2010).

Much of the world's rugby is played in countries such as South Africa, where there is a scarcity of medical personnel well trained in recognising and managing concussion (Marshall & Spencer, 2001). In the case of primary school rugby players, the coaches are often teachers as well. In the absence of healthcare workers and doctors, the coaches are the only people available to identify the child with a concussive injury at practice and games. They are often also responsible to monitor the child of any post-concussion signs and symptoms during return to cognitive activity. As such they play a key role in the recognition and management

of the child with concussion (Guilmette et al., 2007; O'Donoghue et al., 2009; Pleacher & Dexter, 2006).

As healthcare workers, paramedics are often the senior decision makers for health care at rugby games at primary school level. As such they should be able to recognise the concussed child and give the correct advice regarding follow up of the concussive injury. They are responsible for referring the child to the doctor (Pleacher & Dexter, 2006).

Although doctors often do not attend primary school rugby games as match doctors, they are ultimately responsible for returning the concussed student athlete not only to play, but also to cognitive activities (e.g., school work). They should thus be able to follow up the concussed child, be aware of post-concussion sequelae and give the correct advice to the child, parent, coaches, as well as teachers regarding concussive injuries, cognitive and physical rest (Herring et al., 2011; Lebrun et al., 2012; McCrory et al., 2009).

The increased awareness of concussion prevalence and the recovery sequelae thereof is altering the legislative landscape. Legislation regulating concussion management is dedicated to avert the possible devastating effects of the injury. In America a law regulating concussion management was passed initially in the state of Washington in 2009 and many states have since followed (Almasi & Wilson, 2012). In South Africa, it is compulsory for South African rugby coaches at all levels to be *BokSmart* certified in concussion management, including recognising the signs and symptoms of concussion (Patricios et al., 2013; Patricios, 2012).

Concussion is a prevalent medical problem with considerable morbidity and possibly devastating complications. As our knowledge of concussion evolves, we as health care professionals must continue to expand our understanding of this injury in order to provide the care our patients need. Continuous education of parents, athletes, coaches, and medical professionals is thus of utmost importance to correctly identify the concussed child and for correct management to minimise long-term complications of concussion (McGuire, 2011; Provvidenza et al., 2013).

1.2 AIMS OF RESEARCH

Despite a proliferation on research in sports concussion, most of the studies have been done in young adults. This lack of research in children with concussion limits definitive management recommendations (Grady, 2010). As far as could be established this is the first study in South Africa that investigated the knowledge and practice among role players regarding concussion in rugby at primary school level.

The primary aim of this study was to report on the:

(1) knowledge to be able to recognise a concussion by role players potentially involved with a concussed primary school rugby player in the North West Province,
(2) knowledge and practices of role players regarding the prevention of concussion in the rugby playing child,
(3) knowledge and practices of role players regarding the management of a suspected concussion,
(4) knowledge and practices of role players regarding Return to Play (RTP) decision making following a concussion, and
(5) knowledge and practices of role players regarding the consequences of concussion in the rugby playing child.

The science of concussion research and the clinical management of children and who have experienced concussions are rapidly evolving. Therefore a secondary aim of the study is to add to existing literature on concussion in children.

1.3 STUDY SYNTHESIS

This study is structured as a series of related chapters that culminate in an overall discussion. Chapter 2 comprises an overview of the relevant literature and theory that justify the research and analysis of the results. Chapter 3 explains the methods followed for participant selection, data collection and data analysis to fulfil the aims of the research project. Chapter 4 reports on the analytical components of the research. Following the analytical chapter, Chapter 5 consists of a general discussion on the major findings from the study and the implications thereof regarding the primary and secondary aims (Section 1.2), and comments on the limitations of the study. Chapter 6 provides some concluding statements drawn

from the findings and provide recommendations for future research to further knowledge in the field. The appendices contain material for the analytical chapter, the questionnaires given to the participants, supplemental data and permission from the Educational Departments involved, as well as the ethical approval from the Ethics Committee.

CHAPTER 2
LITERATURE STUDY

2.1 INTRODUCTION

The sequelae of brain injuries have been known for at least 3000 years and clinical concussion was initially described over 1000 years ago (McCrory, 2001a). Concussion, from the original Latin *concutere* ("to shake violently") or the Latin *concussus* ("action of striking together"), is one of the most common neurological injuries worldwide (Grady, 2010; Pearce, 2008; Theye & Mueller, 2004). Concussion results from to a direct blow to the head, face or neck, or an impact elsewhere on the body with an impulsive force transmitted to the head, caused by impact forces to the head following intentional or unintentional collisions (Meaney & Smith, 2011; Ommaya, 2002). Sports concussion can occur in any sport when a collision occurs with another player, from body blows as in a tackle, hitting the ground or other hard surface and by the impact of a high velocity missile (such as a ball) against the cranium.

Since the first international symposium on concussion in sport held in Vienna 2001, a large amount of research has been dedicated to sport-related concussion (Patricios et al., 2013; Patricios et al., 2011). Since then three more symposia on concussion in sport have been held, the last one in Zurich, Switzerland in November 2012. Experts were invited to address specific issues involving epidemiology, basic and clinical science, grading systems, cognitive assessment, new research methods, protective equipment, management, prevention, and long-term outcome from concussive injury. Discussions on paediatric concussions were central to the first Zurich Concussion Statement (McCrory, 2001b; McCrory et al., 2009). After the Zurich (2008) symposium, a more multifaceted approach to the management of concussion has been adopted in adults as well as in the paediatric population (McCrory et al., 2009). Unfortunately, many parents, coaches and young athletes still underestimate the potential effects of concussion, and the importance of a medically supervised recovery (Halstead, 2010).

2.2 NOMENCLATURE

In some literature “concussion” is used synonymously with “mild traumatic brain injury” (mTBI) (Cubon et al., 2011). In a recent study by Dematteo et al (2010), it was shown that an injury described as a mild traumatic brain injury was more severe than concussion. When a diagnosis of concussion was made by the treating physician, the child was discharged earlier, sent to school sooner and the family was less likely to consider it as a brain injury than the child with the diagnosis of mTBI. Dematteo went on to suggest that if concussive injuries were to be taken seriously the term “mBTI” might be more appropriate than “concussion” (Dematteo et al., 2010). However, concussion forms one part of a spectrum of mTBI. At Zurich 2012 it was resolved that the term “concussion” be retained and used by health care providers while other terms such as mTBI be avoided in order to prevent confusion (J Patricios, personal communication, 2013).

2.3 DEFINITION OF CONCUSSION

From the 3rd International Conference on Concussion in Sport held in Zurich, November 2008, concussion is defined as a “complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces” (McCrory et al., 2009).

Concussion includes clinical, pathologic and biomechanical injuries that have five major features (Herring et al., 2011; McCrory et al., 2009):

1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head.

2. Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously.

3. Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.

4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course; however, it is important to note that in a small percentage of cases, post-concussive symptoms may be prolonged.

5. No abnormality on standard structural neuroimaging studies such as CT or MRI is usually seen in concussion.

To gain a better understanding of the pathophysiology surrounding a concussion, it is important to look at the gross anatomy and biomechanics involved in the concussive injury.

2.4 EPIDEMIOLOGY

The prevalence of sport-related traumatic brain injuries has been estimated at 300 000, occurring yearly in the United States over all age groups (Gessel et al., 2007). However, this estimation could be under reported because the original estimates included only concussions that involved loss of consciousness (LOC). More recent data suggest that up to 3.8 million concussions occur every year in the United States (Davis et al., 2009; Gioia et al., 2009; Halstead & Walter, 2010; Makdissi et al., 2010). Sports are second only to motor vehicle crashes as the leading cause of traumatic brain injury among people aged 15 to 24 years, and sports concussion accounts for roughly 9% of all high school athletic injuries (Gessel et al., 2007). The incidence of concussion in rugby varies widely (Marshall & Spencer, 2001). However, estimating incidence is difficult since sports-related concussions are frequently undetected due to a lack of recognition of symptoms or intentional underreporting of symptoms (Wiebe et al., 2011).

The Center for Disease Control and Prevention (CDC) in the USA estimates that traumatic brain injuries in children between the ages of 0-14 years result in 435 000 emergency department visits every year (Purcell, 2009). Up to 25 % of these paediatric head injuries occur in children participating in sporting activities (Browne & Lam, 2006), with the highest rates in contact and collision sports (Gessel et al., 2007; Tommasone & McLeod, 2006). Bakhos et al. (2010) estimate that children in the 5 – 18 year group accounted for an estimated 65% of emergency department visits for sports–related concussions (Bakhos et al., 2010). In a study of the

Canadian National Health Population Survey more than half of the concussions reported in children aged 0 to14 were sport related (Gordon 2006). Browne and Lam (2006) found that the most severe concussive injuries occurred primarily in boys 10 years of age and older involved in sport and that children and adolescents involved in organised sports were nearly six times more likely to suffer a severe concussion than those involved in leisure physical activities (Browne & Lam, 2006).

In a study done by Spinks & McClure (2007) in Australian children, the highest injury risk per exposure time, both overall and for only serious injuries, was found for rugby (Spinks & McClure, 2007). The phase of play in which injuries occurred mostly is during the tackle phase (Haseler et al., 2010). According to Patricios (2009), the prevalence of concussion in schoolboy rugby in South Africa is as high as 50% over a 5-year high school rugby career, and many mild head injuries are often not recognised and reported (Patricios, 2009). There is a paucity of controlled studies to identify the age specific frequency and outcome of concussion in the child and adolescent population. Bakhos et al (2010) noted that the number of sports related concussions in young athletes is significant and warrant further research (Bakhos et al., 2010). Sports-related concussion has been recognised as a significant public health concern due both to its incidence and potential effect on young, developing and vulnerable brains (Halstead & Walter, 2010).

2.5 GROSS ANATOMY AND BIOMECHANICS

The brain is composed of soft tissues, “floating” in cerebrospinal fluid (CSF) encased within the hard bone of the skull. Protection from injury is provided by the meninges separating the soft brain tissue from the rigid wall of the skull. In addition to the protection by these layers, CSF cushions the brain within the skull (Palastanga et al., 2006).

Disregarding age, the method of injury in concussion stays the same. Primary injury is the result of the initial mechanical forces impacting on the brain. Concussion typically results from forces directly imparted to the head or indirectly through the neck (Daneshvar & Nowinski, 2011; Ommaya, 2002). This causes a combination of rapid rotational acceleration and/or deceleration forces (a combined coup-countercoup mechanism) that stress or strain the brain tissue, blood vessels and other neural elements (Daneshvar & Nowinski, 2011; Kirkwood et al., 2006; Meaney & Smith, 2011)

2.6 PATHOPHYSIOLOGY

The precise pathophysiology of concussion in humans is still unknown. What is known is largely extrapolated from animal models (Giza & Hovda, 2001; Halstead & Walter, 2010). The symptoms of concussion appear related to acute metabolic dysfunction (Kontos et al., 2004). As described by Greve (2009) and Halstead & Walter (2010), these secondary injuries occur over time and are a result of the activation of bio-molecular and physiological processes separate from, but synergistic with the primary injury (Greve, 2009; Halstead & Walter, 2010). During the pathophysiological process there is a complex chemical and physiological reaction in the brain (a neurochemical cascade) during which cerebral blood flow decreases and diffuse axonal injury (DAI) occurs (Giza & Hovda, 2001). The process starts immediately after impact with a disruption of the neural membrane. This causes unchecked potassium efflux from the affected neurons into the extracellular space, which in turn leads to the release of glutamate. Glutamate further exacerbates the efflux of potassium, depolarising and suppressing neural activity. The sodium-potassium pump tries to restore the balance by increasing activity, utilising more energy. The cycle continues and lactate starts to accumulate, leading to decreased blood flow to the injured area, with a subsequent energy crisis. In addition, a large amount of calcium also accumulates in the cells, thus impairing oxidative metabolism and initiate biochemical cascades that result in cell death. This energy crisis in the injured brain may not be seen for 2-3 days post-injury and may persist for several weeks after the injury (Greve, 2009; Halstead & Walter, 2010). Until the metabolic function has been restored, there is a considerable increase in neurologic vulnerability for consequences such as second impact syndrome (SIS) and post-concussion syndromes (PCS), if a subsequent trauma (even minor) is sustained (Kontos et al., 2004).

2.7 HISTORICAL CONCUSSION GRADING SCALES

Previously the concussion was only described in the presence of either a loss of consciousness or amnesia. Although these remain significant events, the modern approach to concussion include a new individualised definition that does not “pigeonhole” concussion according to certain grades. This means that previous classification systems are outdated and no longer in use. Traditionally classification systems assessed the severity of a concussion according to the presence and duration of loss of consciousness (Makdissi et al., 2010). Several concussion

management grading scales based their return-to-play (RTP) recommendations upon the old classification system. The Cantu Grading System for Concussion, developed by Dr Robert Cantu (Cantu, 1986) and American Academy of Neurology (AAN) classifications were the two most often used in Sports Medicine (Leclerc et al., 2001).

The Cantu Grading System for Concussion and AAN grading scales are no longer valid because they overlooked the subtle physical, sleep, emotional cognitive and behavioural changes that may manifest in the concussed athlete (McClincy et al., 2006). In the 2004 Prague statement, it was suggested that concussions could be divided into the following two categories: 1) a case of simple concussion was defined as one in which neurological symptoms resolved within 7 to 10 days 2) a case of complex concussion was defined as one in which symptoms persisted longer than 10 days or the patient lost consciousness for longer than 1 minute, had a convulsive concussion, or had repeated concussions involving diminishing force (McCrory et al., 2005).

However, at the Zurich 2008 conference this division of concussion was also discarded, as it was not considered useful in the management of concussion. At present it is recommended that management and treatment of athletes with concussion should be individualised and the need for return-to-play decisions to be based on clinical judgment rather than concussion grading scales (McCrory et al., 2009).

2.8 RECOGNITION OF CONCUSSION

One of the most challenging aspects of managing sport-related concussion is recognising it. This is especially true in athletes that do not have obvious signs of concussion (Guskiewicz & Bruce, 2004). To diagnose concussion loss of consciousness (LOC) is no longer necessary as LOC occur in only 8-19% of sports-related concussive injuries (Davis et al., 2009; Halstead & Walter, 2010).

A detailed history of the concussive injury plays an important part in the evaluation and recognition of the patient with concussion – both when injured and when conducting a pre-participation examination, as there are presently no neuro-anatomic or physiologic measurements that can determine the severity of a

concussive injury or when the metabolic dysfunction has cleared (Guskiewicz & Bruce, 2004; Makdissi et al., 2010).

Sport concussion can affect the athlete in four different areas: physical symptoms, cognitive symptoms; emotional symptoms as well as sleep disturbances (see **Table 2.1**). It is important to note that symptoms may not appear until several hours after the concussive episode (Herring et al., 2011; Herring et al., 2006; Kirkwood et al., 2006; McCrory et al., 2005; McCrory et al., 2009).

Table 2.1: The signs and symptoms of concussion (Halstead & Walter, 2010)

Physical symptoms	Cognitive symptoms	Emotional symptoms	Sleep
Headache	Feeling mentally 'foggy'	Sadness	Drowsiness
Nausea	Feeling slowed down	Irritability	Sleeping more than usual
Vomiting	Difficulty concentrating	More emotional	Sleeping less than usual
Balance problems	Difficulty remembering	Nervousness	Difficulty falling asleep
Visual problems	Forgetful of recent information		
Fatigue	Confused about recent information		
Sensitivity to light	Answers questions slowly		
Sensitivity to noise	Repeats questions		
Feeling 'dazed'			
Feeling stunned			

Patients that have pre-existing mental health disorders should be carefully monitored, as the signs and symptoms of concussion are akin to those of depression, anxiety and attention deficit disorder (Collins et al., 2003; Kontos et al., 2004; McCrory et al., 2009). A range of clinical factors that may be associated with

a greater predisposition to concussion as well as a longer duration of symptoms or increased risk of adverse outcomes after concussion were identified by the Zurich (2008) consensus panel. These "modifiers" may significantly influence both susceptibility to concussion and recovery, but are difficult to quantify. These modifiers may call for further investigations such as formal Neuropsychological Testing (NP Testing) balance assessment and neuro-imaging (McCrory et al., 2009). See **Table 2.2**.

Table 2.2: Concussion modifiers (McCrory et al., 2009) ADHD = attention deficit hyperactivity disorder, LD = learning disabilities, LOC = loss of consciousness, TBI = traumatic brain injury.

FACTORS	MODIFIERS
Symptoms	Number Duration (>10 days) Severity
Signs	Prolonged LOC (>1 minute), amnesia
Sequelae	Concussive convulsions
Temporal	Frequency – repeated concussions over time Timing - injuries close together in time ''Recency" – recent concussion or TBI
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion
Age	Child and adolescent (<18 years old)
Co- and pre-morbidities	Migraine, depression or other mental health disorders, ADHD, LD, sleep disorders
Medication	Psychoactive drugs, anticoagulants
Behaviour	Dangerous style of play
Sport	High-risk activity, contact and collision sport, high sporting level

As mentioned previously, loss of consciousness (LOC) was considered the primary indicator of concussion severity. More recently it was suggested that LOC of less than 20 minutes tends to produce cognitive deficits at levels comparable to individuals without LOC (Collins et al., 2003). This may indicate that the presence rather than the duration of (LOC) in the concussed patient serves as the marker of severity. Data showed that individuals with amnesia show slower cognitive recovery than athletes without amnesia (Collins et al., 2003; Lovell et al., 2003; Makdissi et

al., 2010). This indicates that amnesia (either retrograde or anterograde) can serve as indicator of concussion severity. Lovell (2003) and Collins (2003) established that longer periods of confusion or disorientation led to longer duration of recovery of cognitive functioning after concussion (Collins et al., 2003; Lovell et al., 2003). The duration of post concussive signs and symptoms and cognitive deficiencies may be influenced by the age of the concussed athlete (Halstead & Walter, 2010; McCrory et al., 2009; Meehan & Bachur, 2009; Meehan, 2010), as research indicate that concussion symptoms resolve later in high school athletes than college athletes (Field et al., 2003; McClincy et al., 2006).

2.9 EVALUATION OF CONCUSSION

2.9.1 On-field Evaluation of Acute Concussion

Acute concussion management should be done by a health care worker and starts with a systematic medical evaluation (**Table 2.5**). Assess the athlete for adequate airway, breathing and circulation. Cervical spine injury should be excluded, as well as skull fractures and intracranial haemorrhage (Herring et al., 2006; Kirkwood et al., 2006; Patricios, 2009). If this evaluation cannot be accomplished or a health care worker is not available, the player should be safely removed from the field and urgent referral to a physician is warranted (McCrory et al., 2009). Players who have neck pain, any suggestion of upper limb neurology or are confused should be stabilised and stretchered from the field as if the player has a neck injury. A focused neurological assessment using the Maddocks questions (see Appendix G) should be performed (Patricios et al., 2011).

The International Rugby Board (IRB) trialed a new side-line concussion assessment procedure during the 2012 IRB Junior World Championship called the Pitch Side Concussion Assessment (PSCA). Under the trial, if a player had a suspected concussion, he was able to leave the field for a five-minute period of standardised assessment. If the player had concussive symptoms, he left the field permanently (IRB, 2012).

2.9.2 Field side Evaluation of Acute Concussion

Once medical emergencies have been excluded, assessment of the concussive injury should be completed using specific tools e.g. Maddocks Questions, Balance Error Scoring System (BESS), or the Sport Concussion Assessment Tool 2 (SCAT 2) (Appendix F) (Halstead & Walter, 2010; Kirkwood et al., 2006; McCrory et al., 2005; McCrory et al., 2009; Meehan & Bachur, 2009; Patricios, 2009; Patricios et al., 2011). SCAT 2 combines several assessment tools (a symptom checklist, concentration and memory tasks [Maddock's questions], Standardised Assessment of Concussion [SAC], BESS, and Glasgow Coma Scale). The Maddock's questionnaire (Appendix G) is a validated, brief neuropsychological test that is modified for rugby. This tool is useful to discriminate between the concussed and non-concussed athlete (Patricios, 2009). The Maddock's questions are incorporated in the Sport Concussion Assessment Tool 2 (SCAT 2). The SCAT 2 is a clinical tool for the assessment of acute concussion (Patricios et al, 2012). The SCAT 2 incorporates the Balance Error Scoring System (BESS) and Standardized assessment of Concussion (SAC) that has been used before the Zurich 2008 statement announced the SCAT 2 (Halstead & Walter, 2010). The BESS is an assessment of postural stability in three positions, first on a stable surface, then on a 10 cm thick piece of foam. Postural stability deficits last up to 72 hours after a sport related concussion (Wilkins & McLeod, 2004). The Romberg test, sophisticated force plate technology as well as the BESS has been used as assessments in the evaluation and rehabilitation of postural disabilities related to concussion (Davis et al., 2009; Wilkins & McLeod, 2004). The BESS can be used for an objective side-line evaluation to compare baseline stability with the stability after a concussion. One should note, however, that the evaluation of postural stability forms only a small part of the assessment of concussion and should be used along with a symptom checklist, complete neurologic examination, and mental-status testing before RTP decisions is made (Harmon et al., 2013; Wilkins & McLeod, 2004). The Zurich panel states that abbreviated testing paradigms (e.g. SCAT 2) are designed for rapid concussion screening and not meant to replace comprehensive clinical evaluation nor should it be used as a stand-alone tool for on-going management of sports concussions (Harmon et al., 2013; McCrory et al., 2009).

Following a suspected concussion, athletes should be immediately removed from the game, assessed by a healthcare worker and should not return to play to the same game if they showed any signs or symptoms of concussion (Harmon et al., 2013; Herring et al., 2011). Concussion symptoms may evolve. Importantly, symptoms of concussion may initially mimic those of more life-threatening intra-cranial bleeds. For these reasons, the athlete should also not be left alone after an injury and serial monitoring for deterioration of symptoms after injury should be initiated (Herring et al., 2011; Herring et al., 2006; McCrory et al., 2009). Headaches are the most commonly reported symptom in concussion (Gessel et al., 2007; Guskiewicz et al., 2003; Makdissi et al., 2010; Meehan & Bachur, 2009; Stewart et al, 2012). The headache may not be present directly after the injury, and may develop minutes or hours after the injury. It also worsens with exertion. If the headache gets progressively worse, especially if it is accompanied by vomiting or rapidly declining consciousness, it may indicate a life threatening situation (Lovell et al, 2004). The following signs should alert one that the athlete's neurological status is worsening and that he should be urgently referred to hospital/CT scan/neurosurgeon (Halstead & Walter, 2010).

- repeated vomiting, severe or progressively worsening headache,
- seizure activity, unsteady gait or slurred speech,
- weakness or numbness in the extremities,
- unusual behaviour,
- signs of a basilar skull fracture,
- or altered mental status resulting in a Glasgow Coma Score of less than 15.

When examining an athlete that sustained concussion, the physician should update the concussion history and examine the patient carefully for any neurologic deficits including mental status, cognitive functioning, gait and balance (Harmon et al., 2013; Herring et al., 2011).

2.9.3 Post-same day Evaluation and Serial Follow-up

At this time, post-event directives should be provided to the athlete and other role players regarding medical follow up, medication and cognitive and physical rest (Harmon et al., 2013; Herring et al., 2011; Jinguji et al., 2012). As objective data are frequently lacking, systematic review of symptoms reported by the athlete as well as

the parent is essential during follow up. Patricios et al. (2012) suggested the use of a Sports Concussion Office Assessment Tool (SCOAT) that they developed as clinical template to evaluate and record patient care during follow up (Patricios et al., 2012) (available on www.sportsconcussion.co.za/Documents/SCOAT.pdf). The SCOAT differs from the SCAT with regard to a few key aspects (see **Table 2.3**) but still utilises data gathered on the field side SCAT card. It is designed as a comprehensive tool to serially incorporate all of the clinical data required for a return-to-play decision.

Table 2.3 Key aspects of SCOAT (Patricios et al., 2012)

• Allows for more comprehensive epidemiological data
• Records mechanism of injury
• Highlights clinical 'red flags'
• Records management guidance and compliance
• Documents possible modifying factors for recovery and prognosis
• Enables documentation of ongoing symptom analysis
• Weighted scoring for symptoms according to severity on Likert scale
• Documents examination findings (including general, neurological and associated injuries)
• Records computerised cognitive scores for integration with clinical findings
• Documents management guidelines and referrals
• Simplified scoring system
• Includes a final checklist for individualised return-to-play decisions

2.10 DIAGNOSTIC TESTING

2.10.1 Neuroimaging

Concussion is a functional rather than a structural brain injury. Therefore, brain scans (Computed tomography (CT) or magnetic resonance imaging (MRI)) are of limited value (Davis et al., 2009; Harmon et al., 2013). There are, however, a few

indications for CT or MRI scans to assess associated injuries such as intracranial bleed, cerebral oedema, diffuse axonal injury, and/or skull fracture (Herring et al., 2011; McCrory et al., 2009) These include:

- Decreasing level of consciousness
- Increasing severity of signs and symptoms
- Persistent focal neurologic deficits

A normal brain CT or MRI scan does not rule out a brain injury or concussion (Bazarian et al., 2006; Jagoda et al., 2008; McCrory et al., 2009). In the case of a normal CT scan, many might be lured into ruling out a brain injury and concussion. A negative scan also does not rule out an axonal injury that might be the cause of the acute cognitive and motor difficulties observed after a concussion (Bazarian et al., 2006; Jagoda et al., 2008). In the end, the need for further neuroimaging and the diagnosis of concussion remains a clinical decision (Grady, 2010).

Developing forms of imaging modalities such as functional magnetic resonance imaging (fMRI), proton magnetic resonance spectroscopy (H-MRS) and diffusion tensor imaging (DTI) are under investigation; however, evidence is limited, and the methods are not readily available or affordable (Davis et al., 2009; Patricios et al., 2012). Modalities such as the fMRI could play a possible role in future return to play decisions after a concussive injury (Lovell et al., 2007).

2.10.2 Neuropsychological Testing

Neuropsychological (NP) Testing has given clinicians an additional tool to evaluate the athlete with a concussive injury, as NP testing is a tool that can identify occult cognitive impairment and may also assist in documenting the concussed athlete's recovery (Makdissi et al., 2010; McCrory et al., 2005; McCrory et al., 2009; Randolph et al., 2005). In the Zurich statement of 2008 it is stated that "the application of neuropsychological testing in concussion has been shown to be of clinical value and continues to contribute significant information in concussion evaluation." (McCrory et al., 2009). The following forms of such tests are available:

- Paper and pencil tests: associations without the necessary resources and facilities may use paper and pencil tests. These tests can be performed at the sports field and do not require sophisticated equipment. These tests can also be scored immediately. They are also time consuming and labour intensive.
- Comprehensive protocols administered by neuropsychologists.
- Computerised tests (simpler to administer and take 10-30 minutes to complete and may minimise the learning effect – e.g. CogState Sport, Automated Neurocognitive Assessment Metrics (ANAM), Headminders, and Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) tests are also able to provide a more precise measurement of cognitive function, such as reaction time and speed of information processing (Meehan et al., 2011).

Pre-injury testing (baseline testing) is useful in all players to provide a normative standard for that individual. This is followed by post injury testing optimally once a player is near-asymptomatic, which allows a comparison between the athlete's performance pre-injury and after the concussion. Baseline testing may be performed using the SCAT2 and/or computerised platforms. NP testing can then be used in assisting Return to Play (RTP) decisions by ensuring that it returns to baseline before the athlete is allowed to return to play. Even in the absence of such a baseline test the neuropsychological assessment is still valuable when compared to normative age-matched data (Grady, 2010; Makdissi et al., 2001). Several variables may affect testing performance, such as epileptic medication that slows down reaction time and the "practice effect" when tests are repeated over a short time gap (Grady, 2010; Moser et al., 2007). There is at present no established, validated computerised Neuropsychological Test available for the primary school athlete, but Halstead and Walter (2010) report that a computerised test for the athlete younger than 12 years is in a developmental stage (Halstead & Walter, 2010). It has been suggested that NP tests are best interpreted by neuropsychologists but many computerised platforms are designed to be administered by medical doctors and interpreted in the context of medical findings (McCrory et al., 2009).

2.11 MANAGEMENT AND RETURN TO PLAY

Serial clinical assessments, both neurological and cognitive, preferably by a medical doctor remain the cornerstone of management of concussion. One of the key changes in the management of concussions was the abandonment of the previous Return-to-Play (RTP) criteria based on the grading of concussions (Halstead & Walter, 2010; Makdissi et al., 2010; McCrory et al., 2009).

One must take into account the individual variability of concussive injuries and variable rates of recovery as each concussive episode and athlete is unique, and it is recommended that they be treated as such rather than following criteria based on few symptoms or loss of consciousness (Guskiewicz et al., 2003; Herring et al., 2011; Kutcher & Eckner, 2010; Makdissi et al., 2010). Return to play remains the goal of most injured athletes and sports physicians, without putting the athlete at undue risk for further or re-injury (Putukian et al., 2009). Most athletes recover within 7-10 days (McCrory et al., 2009) while others may take weeks (Kohler, 2004).

From a cognitive perspective, recovery may be prolonged in the younger athlete (Kirkwood et al., 2006; Thomas et al., 2011). McCrory (2009) recommended that an athlete should be removed from play immediately and may not return to play in the current game in the presence of any signs or symptoms of concussion (McCrory et al., 2009). The Zurich (2008) panel states, "the cornerstone of concussion management is physical and cognitive rest until symptoms resolve and then a graded program of exertion prior to medical clearance and RTP" (McCrory et al., 2009).

Currently there is no evidence for the pharmacologic treatment of concussion that may influence recovery. Interventions that have been postulated include Corticosteroids, Calcium channel antagonists and drugs inhibiting arachidonic acid metabolism (McCrory, 2002). The 2008 Consensus statement suggests only two situations where pharmacological therapy in sports concussion may be considered: in the management of specific prolonged symptoms (e.g. sleep disturbance, anxiety etc.) or where drug therapy is used to modify the underlying pathophysiology of the condition with the aim of shortening the duration of the concussion symptoms (McCrory et al., 2009). Meehan (2011) believes that pharmacologic management of sport-related concussions should be considered only if (Meehan, 2011):

1. The athlete's symptoms lasted longer than the usual recovery period for a sport-related concussion.
2. The symptoms adversely affect the patient's life so much that the possible benefit of treatment offsets the possible risks of the medication being considered.
3. The doctor that cares for the athlete is knowledgeable and experienced in the assessment and management of sport-related concussion.

If medication is still used to control concussion symptoms, it implies that the athlete has not recovered completely and therefore should not return to play (Halstead & Walter, 2010; McCrory et al., 2009). While exercise has been shown to be beneficial to general health and has been associated with a decrease in cognitive decay (Friedland et al., 2001), in a study on animal models by Griesbach (2004) it is suggested that early activity may worsen or prolong the initial concussive injury (Griesbach et al., 2004). Physical activity changes blood pressure and blood flow patterns and thus will exacerbate concussion symptoms as the brain is more vulnerable to additional stress during the acute healing phase of concussion (Giza & Hovda, 2001; Greve, 2009; Halstead & Walter, 2010; Kontos et al., 2004; Leddy et al., 2007). These findings give highlight to the importance of prompt injury identification and physical as well as cognitive rest, the cornerstone of initial management of concussion (Halstead & Walter, 2010; Kirkwood et al., 2006; McCrory et al., 2009; Meehan & Bachur, 2009; Reddy & Collins, 2009).

Cognitive rest has been advocated in the recent international consensus statements on concussion (McCrory, 2004; McCrory, 2009). Cognitive rest implies that the athlete refrain from activities that involve mental exertion as it may exacerbate symptoms and cause a delay in recovery (McLeod & Gioia, 2010; Moser et al., 2012; Valentine & Logan, 2012). This includes but is not restricted to: working on a computer, watching television, using a cell phone, reading, exposure to loud music, etc. (McLeod & Gioia, 2010). Thus, after a concussive injury, all athletes should be restricted from physical activity. This includes not only the sporting activity that resulted in the concussion, but also training activities as well as leisure activities such as bike riding (Halstead & Walter, 2010). Full recovery, clinical and cognitive, is essential before there could be any consideration for RTP (Guskiewicz & Bruce, 2004; Harmon et al., 2013; Herring et al., 2011; Herring et al., 2006; McCrory et al., 2009).

The Zurich (2008) panel proposed that RTP should be graduated (see **Table 2.4**) (McCrory et al., 2009). The key to graduated return to play is that the athlete should be symptom free throughout each step before continuing on to the next step or returning to play. If any symptoms of concussion appear while the athlete is in the rehabilitation programme, he has to return to the previous step within the graduated RTP protocol/process. The time delay between each graduated step should be 24 hours.

Table 2.4 Graduated return to play protocol (McCrory et al., 2009)

• 24 hours per step •If there is recurrence of symptoms at any stage, return to previous step

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
1. No activity	Complete physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity,70% maximum predicted heart rate No resistance training	Increase heart rate
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
4. Non-contact training drills	Progression to more complex training drills, e.g. passing drills in football and ice hockey May start progressive resistance training	Exercise, coordination, and cognitive load
5. Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

2.12 POTENTIAL COMPLICATIONS AND SEQUELAE OF CONCUSSION

Although complications after concussion are rare, they are potentially serious. A wide range of short- or long-term complications that may affect thinking, sensation, language or emotions may develop after a concussive injury. This may in turn lead to difficulties with memory, depression and early onset of dementia (Herring et al., 2011).

2.12.1 Early complications

Diffuse Cerebral Oedema

Diffuse Cerebral Oedema sometimes referred to as Malignant Cerebral Oedema or Second Impact Syndrome (SIS) is a severe form of re-injury in the athlete whose first concussion has not fully resolved (Cantu & Gean, 2010). The second impact may even be relatively minor. Diffuse Cerebral Oedema involves rapid brain swelling and herniation. This is a rare condition that mainly occurs in adolescent athletes (Cobb & Battin, 2004). Certain activities like tackling in rugby increases the likelihood of repetitive head injury and thus SIS (Cobb & Battin, 2004). This is thought to occur because of disruption of the auto regulation of the brain's blood supply (Cantu & Gean, 2010; Meehan & Bachur, 2009), which in turn leads to vascular engorgement, diffuse cerebral swelling, increased intracranial pressure, brain herniation, and may even result in coma and death (Kirkwood et al., 2006; Meehan & Bachur, 2009). Diffuse Cerebral Oedema may occur with an associated small subdural hematoma (Cantu & Gean, 2010). Some authors dispute the existence of Diffuse Cerebral Oedema and refer to it as diffuse cerebral swelling (DCS). According to these authors, the rarity of DCS suggests that it is more likely to be due to an underlying genetic predisposition than purely a response to impact alone (McCrory et al., 2012).

Convulsive motor phenomena (Concussive convulsions)

A concussive convulsion is defined as a convulsive episode that begins within seconds of impact associated with a concussive brain injury and can last several minutes (Perron et al., 2001). It consists of tonic posturing or convulsive movements and is usually benign (Herring et al., 2011). Convulsive motor phenomena are a non-epileptic phenomenon that does not warrant anti-epileptic treatment or avoidance of future contact sports (Kohler, 2004; McCrory, 1999).

2.12.2 Late complications

Post-concussion syndrome

Post-concussion syndrome (PCS) is defined by the World Health Organization as persistence of three or more of the following symptoms after head injury: headache,

dizziness, fatigue, irritability, insomnia, concentration or memory difficulty (Leddy et al., 2007). Although most athletes with concussion recover within 7 -10 days, PCS should be considered when the athletes remain symptomatic for three weeks or more after the concussive injury (Leddy et al., 2007; Ryan & Warden, 2003). The cornerstone of PCS management is time, and recovery can be a long and slow process (Harmon et al., 2013). Patients with PCS are advised not to exercise intensely if exercise leads to worsening of the symptoms (Leddy et al., 2007). However, extended rest in athletes leads to deconditioning and may lead to secondary depression. Leddy (2007) proposes that these problems (including PCS) may be reduced or alleviated by individualised aerobic exercise that does not elicit worsening of symptoms (Leddy et al., 2007).

Chronic Traumatic Encephalopathy

Chronic traumatic encephalopathy (CTE) is a chronic progressive neurodegenerative disorder seen in people exposed to repeated mild head injury. CTE has been associated with athletes who participate in contact sports such as American football and boxing. Although rugby is not directly associated with CTE, it has been well-documented in cases of concussion and thus may predispose rugby players to CTE (Baugh et al., 2012; Saulle & Greenwald, 2012). The incidence and prevalence of CTE is unknown (Herring et al., 2011). Symptoms include decline in memory, headaches, mood disorders, agitation, and motor problems. Neuropathology reveals atrophy (frontal, temporal, and parietal lobes), substantia nigra pallor, and accumulation of tau and amyloid proteins (Baugh et al., 2012). First signs and symptoms do not normally become evident until decades after the trauma (ages 40-50y) (Herring et al., 2011).

2.13 PREVENTION OF CONCUSSION

Prevention of any form of injury includes primary, secondary, and tertiary strategies (Tator et al., 2012). Primary strategies in the prevention of concussion are those that prevent concussions from happening. These strategies include the wearing of protective gear and rule changes. However, no fool proof method exists for preventing concussion in sports (Herring et al., 2011).

In the incidence of rugby union injuries, most injuries take place during the tackle phase (Lee & Garraway, 1996). Tackling also has been shown to be the cause of 25% and 14% of injuries in schoolboy and adult South African rugby players respectively (Posthumus & Viljoen, 2008) and concussion accounts for 14% of injuries incurred while tackling (Roux et al., 1987). Rule changes to do away with dangerous behaviours in sports may have a more protective effect to prevent concussive injuries (Scorza et al., 2012). These rules should be stringently enforced by coaches and officials (Harmon et al., 2013). Crouch-touch-pause-engage sequence of scrum engagement and the outlawing of the high and spear tackles are examples of rule changes decreed to reduce the incidence of injuries (Posthumus & Viljoen, 2008; Viljoen & Patricios, 2012).

Using protective gear and rule modifications are the foremost means that have been suggested to prevent head injuries (Steffen et al., 2010). However, the benefits of protective equipment remain controversial (Benson et al., 2009; Navarro, 2011). The use of mouth guards for reducing the risk of concussion remains controversial as there is no concrete proof that mouth guards reduce the risk of sustaining a concussion (Navarro, 2011). Currently, mouth guards are recommended for reducing dental trauma (McCrory, 2001b). The use of helmets or head protectors to reduce traumatic brain injury in sport is also controversial. In cycling and ice hockey, there exists evidence for the protective effect of helmets (Finch et al., 2001). However, no sport specific helmets have been shown to be of benefit in reducing rates of head injury in rugby (Finch et al., 2001; Herring et al., 2011; McIntosh & McCrory, 2001). A possible reason for the ineffectiveness of helmets to reduce the risk of concussion is that the type of material used in helmets cannot bear up to the high impacts associated with collision sports such as rugby (Benson et al., 2009). In addition, no helmet can limit the coup and contra-coup forces associated with rotational mechanisms of injury. The most important reasons for wearing headgear are to prevent lacerations and abrasions to the scalp (Herring et al., 2011; Pettersen, 2002). Children using helmets in rugby show increased risk behaviour and thus increase their risk of sustaining concussion (McCrory et al., 2004; Pettersen, 2002).

According to Boggild & Tator (2012), secondary prevention refers to proficient management of a sustained concussion. Secondary prevention strategies intend to prevent worsening of the concussed patient, such as that which occurs with second impact syndrome. Another important factor in the secondary prevention of post-

concussive complications is the knowledge and awareness about concussion by the physician. This ensures that signs of concussion are recognised, that symptoms are monitored, and that second blows to the head before full recovery and premature return-to-activity are avoided (Boggild & Tator, 2012).

Keeping in mind that the ability to treat or reduce the effects of concussive injury after the event is minimal, one of the most important aspects of prevention of concussion lies in the education of the team doctors and other role players that are involved in the care of the athlete with concussion to prevent re-injury (Harmon et al., 2013; McCrory et al., 2009; McKeever & Schatz, 2003). Education of athletes, parents/guardians and coaches in the prevention of short- and long-term health consequences of concussion, such as chronic traumatic encephalopathy (Saulle & Greenwald, 2012), is one of the tertiary strategies in the prevention of concussion (Herring et al., 2011; Tator et al., 2012) (**Table 2.5**). Importantly, children and adolescents appear more vulnerable to concussion and may take longer to recover (Cohen & Gioia, 2009; Field et al., 2003; Halstead & Walter, 2010; Kirkwood et al., 2006; McCrory et al., 2004; Meehan & Bachur, 2009). Anecdotally, it is these groups that are less likely to have field side concussion expertise available making it increasingly important that coaches, referees and parents are aware of concussion signs and management protocol. It is unclear what knowledge athletes, coaches, trainers and medical personnel possess on sport concussion, with an incomplete or a lack of standardised knowledge these role players should have (Boggild & Tator, 2012; Broglio et al., 2010; Cusimano, 2009; Guilmette et al., 2007; McCrea, 2005; Mcleod, 2007; Sye et al., 2006). Doctors, coaches, referees and parents should be able to recognise concussion and be able to apply appropriate guidelines in returning the athlete to sport safely (Finch et al., 2001; Halstead & Walter, 2010; Lebrun et al., 2012; McIntosh et al., 2010; McIntosh & McCrory, 2001). In this regard community concussion programmes such as the South African Rugby's *BokSmart* programme (www.boksmart.com) and Sportsconcussion (www.sportsconcussion.co.za) play an important role. *BokSmart* is a compulsory course that all coaches and referees in South Africa must attend on a biennial basis (Viljoen & Patricios, 2012). *BokSmart* addresses the issue of rugby safety from technique and prevention to treatment of concussion. In the United States of America the "Heads Up: Concussion in High School Sports" tool kit was published by the CDC in 2005 (Halstead & Walter, 2010).

2.14 SPECIFIC PAEDIATRIC CONSIDERATIONS

Despite the cognitive sequelae of concussion in adults and children being the same (reduced speed of information processing, poor attention, and impaired executive function) with additional symptom clusters involving physical, emotional and sleep disturbance manifestations (McCrory et al., 2004), children have more significant cognitive effects after sustaining a concussion (Field et al., 2003; Purcell, 2009).

Physiologically children are not “little adults”. Their bodies are still developing physically, cognitively, socially and emotionally, and will thus respond differently to injury. Being scholars, they are inherently exposed to a learning environment synonymous to cognitive stress on the injured brain. Post-concussion symptoms may affect learning, which may be aggravated even further by studying. This implies that children need to make a gradual transition back to the academic demands associated with schooling following a concussion (Gioia et al., 2009; Kirkwood et al., 2006; McCrory et al., 2009; Purcell, 2009).

Physical rest alone fails to address a further key aspect of brain function in the formative years of children, namely mental exertion associated with school activities (McLeod & Gioia, 2010). The concept of cognitive rest is clearly outlined in the 2008 consensus statement on sports concussion (McCrory et al., 2009). Cognitive rest in the concussed child may be useful in treating concussion related symptoms, whether applied soon after a concussion or at a later time (Moser et al., 2012). In an article by McGrath (2010), guidelines for supporting student athlete are outlined (McGrath, 2010). Cognitive recovery from concussion requires a collaborative approach among school professionals, health care professionals, coaches, parents, and students. All school staff should be educated and informed about the returning student’s injury and symptoms (**Table 2.5**). School staff must assist with the transition process and make accommodations for the athlete that may help the student-athlete to strike an optimum balance between rest and continued academic progress during recovery (McGrath, 2010; McLeod & Gioia, 2010). This includes absence from school and/or shortened school days, decreased workload and longer time for tests, as well as activities viewed by many young persons as integral activities of daily living such as video games, TV, computer work, texting and reading (McCrory et al., 2009; McGrath, 2010).

2.14.1 Biomechanics of concussion in children

The causes of injury in concussion are the same, irrespective of age. As mentioned previously, concussion occurs because of rotational acceleration and/or deceleration forces that stress or strain the brain tissue, vasculature and other neural elements (Kirkwood et al., 2006; McCrory et al., 2004; Meaney & Smith, 2011; Ommaya, 2002). However, the effects of these forces are age dependent (Giza, 2006). Because of the difference in the composition of the head and brain in adults and children such as the brain water content (higher in children) and cerebral blood volume (higher in children and declines with maturity), the biomechanics of concussion in children and adults differ (Giza & Hovda, 2001; Giza, 2006; Goldsmith & Plunkett, 2004; Kirkwood et al., 2009; McCrory et al., 2004). It has been proposed that if a child has clinical symptoms after a head injury, one has to assume that greater force was involved (Halstead & Walter, 2010; Kirkwood et al., 2006; McCrory et al., 2004). Despite having a lower force to mass ration which will protect children in various circumstances, children are smaller in size with reduced strength, developing bodies and weaker neck muscles compared to adults. As a consequence, the force of a collision is directly transferred throughout the body onto the head (Kirkwood et al., 2006), making children more suscpetable to concussive injuries with slower recoveries (Field et al., 2003; Theye & Mueller, 2004).

In addition, the pathophysiological response after a concussion differs between adults and children (Giza & Hovda, 2001; McKeever & Schatz, 2003). The developing brain goes through a phase of maximal synaptogenesis, leading to increased levels of glucose metabolism that may confer increased excitability to the immature brain of the child. This increased excitability may also lead to increased risk of posttraumatic seizures and excitotoxicity (Giza, 2006). In children with concussion, there is a more diffuse and prolonged cerebral swelling compared to adults. This prolonged swelling of the adolescent brain could also lead to a delayed recovery period (Field et al., 2003).

2.14.2 Neurocognitive differences between adults and children

Neurocognitive development is rapid during childhood. This complicates neuro-psychological testing, implying that baseline testing may have to be done more often in children and adolescents (Patel et al., 2005).

As mentioned before, the immature brain is more vulnerable to injury than the adult brain. According to Kirkwood (2006), there are a few hypotheses that could help to explain these phenomena (Kirkwood et al., 2006):

(1) at the time of injury, neurocognitive skills that are not yet well established could be more susceptible to disruption than those that are well established;
(2) brain systems that are responsible for acquiring new skills could be affected directly by diffuse injury;
(3) because the child has less existing skills, recovery may be restricted; and
(4) neurobiological interference with the sequence of chemical and anatomical events necessary for normal development could take place.

2.14.3 Management of concussion in children

In the case of children, symptom assessment data should not only be obtained from the child but also from coaches and teachers to form a more reliable picture. The symptom vocabulary and ability of children aged 5-12 years makes it necessary to incorporate other observers in addition to self-report measures (Gioia et al., 2009).

There are no comprehensive management guidelines and very limited research studies have been published that focus specifically on sport concussion in the paediatric population (Kirkwood et al., 2006; McCrory et al., 2004). During the consensus statement in Zurich 2008 it was unanimously agreed that evaluation and management of concussion used for adults could be applied to adolescents and children down to the age of ten (McCrory et al., 2009). Previously, the idea of rest was primarily related to refraining from bouts of physical activity and contact activities, but recently this has been extended to include cognitive activities as well (McCrory et al., 2009). Full recovery, clinical and cognitive, is essential before there could be any thought of RTP (Guskiewicz & Cantu, 2004; McCrory et al., 2009). As

discussed in Section 2.12.1, in rare cases, some children and adolescents may experience acute cerebral swelling which can lead to death. This calls for the concussed child or adolescent athlete with any symptoms not to RTP on the same day (Lovell & Fazio, 2008), which is in agreement with the Zurich guidelines that same day RTP is not recommended in children (McCrory et al., 2009). McCrory (2009) states that children and adolescents should be exposed to an extended time to RTP since they have different physiological responses to concussion compared to adults with increased vulnerability for serious consequences (e.g. diffuse cerebral swelling) during childhood and adolescence (McCrory et al., 2009).

As mentioned earlier, most athletes recover from sport related concussion in a relatively short period of time (Guskiewicz, 2001; Guskiewicz et al., 2003; Iverson et al., 2006; McCrory et al., 2009). Children younger than ten years of age may report different concussion symptoms from adults, and children and adolescents younger than 18 years should be treated more conservatively as they could have delayed onset of concussive symptoms, as well as take longer to recover than adult athletes (McCrory et al., 2009; Purcell, 2009). Thomas (2011) found in a study done in Pittsburgh that 41% of children aged 11-17 years old still had not returned to normal activity at 2 weeks post injury and 10% at 6 weeks (Thomas et al., 2011). Majerske (2008) demonstrated that if the concussed athlete engages in activities demanding high levels of physical exertion soon after concussion, it is linked to greater impairment on neurocognitive testing. In this study it was also demonstrated that high school athletes have slower cognitive recovery if they exert themselves before disappearance of the concussion symptoms than collegiate athletes (Majerske et al., 2008). Not only is the child athlete slower to recover from a concussive injury, but it was shown in experimental models that the developing brain might be more vulnerable to injury during the acute recovery period (Giza & Hovda, 2001; Lovell & Fazio, 2008). A severe concussive injury in childhood may have a significant impact on later development of the child (Anderson et al., 2005; Garon et al., 2008), including long-term problems in psychosocial function (McKinlay et al., 2002; McKinlay et al., 2010).

It is thus important to stress to the athlete, families, and coaching staff that they must allow time for a full physical recovery, which means no physical activity until the child is asymptomatic at rest. Physical activity includes not only sport, but also other training and recreational activities such as biking and hiking. When the athlete has been asymptomatic for 24 hours, a graded RTP can be initiated. However,

school performance and cognitive stress levels should return to a normal without any symptoms before implementing a physical exertion programme (McLeod & Gioia, 2010) (**Table 2.5**).

The Zurich consensus panel suggested that concussion modifiers (**Table 2.2**) play an even greater role in children and adolescents (McCrory et al., 2009). Kirkwood (2006) suggests the following when managing the child with sport-related concussion (**Table 2.5**):

Table 2.5 Clinical Management Overview of Paediatric Sport-Related Concussion (Kirkwood et al., 2006)

1. Pre-participation medical contact	Gather relevant data: • *Brain injury history, including symptom-based concussion assessment* • *Baseline level of "post concussive" symptomatology*
2. Provide education regarding:	Injury prevention Injury recognition (e.g., loss of consciousness is not the only indication of a concussion)
3. Immediate post concussion evaluation	Rule out medical emergencies • *Thorough physical examination* • *Neuroimaging as indicated* Assess mental status in standardised fashion If concussion is suspected, no return to play until medically cleared
4. Recovery tracking	Conduct serial physical examination Systematically evaluate PCS
5. Return to play	At earliest, return athlete to play when: • *No signs or symptoms of any kind are apparent at rest or during exertion* • *Neurologic examination is normal* • *Neuroimaging is unremarkable when performed* • *NP testing returned to baseline/normal where performed* Return in gradual, stepwise fashion with gradually increasing exposure to exercise.
6. Non-sport considerations	Provide general concussion education to patient, parents, and school personnel Ensure appropriate support in place for transition back to school Treat each medical problem symptomatically Expect positive outcome for most children • *When recovery is not proceeding as expected, promptly refer to specialists (e.g., in neuropsychology, neurology, rehabilitation, sports*

2.15 ROLE PLAYERS IN THE LIFE OF THE CONCUSSED CHILD

The presence of trained medical personnel at sporting events at school level is rare, which implies that essential medical decision making is left up to individuals with little or no training or experience in managing the child with concussion (Lovell & Fazio, 2008). Hence, in addition to doctors, coaches and paramedics play a cardinal role in the recognition and management of the concussed child.

2.15.1 Coaches

Although the attendance of healthcare workers is important to evaluate and safeguard young athletes following a concussive injury, it is important to allow for the reality that health care workers are not always available and that coaches play a crucial role in the assessment and management of the concussed child (Pleacher & Dexter, 2006; Provvidenza & Johnston, 2009). Coaches are often the first responders to assess sport-related concussions in athletes (O'Donoghue et al., 2009). This means that primary school coaches will mostly be the primary responder at practices and matches and must monitor the child athlete for suspected concussions at these games. It is extremely important that coaches be particularly perceptive in recognising the signs and symptoms of concussion (Guilmette et al., 2007). Coaches should not pressure the athlete into returning to play early and must provide encouragement to the athlete to be honest about potential signs and symptoms of injury. Understanding concussion and the effects from concussion that may ensue are vital to the developing child, especially in children that participate in collision sports such as rugby, seeing that there is a probability of multiple concussions. Primary school coaches, often being teachers as well, are ideally positioned to be a primary source of information on concussion recovery, not only for the child and his parents, but also his colleagues that will be interacting with the child recovering from concussion.

2.15.2 Paramedics

Anecdotally, certified paramedics are one of the chief providers of emergency care, concussion education and evaluation at the rugby matches at primary school level in South Africa. As health care providers, paramedics have to be able to recognise and manage the side-line evaluation of the concussed child and administer baseline tests. Not only should paramedics be able to advise the concussed child, his

parents and coach to see a doctor, they also should be able to recognise worsening signs of concussion to be able to send the concussed child for further evaluation at a hospital.

2.15.3 Doctors

With the increase of children participating in sport, every doctor is likely to be called upon to assess a concussion at some stage of their careers. Doctors, as gatekeepers, play a critical role in the management of the concussed child. Not only should every concussed child be assessed by a doctor (McCrory et al., 2009), but doctors also serve as a gateway to further medical care, including MRIs or brain scans and access to other professionals such as psychologists and neurologists. Doctors, as health care providers, should be able to administer baseline tests for concussion, monitor the post injury course in the concussed child, and be able to notice worsening signs that will need hospitalisation. Doctors have known for years that physical rest is important in the treatment of concussion. However, the impact of cognitive rest is seemingly much less appreciated by doctors (Valentine & Logan, 2012). Doctors are seen by coaches as the most helpful source of information on concussion (Lebrun et al., 2012).

2.16 CONCLUSION

From literature it is clear that the recognition and management of concussions is not only complex, but also essential to be handled appropriately. Considering that the guidelines on recognition and management have changed considerably over the last two decades and calls for special considerations with regards to children, it is important to assess the knowledge of role players involved with a potentially concussed child on concussion guidelines which may influence medical or RTP decision making. Chapter 3 will give an account of the research methodology applied to achieve the aims set out in Section 1.2.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

This chapter explains the experimental approach used to achieve the aims set out in Section 1.2. The process for the development of the survey for data collection, the data collection itself and the treatment of the data will be described. Included in the chapter is a brief overview of the scoring of the questionnaires (Appendices D(i-iii)) and the representation of values reported in each table.

3.2 STUDY DESIGN

This study was a descriptive study to assess the knowledge and practices of role players potentially involved with concussed primary school rugby players.

3.3 STUDY PARTICIPANTS

3.3.1 Target population

The target population for this study consisted of primary school rugby coaches, paramedics working at three private ambulance services and doctors in the Klerksdorp, Orkney, Stilfontein and Hartbeesfontein (KOSH) area. The doctors that were targeted belong to the KOSH Independent Practitioners Association (IPA). There are 16 rugby playing primary schools in the KOSH area. For the age groups 9 to13 years, there are approximately 50 coaches (most of whom are teachers). The Ambulance Services make use of paramedics (from a pool of approximately 70 paramedics) during rugby games, while 28 doctors belong to the KOSH area IPA.

3.3.2 Sample population

A total of 51 coaches, 20 doctors and 39 paramedics responded to the invitation to participate and completed the questionnaires.

3.4 MEASUREMENT

3.4.1 Compilation of questionnaire

A self-reported, anonymous questionnaire was used for data collection. The questionnaire consisted of single answer questions where the participants had to choose the most appropriate answer, as well as multiple answer questions where the participants had to choose all the appropriate answers. A separate questionnaire with the same foundational contents was used for each group. The information sheet and questionnaires were available in both English and Afrikaans to offer the participants the opportunity to make an informed decision to take part or not and complete the questionnaire in their language of choice. For practicality and ease of completion, the questionnaires were organised to group all the single answer questions and all the multiple answer questions together. The questionnaires consisted of questions fundamental to the issues role players could face in a child with suspected concussion and addressed five areas: concussion knowledge and terminology, prevention, management, consequences of concussion and return to play (RTP) issues. Professional background information was also obtained in the questionnaire. The content of the questionnaire was based on the 3rd Consensus Statement on Concussion in Sport (McCrory et al., 2009) and Concussion (mild traumatic brain injury) and the team physician: a consensus statement (Herring et al., 2006). The structure of the questionnaire drew heavily from other questionnaires used in similar research on different population groups who divided the assessment areas into (1) knowledge, (2) prevention, (3) management and (4) RTP when analysing the results (Cusimano, 2009; Guilmette et al., 2007; O'Donoghue et al., 2009).

3.4.2 Analysis and scoring of questionnaire

The questions on knowledge assessment within the questionnaire (Appendix Di-iii) have been sorted under 5 different concussion-related topic areas, namely prevention of concussion, recognition of concussion, management of concussion, the consequences of concussion and return to play decisions. Each question was scored according to the percentage of participants who answered correctly according to the guidelines found in literature (Herring et al., 2006; McCrory et al., 2009). Where single most appropriate answers were required, participants had to choose the single correct answer to have it counted toward the percentage of

participants who answered correctly for that specific question within the topic area.

Where multiple answers were possible within a question, each correct answer is listed with the percentage of participants who answered correctly for that specific option within the question.

Each topic area was given an overall topic area score which included all the questions within the specific topic area. Each question had an equal weighting to contribute to a potential total of 100% if all the correct answers were chosen. Where multiple answers were present in a question, each correct answer had an equal weighting so that the combined weight of all the correct answers totalled 1 for that question. Where incorrect answers were chosen within multiple answer questions, incorrect answers also carried a proportionate negative weight so that the sum of all the correct and incorrect answers had a summated value of zero for that specific question. From there a group mean (± standard deviation) and median were calculated for each topic area to explore trends relating to strengths and weaknesses for the respective role players. In addition, the questions which assessed concussion-related knowledge that are considered to be essential are indicated and reported within each topic area. The memorandum for the correct answers can be found in Appendix E.

3.4.3 Data collection

After obtaining approval, participants were handed a research pack, consisting of the following:

(1) Cover letter (Appendix C)
(2) Information sheet/Informed consent (Appendix C)
(3) Questionnaire (Appendix Di-iii)

In the case of the coaches, contact was made with the principals of the primary schools that were included in the study. The aims of the study were explained to the participants by the principal investigator or an appropriate helper familiar to the principals of the different schools. The research pack was both handed out and collected by the principal investigator or helper. The same approach was used with the Ambulance Services and general practitioners who gather weekly at a

Continuous Medical Education (CME) meeting, also attended by the principal investigator. The data collection process is illustrated by **Figure 3.1**.

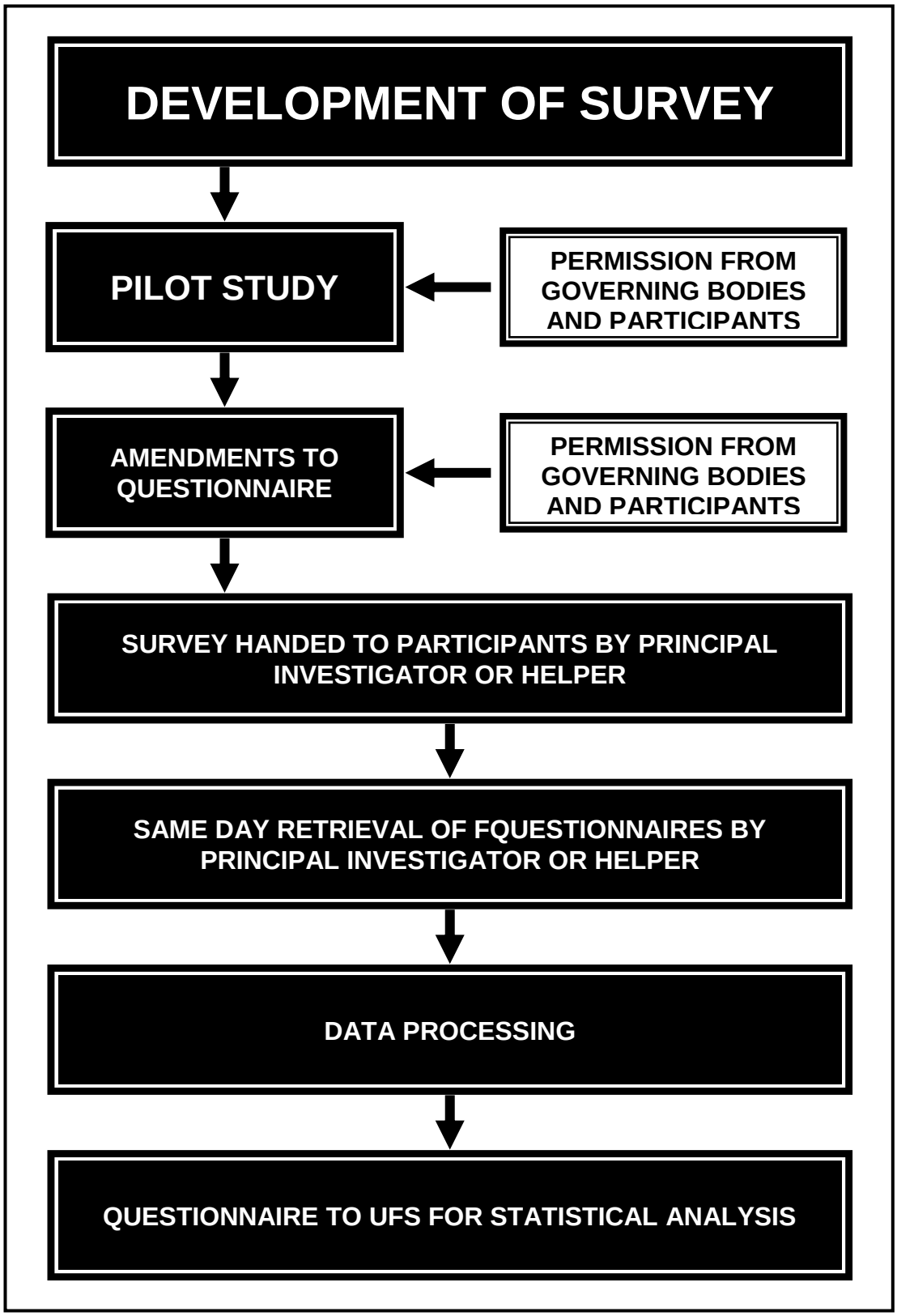

Figure 3.1 Schematic representation of the data collection.

3.5 METHODOLOGICAL AND MEASUREMENT ERRORS

Even though it was highly unlikely, there was a small possibility that the principals of the schools involved may have prepared their coaches beforehand that they may receive a questionnaire regarding their knowledge of concussion. To avoid this, the investigator visited the principals/heads of each individual school to get permission to approach the coaches with the questionnaires. It was explained to the principals that the questionnaires would be completely anonymous and therefore it would be impossible to tell from which school the questionnaires were received. Consequently there was no gain whatsoever to score “better” in the questionnaire. For the purpose of masking what is being assessed and to minimise measurement error, the questionnaires were organised to group all the single answer questions and all the multiple answer questions together instead of grouping the questions under the specific assessments (knowledge, prevention, management and RTP).

The research pack was handed out to all the coaches in a single session and collected shortly afterwards. It was continually stressed that communication should be avoided between the participants prior to completion, as it is important to receive true data to draw accurate conclusions that will benefit the children indirectly. The same approach was used with the Ambulance Services and general practitioners who gather weekly at a Continuous Medical Education (CME) meeting, also attended by the principal investigator.

As contextual errors are common during the translation of questionnaires for use in different cultural or linguistic settings, results based on such questionnaires may therefore not accurately reflect what they are supposed to measure (Gjersing et al., 2010). In an attempt to avoid translation errors a professional translator proficient in both English and Afrikaans was used to translate the questionnaires. Recall bias is a major concern when questionnaire data is used to assess past exposure (Infante-Rivard & Jacques, 2000). The trend is to inflate the risk to exposure and thus the results of the study should be interpreted with caution (Hassan 2006). However, recall bias should not have been a major problem in this study since the events to be recalled were both major and carried into the present at the time of data collection.

3.6 PILOT STUDY

A pilot study was done among five primary school coaches of Grey College, Bloemfontein, two general practitioners and five paramedics in Bloemfontein to trial the questionnaire. The pilot study was done to expose any inadequacies in the questionnaire and the completion thereof. It was also noted how long it took to complete the questionnaire (on average) to include this information in the information sheet. Modifications to the phrasing of questions to resolve ambiguity and to the general organisation of the survey were made. Any repeating questions were removed. Amendments to the questionnaires were made accordingly.

3.7 ANALYSIS OF THE DATA

Statistical analysis was done by the Department of Biostatistics, Faculty of Health Sciences, University of the Free State (UFS). Data were analysed using descriptive statistics to summarise frequencies, percentages, means medians and standard deviations.

3.8 IMPLEMENTATION OF FINDINGS

Results of the study will be reported to the school principals and heads of the Ambulance Services to facilitate better understanding and treatment of the concussed child, and if needed increased training in concussion. An envisaged publication will raise awareness of the medical responsibility placed on role players other than doctors, as well as the knowledge and practices of different role players dealing with a concussed child. This study can also be used to provide feedback for sport concussion prevention and management programmes regarding their programmes to certify rugby coaches at school level and motivate more focus for CME in the case of the doctors.

3.9 ETHICS

3.9.1 Ethical approval

This study was approved by the Ethics Committee, Faculty of Health Sciences, University of the Free State (ETOVS No 90/2010) (Appendix B). Additional permission was sought and granted by the Department of Education from both the Free State and the North West Province (Appendix A) to conduct research under school teachers.

3.9.2 Information to participants and informed consent

After obtaining approval from all the relevant authorities, participants were handed a research pack to describe the motivation and the nature of the research. The information sheet and questionnaires were available in both English and Afrikaans to offer the participants the opportunity to make an informed decision to take part of and complete the questionnaire in their language of choice. The information sheet ensured that all participants received the same information. Emphasis was placed on the fact that their participation would be completely voluntary and all information was to be treated confidentially. In addition it was pointed out that there would be no merit in providing false information, and that the results may potentially be published in a scientific journal.

CHAPTER 4
RESULTS

Section 4.1 to 4.3 of this chapter will focus on an overview of the demographic, concussion training and medical responsibility profiles at rugby matches of coaches, paramedics and doctors. The results of these role players' knowledge and practices in terms of concussion prevention, recognition, management and return to play (RTP) will be reported in Section 4.4.

4.1 DEMOGRAPHIC, CONCUSSION TRAINING AND MEDICAL RESPONSIBILITY PROFILES OF COACHES

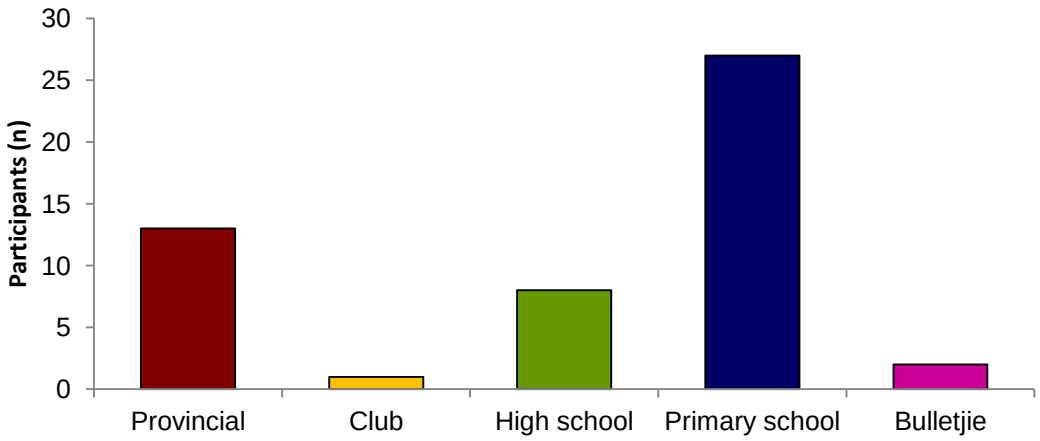

Figure 4.1.1 Highest level of rugby coaching by coaches (n = 51)

Most of the coaches have only coached at primary school level (n = 17, 53%). Thirteen (25%) of the coaches indicated that they had coaching experience at provincial level. One participant had coaching experience on club level. Only two (4%) of the coaches' highest level of coaching experience was at Bulletjie rugby level. (Bulletjie rugby is played by 5-8 year old children).

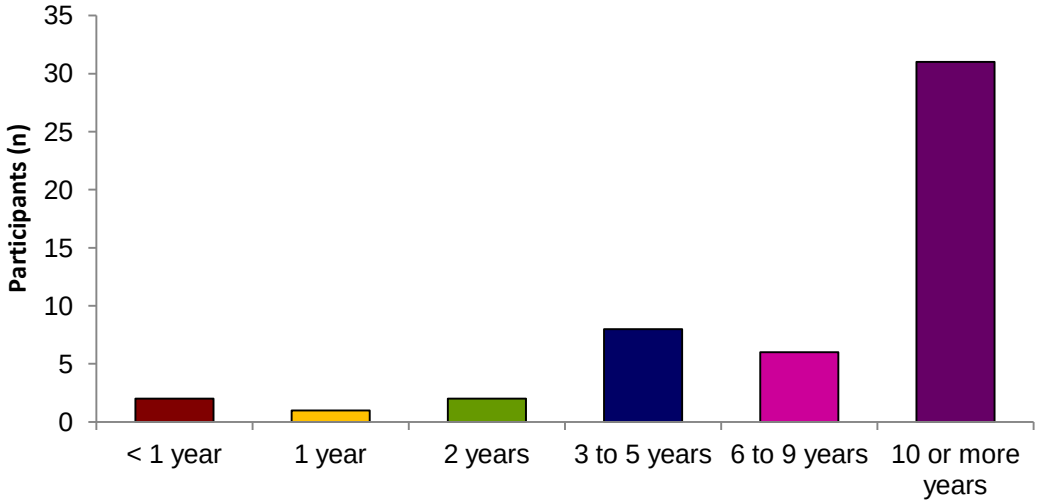

Figure 4.1.2 Years of rugby coaching experience reported by coaches (n = 51)

Thirty one (62%) of the coaches had more than 10 years of experience in coaching rugby, while six (12%) had been coaching for 6-9 years. Eight coaches (16%) had 3-5 years' experience in coaching rugby, with only 2 (4%) of the coaches coaching rugby for less than one year.

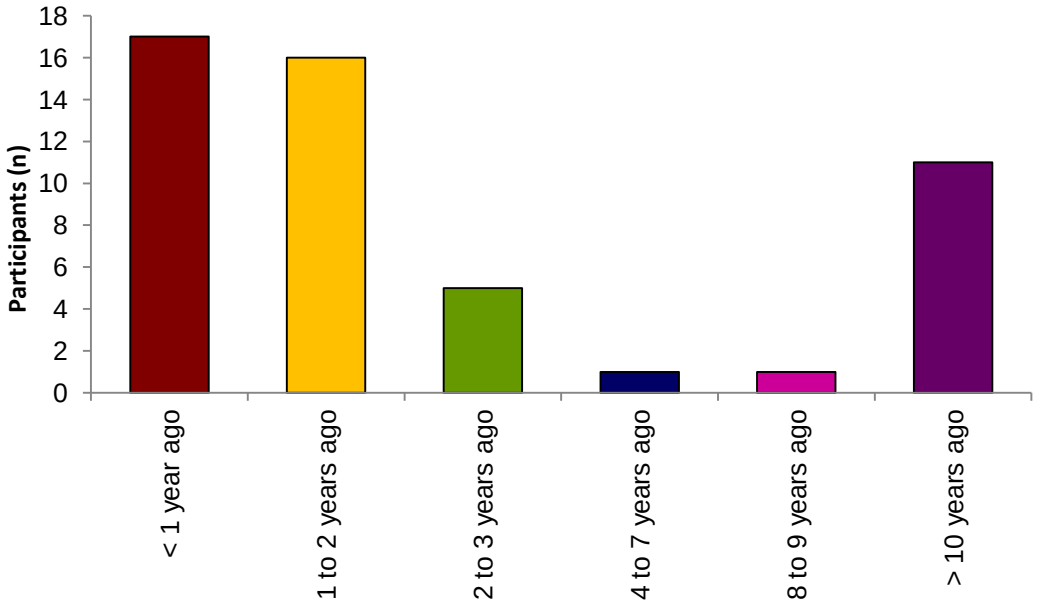

Figure 4.1.3 Time since last concussion-related information received by coaches (n = 51)

A third (n = 17, 33.0%) of the coaches received concussion-related information less than a year ago, and 16 (31.0%) of the coaches one to two years prior. A further five (10.0%) of the coaches were updated on concussion 2-3 years ago, one coach 4-7 years ago and one coach 8-9 years ago. Almost three quarters (n = 28, 74.0%) of coaches received information regarding concussion less than 3 years ago, whereas 11 (22.0%) of the coaches did not receive information regarding concussion in the past 10 years.

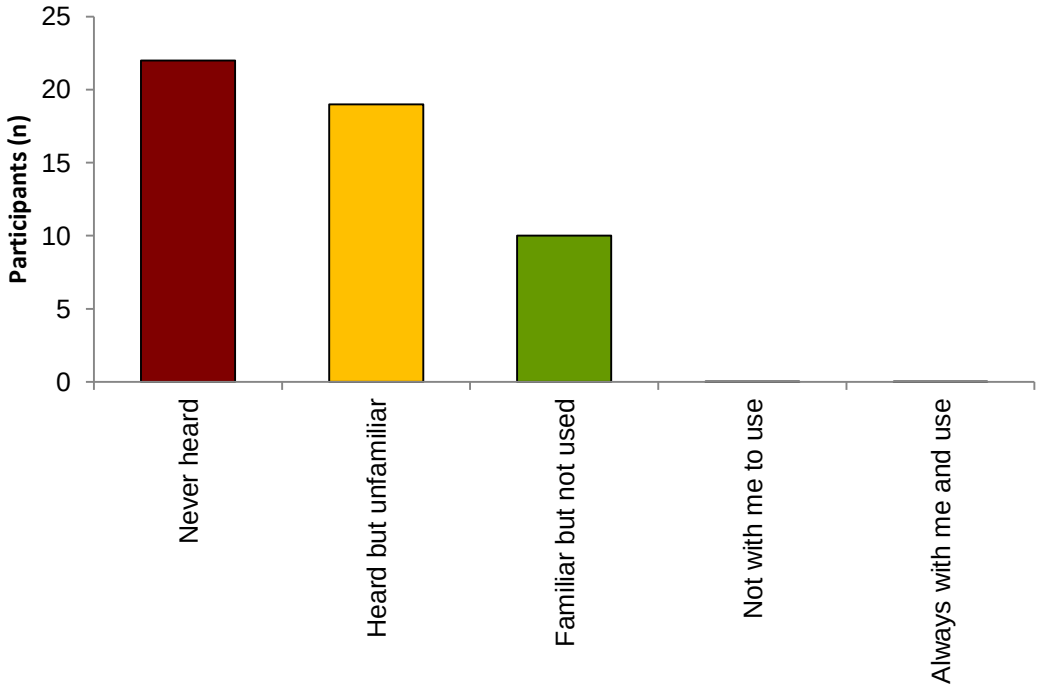

Figure 4.1.4 Familiarity with and use of SCAT by coaches (n = 51)

None (0.0%) of the coaches had the SCAT with them to use when coaching, and 22 (43.0%) reported they had never heard of the SCAT. Nineteen (37.0%) of the coaches had heard of the SCAT previously, but were unfamiliar with it. Ten (20.0%) of the coaches reported that they were familiar with this tool, but had not used it, while none of the coaches indicated that they used SCAT.

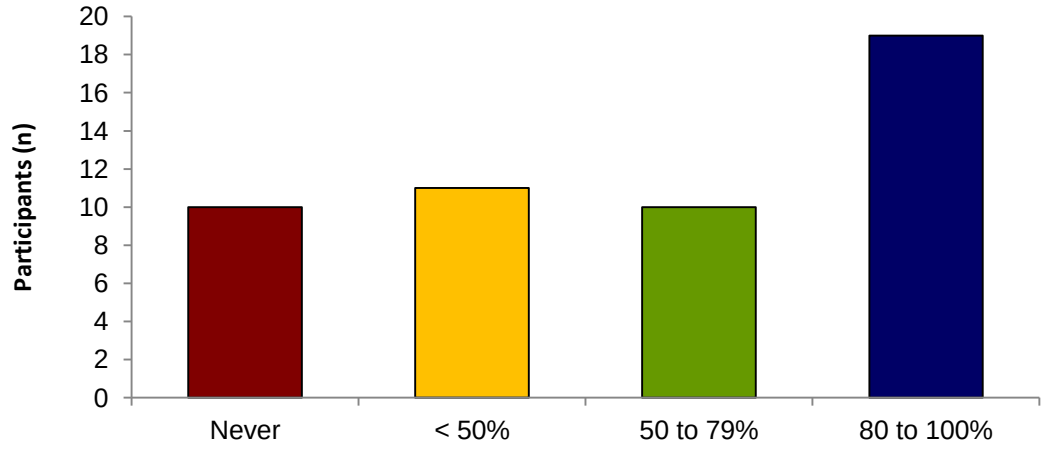

Figure 4.1.5 Distribution of coaches being the most senior person at a rugby game and responsible for managing medical emergencies
(n = 51)

Nineteen (38.0%) of the coaches reported that they were responsible for medical emergencies 80%-100% of the time, with 10 (20.0%) of the coaches responsible for medical emergencies 50%-79% of the time. This accounted for more than half of the coaches (n = 29, 58.0%) being the person responsible for medical emergencies more than 50% of the time. Only ten (20.0%) of the coaches said that they were never responsible for medical emergencies at a rugby game.

4.2 DEMOGRAPHIC, CONCUSSION TRAINING AND MEDICAL RESPONSIBILITY PROFILES OF PARAMEDICS

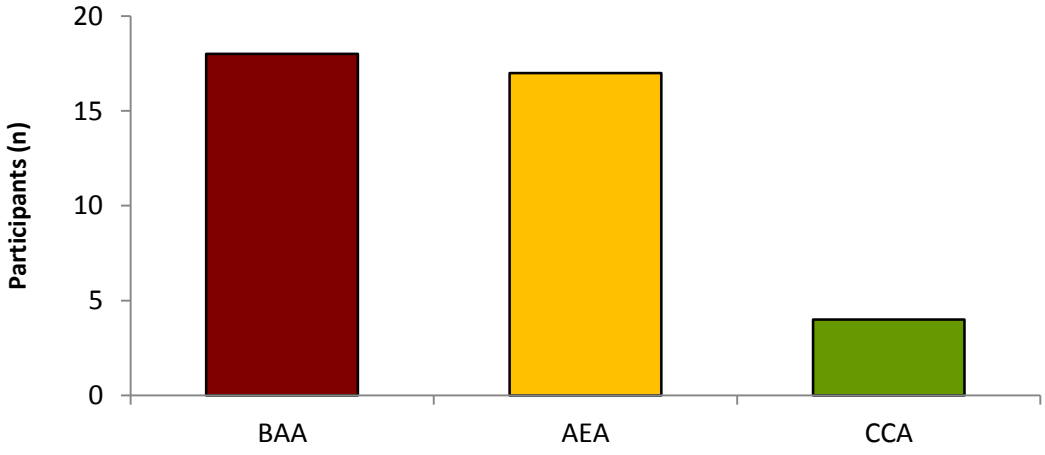

Figure 4.2.1 Highest qualification obtained by paramedics (n = 39)

Eighteen (45.0%) of the paramedics qualified as Basic Ambulance Assistants (BAA), 17 (44.0%) as Ambulance Emergency Assistants (AEA) and four (10.0%) as Critical Care Assistants (CCA).

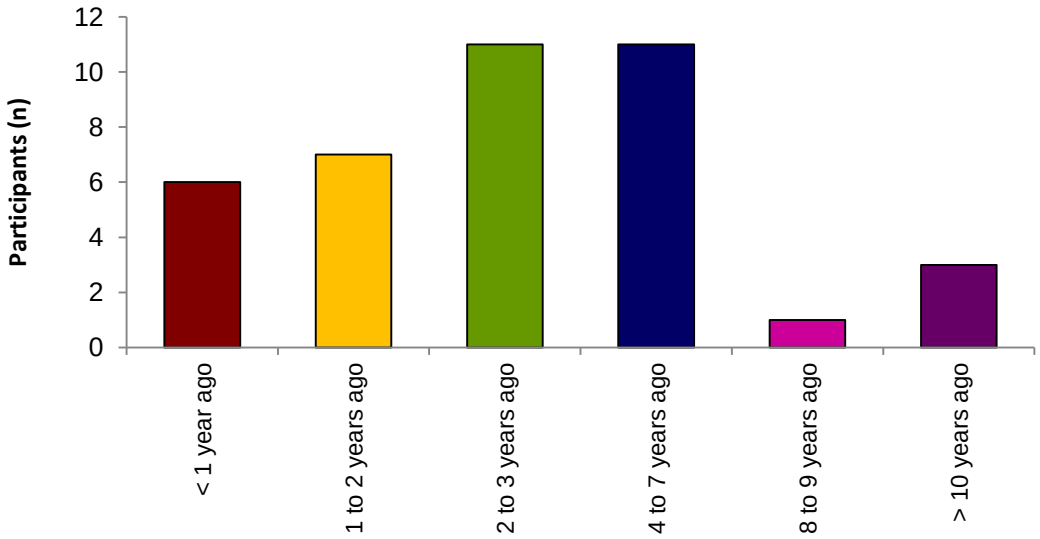

Figure 4.2.2 Time since last concussion-related information received by paramedics (n = 39)

Six (15.0%) out of the paramedics that completed the questionnaire received information pertaining to sports concussion in the previous year, seven (18.0%) 1-2 years ago and 11 (28.0%) 2-3 years ago. Eleven paramedics (28%) paramedics received concussion information 4-7 years ago. One paramedic received information on sports concussion 8-9 years ago, while three (8.0%) of the paramedics received concussion information more than 10 years ago.

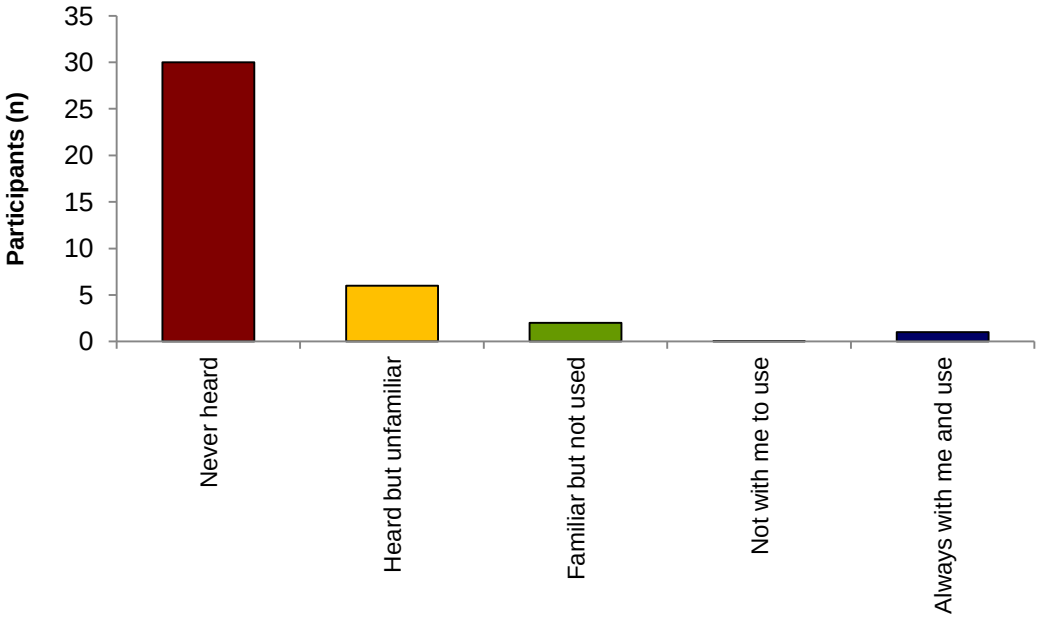

Figure 4.2.3 Familiarity with and use of SCAT by paramedics (n = 39)

Of the 39 paramedics that completed the questionnaire, 30 (77.0%) had never heard about the SCAT. Only two (5.0%) of them were familiar with this tool, but did not use it. Just one (3.0%) of the paramedics was familiar with the SCAT and made use of it.

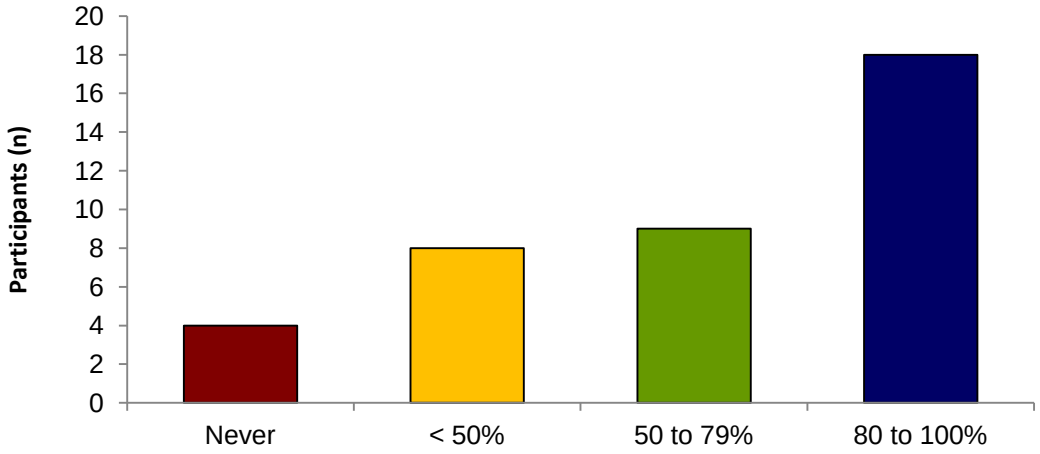

Figure 4.2.4 Distribution of paramedics being the most senior person responsible for managing medical emergencies at a rugby game (n = 39)

Five (10.0%) of the paramedics reported that they were never the most senior person responsible for medical emergencies at a rugby game. Eight (21.0%) of the paramedics said that were the most senior person less than 50% of the time. Nine (23.0%) of the paramedics indicated that they were the most senior person available for medical emergencies at rugby games 50%-79% of the time, while 18 (46.0%) of the paramedics reported that they were the most senior person responsible for medical emergencies at a rugby game 80%-100% of the time.

4.3 DEMOGRAPHIC, CONCUSSION TRAINING AND MEDICAL RESPONSIBILITY PROFILES OF DOCTORS

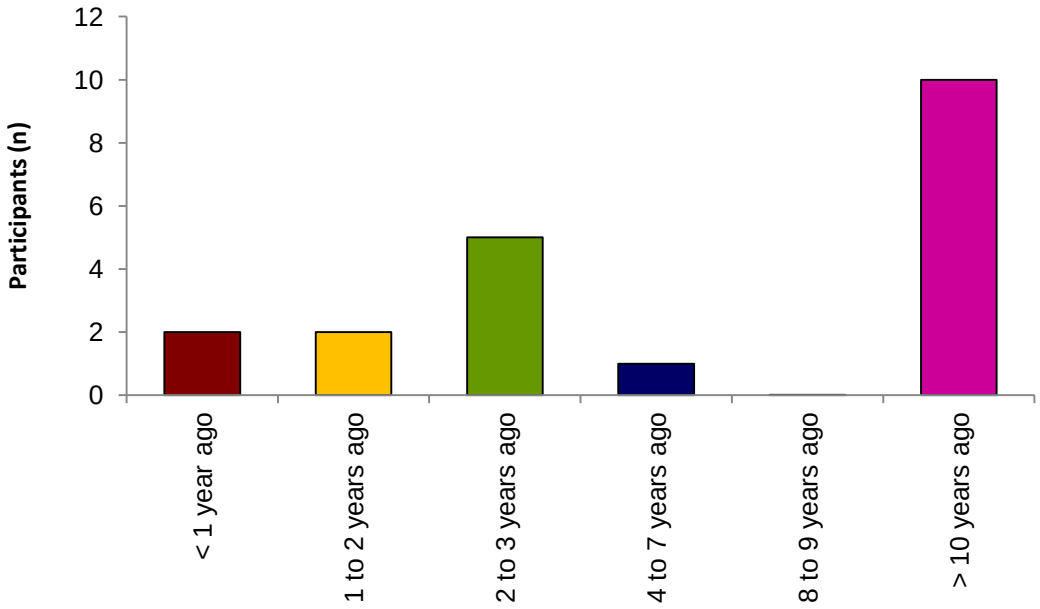

Figure 4.3.1 Time since last concussion-related information received by doctors (n = 20)

Of the 20 doctors that participated in the study, half (n = 10, 50.0%) reported that it had been more than 10 years ago since they received sports concussion related information. Of the 10 remaining doctors, one (5.0%) received information 4-7 years ago, 5 (25.0%) 2-3 years ago, 2 (5.0%) 1-2 years ago and only 2 (5.0%) less than a year ago.

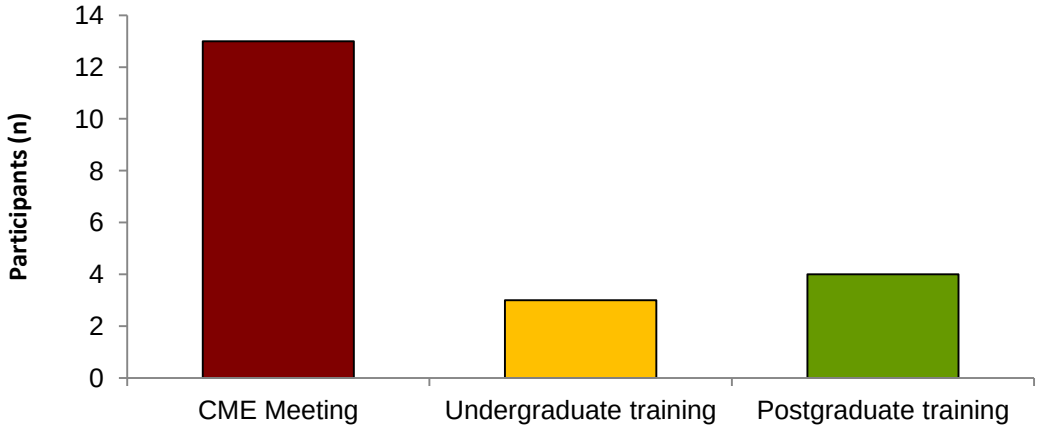

Figure 4.3.2 Main source of concussion-related information for doctors (n = 20)

Thirteen (65.0%) of the doctors received information regarding concussion at Continuous Medical Education (CME) meetings, four (20.0%) during post graduate training, with the remaining three (15.0%) reporting that they received concussion-related information only during their undergraduate training.

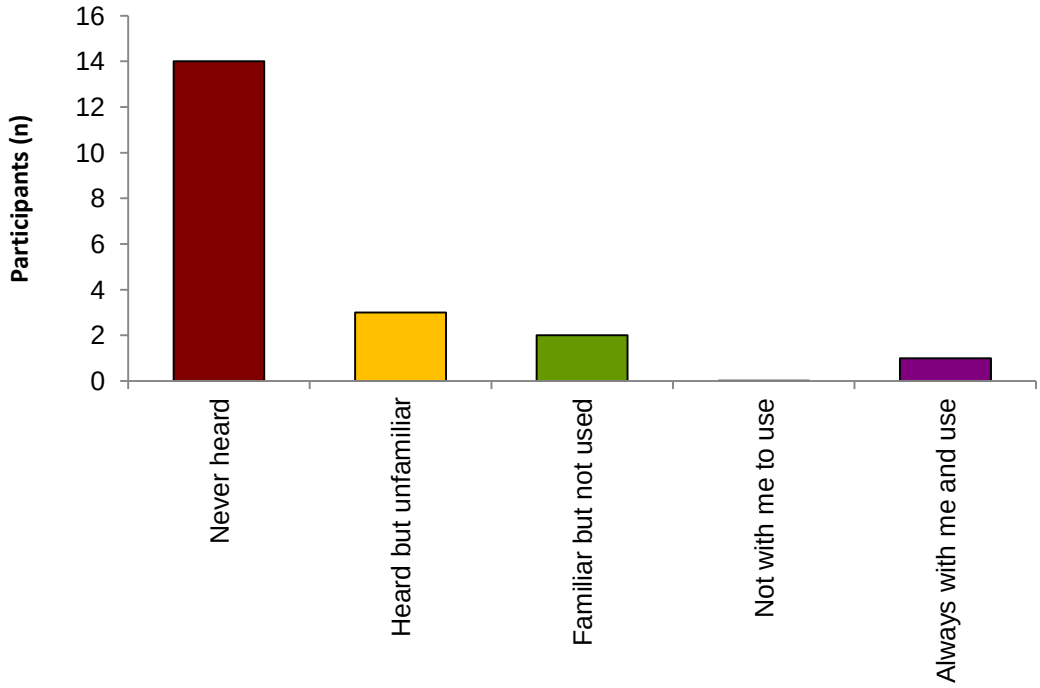

Figure 4.3.3 Familiarity with and use of SCAT by doctors (n = 20)

Fourteen (70.0%) of doctors had never heard of the SCAT, with three (15.0%) having heard about it, but were unfamiliar with this tool. Only two (10.0%) out of the twenty doctors were familiar with the tool, but were not using it. Nineteen of the twenty (95.0%) doctors that completed the questionnaire did not make use of this useful tool at all. Only one (5.0%) doctor was both familiar with the SCAT and also used it.

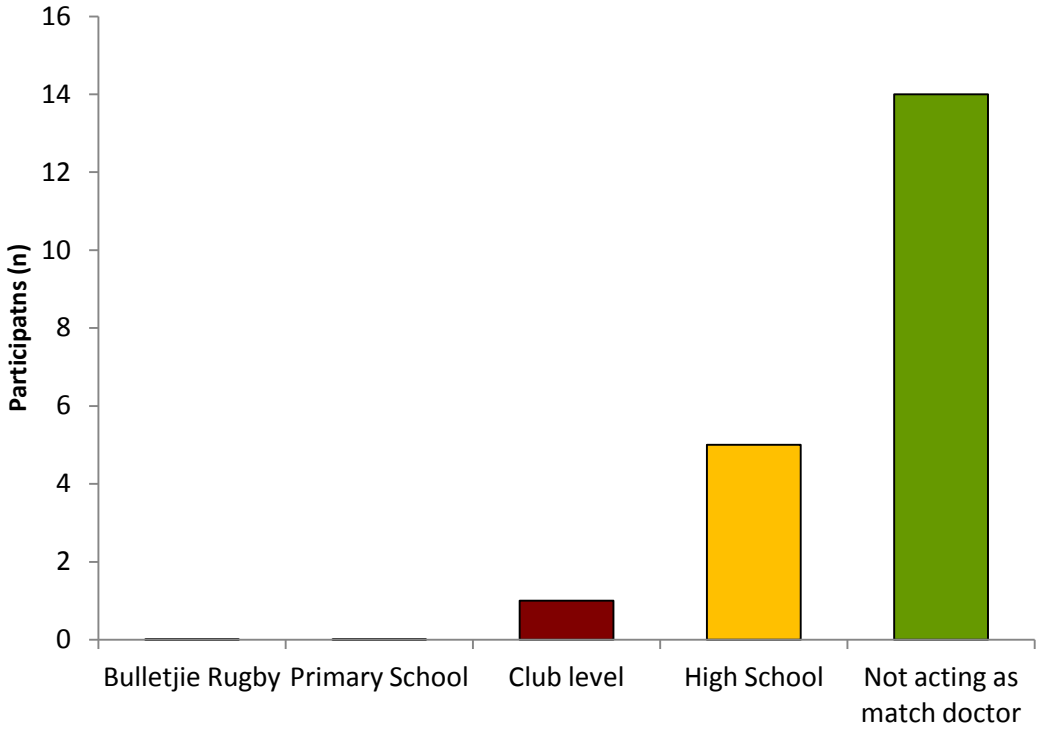

Figure 4.3.4 Distribution of doctors acting as match doctor for rugby games at different levels (n = 20)

When looking at **Figure 4.3.4**, it can be seen that one doctor (0%) had acted as match doctor on club level. Five (25.0%) of the doctors had been match doctors at high school level, while most doctors (n = 14, 70.0%) had not acted as match doctor at all. None (0%) of the doctors had been match doctors at primary school rugby and none (0.0%) at Bulletjie rugby matches.

4.4 KNOWLEDGE AND PRACTICES OF COACHES, PARAMEDICS AND DOCTORS

In order to preserve statistical power and avoid Type 2 errors due to small sample sizes, differences and relationships where further division of sub-categories were needed were not determined for the paramedics and doctors. Where relationships between different variables for the coaches or differences between all three groups as a whole were explored, significance was set at $p < 0.05$ with 95% confidence intervals.

Combined score for the assessment area (prevention, recognition, management, return to play and consequences) were calculated as the number of participants who answered each question correctly. Where multiple answers were present in a question, each correct answer had an equal weighting so that the total of all the correct answers totalled a weighting of 1 for that question. Where incorrect answers were chosen, incorrect answers also carried a proportionate negative weight so that the sum of all the correct and incorrect answers had a summated value of zero for that specific question.

Table 4.4.1 Knowledge on prevention of concussion

Participants knew that:	% Correct		
	Coaches (n = 51)	**Paramedics (n = 39)**	**Doctors (n = 20)**
Concussions most often occur in the tackle phase	80.4	69.2	75.0
A helmet doesn't prevent concussion and may even lead to risky behaviour	2.0	18.0	10.0
Previous sport-related concussion may put a player at risk for another concussion	84.3	89.7	80.0
Being educated about concussion is the most effective way to reduce the risk of sustaining a concussion	68.6	2.6	100
Overall topic area score			
Mean ± SD	58.8±18.6%	59.0±21.8%	66.3±16.8%
Median	50.0%	75.0%	75.0%

Overall topic area score included all the questions within this assessment area (prevention). Each question had an equal weighting to contribute to a potential total of 100% if all the correct answers were chosen.

4.4.1 Knowledge on prevention of concussion

As seen in **Table 4.4.1**, the mean score for the coaches' base of knowledge regarding the prevention of sports concussion was 58.8%±18.6 (median 50.0%). However, most of the coaches (80.4%) were well aware that concussions occur most often during the tackle phase in rugby and that a previous sport-related concussion may put a player at risk for another concussion (84.3%). Only one (2.0%) of the coaches knew that not only does a helmet not prevent concussion, but may even lead to risky behaviour. Most of them (84.3%) were aware that a previous sport-related concussion may put a player at risk for another concussion. More than two thirds of the coaches (68.6%) also seemed to know the importance of education

in the prevention of concussion. There was no relationship between the coaches' years of experience in coaching rugby (p = 0.506), the training they received regarding concussion (time since last information received and whether it was a recognised programme) (p = 0.591) and their knowledge on prevention of concussion. There was, however, a strong relationship between the time coaches were the most senior person responsible for managing medical emergencies next to the rugby field (p = 0.042) and their knowledge on concussion prevention.

As seen in **Table 4.4.1**, the mean score for the paramedics' base of knowledge regarding the prevention of sports concussion was 59.0%±21.8 (median 75.0%). Although more than two thirds of the paramedics (69.2%) are well aware that concussions occur most often during the tackle phase in rugby and most of them (89.7%) knew that a previous sport-related concussion may put a player at risk for another concussion (84.3%), only 18.0% of the paramedics knew that not only does a helmet not prevent concussion, but may even lead to risky behaviour. Only one (2.6%) paramedic knew about the importance of education in the prevention of concussion.

As seen in **Table 4.4.1**, the mean score for the doctors' base of knowledge regarding the prevention of sports concussion was 66.3%±16.8 (median 75.0%). However, as in the case of the coaches and the paramedics, most of the doctors (75.0%) were well aware that concussions occur most often during the tackle phase in rugby and that a previous sport-related concussion puts a player at risk for another concussion (80.0%). Only two (10.0%) of the doctors knew that not only does a helmet not prevent concussion, but may even lead to risky behaviour. All the doctors (100%) regarded being educated about concussion is the most effective way to reduce the risk of sustaining a concussion.

There was no significant difference (p = 0.316) between the knowledge of coaches, paramedics and doctors on the prevention of concussion.

4.4.2 Knowledge to be able to recognise a concussion

From **Table 4.4.2** it is seen that the mean score for the coaches' base of knowledge to be able to recognise a concussion was 74.5±19.7% (median 81.1%) However, concerning the possible signs and symptoms of concussion, only 23.5% knew that a child may experience difficulty in falling asleep if he was concussed. Other signs

and symptoms which stood out as being less commonly known by the coaches were convulsions (43.1%), feelings of euphoria (23.5%) and increased irritability (52.9%). None of the coaches were able to correctly identify all the possible signs and symptoms of concussion, while 13 (25.5%) were able to identify all the signs of a worsening concussion. There was a significant relationship ($p = 0.002$) between the coaches' experience in coaching rugby and their knowledge needed to be able to recognise a concussion. However, there were no relationships between the coaches' concussion-related training received ($p = 0.338$) or their medical responsibility next to the rugby field ($p = 0.738$) with their knowledge needed to recognise a concussion.

When looking at the questions that are considered to be essential concussion-related knowledge (Herring et al., 2006; McCrory et al., 2009) 8 coaches (15.7%) scored below 50%, 13 coaches (25.5%) scored between 50% and 74%, while 30 coaches (58.8%) scored above 75% out of a potential 100% if all the essential knowledge questions regarding recognition were answered correctly. There was a strong positive relationship between the coaches' level of experience in coaching rugby ($p = 0.002$) and their essential knowledge to be able to recognise a concussion. However, there were no relationships between the coaches' concussion-related training received ($p = 0.114$) or the amount of time they are responsible for managing medical emergencies next to the rugby field ($p = 0.608$) and their essential knowledge needed to recognise a concussion.

Table 4.4.2 Knowledge to be able to recognise a concussion

Participants knew that:	% Correct		
	Coaches (n = 51)	**Paramedics (n = 39)**	**Doctors (n = 20)**
A concussion is an injury to the brain	82.4	100	100
A player doesn't have to lose consciousness to have a concussion	88.2	87.2	90.0
Concussion most often occurs in the tackle phase	80.4	69.2	75.0
The following may indicate that a child's concussion is getting worse:			
• Slower reaction time	66.7	74.4	85.0
• Unusual, confused or irritable behaviour	76.5	82.1	85.0
• Worsening headache	96.1	87.2	95.0
• Being sleepy all the time	66.7	87.2	85.0
The following are signs and symptoms of concussion:			
• Headache	98.0	97.4	100
• Feeling dazed or in a "fog"	98.0	92.3	90.0
• Difficulty falling asleep	23.5	5.1	100
• Difficulty concentrating	66.7	76.9	95.0
• Convulsions	43.1	69.2	85.0
• Inability to describe time and place	82.4	79.5	90.0
• Feelings of euphoria	23.5	15.4	20.0
• Difficulty with memory	92.2	89.7	90.0
• Increased irritability	52.9	84.6	65.0
Overall topic area score			
Mean ± SD	74.5±19.7%	78.8±15.1%	81.8±16.0%
Median	81.1%	81.1%	86.1%

Overall topic area score included all the questions within this assessment area (recognition). Each question had an equal weighting to contribute to a potential total of 100% if all the correct answers were chosen. * Indicates essential knowledge (Herring, et al., 2006; McCrory et al., 2009)

From **Table 4.4.2** it is seen that the mean score for the paramedics' base of knowledge to be able to recognise a concussion was 78.8±15.1% (median 81.1%). However, concerning the possible signs and symptoms of concussion, only two of the respondents (5.1%) knew that a child may experience difficulty in falling asleep if he was concussed. Other signs and symptoms which stood out as being less commonly known by the paramedics were convulsions (69.2%) and feelings of euphoria (15.4%). None of the paramedics (0.0%) were able to correctly identify all the possible signs and symptoms of concussion. Not one of the paramedics (0.0%) was able to identify all the signs of a worsening concussion.

In as far as the questions that are considered to be essential concussion-related knowledge (Herring et al., 2006; McCrory et al., 2009) the score of one paramedic (2.6%) was below 50%; 10 paramedics (25.6%) scored between 50% and 74%. A score above 75% out of a potential 100% was given to 28 paramedics (71.8%), given all the essential knowledge questions regarding recognition were answered correctly.

From **Table 4.4.2** it is seen that the mean score for the doctors' base of knowledge to be able to recognise a concussion was 81.8%±16.0 (median 86.1%). However, concerning the possible signs and symptoms of concussion, only 20.0% knew that a child may experience feelings of euphoria if he was concussed. Another sign which stood out as being less commonly known by the doctors was increased irritability (65.0%). None of the doctors (0.0%) were able to correctly identify all the possible signs and symptoms of concussion, while only ten (50.0%) of the doctors were able to identify all the signs of a worsening concussion.

With regards to the questions that are considered to be essential concussion-related knowledge (Herring et al., 2006; McCrory et al., 2009) none of the doctors (0.0%) scored below 50%, 4 doctors (20.0%) scored between 50% and 74%, 16 doctors (80.0%) scoring above 75% out of a potential 100% given all the essential recognition questions regarding recognition were answered correctly.

There was no significant difference ($p = 0.239$) between the knowledge of coaches, paramedics and doctors on the recognition of concussion. However, when considering these items regarded as essential knowledge on the recognition of concussion, the coaches scored significantly worse compared to both the

paramedics (p = 0.024) and doctors (p = 0.008), while there were no difference in the essential knowledge between the paramedics and doctors (p = 0.523).

Table 4.4.3 Knowledge on management of a concussion

Participants knew that:	% Correct		
	Coaches (n = 51)	Paramedics (n = 39)	Doctors (n = 20)
A normal brain scan doesn't exclude a concussion	90.2	94.9	100
A child who has hit his head severely during a rugby game should stop playing immediately and tell the coach	82.2	79.5	85.0
A child who had a severe blow to the head shouldn't continue playing for the rest of the day	92.2	76.9	95.0
A child's parents should be notified when a child has a suspected concussion	86.3	87.2	65.0
A player showing concussion-related symptoms shouldn't participate in any sporting activities, including playing during school breaks	86.3	79.5	85.0
Neuropsychological testing allows for pre- and post-concussion performance evaluation	39.2	35.9	55.0
A child under treatment for concussion should:			
• Refrain from participation in any physical activity	80.4	59	65.0
• Refrain from activities requiring concentration	25.5	25.6	30.0
Overall topic area score			
Mean ± SD	73.2±14.3%	68.1±15.7%	74.3±13.0%
Median	78.6%	71.4%	75.0%

Overall topic area score included all the questions within this assessment area (management). Each question had an equal weighting to contribute to a potential total of 100% if all the correct answers were chosen. * Indicates essential knowledge (Herring et al., 2006; McCrory et al., 2009)

4.4.3 Knowledge on management of concussion

From **Table 4.4.3** it is seen that the mean score for the coaches' base of knowledge to be able to manage a concussion was 73.2 ± 14.3 (median 78.6%). However, less than half of the coaches (39.2%) were aware of the fact that Neuropsychological testing allows for pre- and post-concussion performance evaluation. Most of the coaches (80.4%) knew that a child under treatment for concussion should refrain from participation in any physical activity, but only a quarter of the coaches (25.5%) knew that the child should also refrain from activities requiring concentration.

There was no relationships between the coaches' level of experience in coaching rugby (p = 0.087), the training they received (p = 0.585) and their medical responsibility next to the rugby field (p = 0.787) with their knowledge on the appropriate management of a concussion.

With regards to the questions that are considered to be essential concussion-related knowledge (Herring et al., 2006; McCrory et al., 2009) 6 coaches (11.8%) scored below 50%, 12 coaches (23.5%) scored between 50% and 74%, with 33 coaches (64.7%) scoring above 75% out of a potential 100% given all the essential knowledge questions regarding management were answered correctly. There were no significant relationships between the coaches' level of experience in coaching rugby (p = 0.230), their training received (p = 0.604) and their medical responsibility net to the rugby field (p = 0.788) with their essential knowledge on the management of a concussion.

From **Table 4.4.3** it is seen that the mean score for the paramedics' base of knowledge to be able to manage a concussion was 68.1%±15.7 (median 71.4%). Almost all of the paramedics (94.9%) knew that a normal brain scan doesn't exclude a concussion. In contrast just 35.9% of the paramedics were aware of the fact that Neuropsychological testing allows for pre- and post-concussion performance. Just 59% of the paramedics knew that a child under treatment for concussion should refrain from participation in any physical activity, and only a quarter of the paramedics (25.6%) knew that the child should also refrain from activities requiring concentration. Only 5 (12.8%) of the paramedics knew that a child suffering from concussion should refrain from participation in any physical activity and refrain from activities requiring concentration.

In terms of the essential conclusion-related knowledge questions (Herring et al., 2006; McCrory et al., 2009) 5 paramedics (12.8%) scored below 50%, 15 paramedics (38.8%) scored between 50% and 74%, while 19 paramedics (48.7%) scored above 75% out of a potential 100% given all the essential knowledge questions regarding management were answered correctly.

From **Table 4.4.3** it is seen that the mean score for the doctors' base of knowledge to be able to manage a concussion was 74.3%±13.0 (median 75.0%). Sixty five percent of doctors indicated that a child's parents should be notified when a child has a suspected concussion. Just more than half of the doctors (55.0%) knew that

Neuropsychological testing allows for pre- and post-concussion performance. About two thirds of the doctors (65.0%) knew that a child under treatment for concussion should refrain from participation in any physical activity, but less than a third of the doctors (30.0%) knew that the child should also refrain from activities requiring concentration.

When looking at the questions that are considered to be essential concussion-related knowledge (Herring et al., 2006; McCrory et al., 2009) none of the doctors (0.0%) scored below 50%, nine doctors (45.0%) scored between 50% and 74%, while 11 doctors (55.0%) scored above 75% out of a potential 100% if all the essential knowledge questions regarding management were answered correctly.

There was no significant difference between the knowledge ($p = 0.176$) or essential knowledge ($p = 0.177$) of coaches, paramedics and doctors on the management of concussion.

Table 4.4.4 Knowledge on the consequences of a concussion

Participants knew that:	% Correct		
	Coaches (n = 51)	**Paramedics (n = 39)**	**Doctors (n = 20)**
It is important to recognise concussion in paediatric rugby players, because:			
• It will influence when the child can play sports again	82.3	69.2	85.0
• It may have an impact on the child's school work	72.5	48.7	90.0
• It is always a serious injury that may cause long-term problems	98.0	84.6	80.0
The risks of a child playing too soon after suffering a concussion include:			
• Death from a second blow to the head	82.3	61.5	85.0
• Persistence of concussion-related symptoms for a longer period	88.2	69.2	85.0
• Poor performance in class	43.1	30.7	80.0
• Concussion may result in long-term learning and personality problems	68.6	53.8	75.0
Second Impact Syndrome:			
• Is mostly seen in children under the age of 18 years	11.8	10.3	0.0
• Follows after a second blow on the head if the previous concussion has not resolved	72.6	59.0	80.0
• May lead to brain oedema and death	60.9	71.8	90.0
Overall topic area score			
Mean ± SD	62.1±20.8%	50.1±19.2%	66.5±15.4%
Median	66.7%	50%	68.1%

Overall topic area score included all the questions within this assessment area (consequences). Each question had an equal weighting to contribute to a potential total of 100% if all the correct answers were chosen. * Indicates essential knowledge (Herring, et al., 2006; McCrory et al., 2009).

4.4.4 Knowledge on the consequences of concussion

As seen in **Table 4.4.4**, all the questions relating to the consequences of concussion are considered to be essential knowledge (Herring et al., 2006; McCrory et al., 2009). Consequently, the mean scores for this assessment area are also representative for the scoring of essential knowledge.

From **Table 4.4.4** it is seen that the mean score for the coaches' base of knowledge regarding the consequences of a concussion was 62.1±20.8% (median 66.7%). Although they recognised the importance of recognition of concussion in paediatric rugby players as pertaining to when the child can play sports again (83.2%), and that concussion is always a serious injury that may cause long-term problems (98%), they were less aware that concussion may have an impact on the child's school work (72.5%). The same trend holds true for the risks of a child playing too soon after suffering a concussion. Only 68.6% knew that concussion may result in long-term learning and personality problems, with less than half (43.1%) of the coaches knowing that concussion may cause poor performance in the classroom. Only 11.8% of the coaches knew that Second Impact Syndrome is mostly seen in children under the age of 18 years. There was a strong relationship ($p = 0.021$) between the coaches' level of experience and their knowledge on the consequences of a sustained concussion, but not with the training they received ($p = 0.742$) or their medical responsibility next to the rugby field ($p = 0.767$) with their knowledge on the consequences of a concussion.

From **Table 4.4.4** it is seen that the mean score for the paramedics' base of knowledge regarding the consequences of a concussion was 50.1%±19.2 (median 50%). Although they knew that concussion is always a serious injury that may cause long-term problems (84.6%), only 48.7% ($n = 39$) of the paramedics were aware that concussion may have an impact on the child's school work (48.7%). They were even less aware of the risks of a child playing too soon after suffering from a concussion. Only 53.8% of the paramedics knew that concussion may result in long-term learning and personality problems, with less than a third (30.7%) of the paramedics knowing that concussion may cause poor performance in the classroom. Just over a third of the paramedics (38.5%) indicated that having concussion will influence when the child can play sports again, it may have an impact on the child's school work, and that concussion in a child is always a serious

injury that may cause long-term problems. Only 10.3% of the paramedics knew that Second Impact Syndrome is mostly seen in children under the age of 18 years.

From **Table 4.4.4** it is seen that the mean score for the doctors' base of knowledge regarding the consequences of a concussion was 66.5%±15.4 (median 68.1%). However, most of the doctors acknowledged the fact that it is important to recognize concussion in paediatric rugby players as pertaining to when the child can play sports again (85.0%), that concussion may have an impact on the child's school work (90.0%), and that concussion is always a serious injury that may cause long-term problems (80.0%). Seventy five percent of doctors were also aware of the fact that concussion may result in long-term learning and personality problems. None of the doctors knew that Second Impact Syndrome is mostly seen in children under the age of 18 years.

The paramedics' knowledge on the consequences of concussion were significantly poorer compared to both the coaches ($p = 0.006$) as well as doctors ($p = 0.002$). The knowledge of the coaches and doctors on the consequences of concussion were similar ($p = 0.390$).

4.4.5 Knowledge on return to play guidelines for concussion

From **Table 4.4.5** it is seen that the mean score for coaches regarding return to play decisions after concussion was 68.9 ±15.9% (median 71.4%). Just over two thirds (39.2%) of the coaches knew that players of all ages should not adhere to the same return to play guidelines, as children take longer to return to sport after a concussive injury than other rugby players. As noted before, less than half of the coaches (39.2%) were aware of the fact that Neuropsychological testing allows for pre- and post-concussion performance. There were no relationships between the coaches' level of experience in coaching rugby ($p = 0.269$) or the concussion-related training they received ($p = 0.502$) and their knowledge on the appropriate return to play guidelines for a concussed player. However, there was a strong relationship between the time coaches are the most senior person responsible for managing medical emergencies next to the rugby field ($p = 0.032$) and their knowledge on the appropriate return to play guidelines for a concussed player.

Table 4.4.5 Knowledge on return to play guidelines for concussion

	Participants knew that:	% Correct		
		Coaches (n = 51)	Paramedics (n = 39)	Doctors (n = 20)
	A normal brain scan after a concussive injury means that the child still may have a concussion, and that a normal brain scan does not exclude a concussion	90.2	94.9	100
*	An adult professional rugby player can return to play after a concussion once he has been assessed by a doctor and cleared, but never on the same day	84.3	69.2	80.0
*	If a child has sustained a concussion, he can return to play after a concussion after he has been cleared by a doctor and has followed a graded return to play protocol.	92.1	79.5	100
*	Players of all ages should not adhere to the same return to play guidelines, as children take longer to return to sport than other rugby players.	39.2	25.6	35.0
*	The decision to return a child to sport after a concussion should rest with a doctor	82.3	84.6	100
	Neuropsychological testing (NP testing) allows comparison between pre- and post- concussion performance	39.2	35.9	55.0
*	Before returning to play following a concussion a child should:			
	• Be cleared by a doctor with sport-related concussion experience	96.1	97.4	95.0
	• Be free of concussion symptoms (e.g. dizziness) during rest	76.5	76.9	70.0
	• Be free of concussion symptoms (e.g. dizziness) during activity	72.6	69.2	80.0
*	Following a rugby game, if a player had no loss of consciousness but presents with posttraumatic amnesia for 1 minute, and the following day he reported post-concussion symptoms but appeared normal on standardised methods of concussion recognition, the doctor should not let the player return to competition			100
	Overall topic area score			
	Mean ± SD	68.9±15.9%	64.1±18.6%	79.6±10.8%
	Median	71.4%	66.7%	79.2%

Overall topic area score included all the questions within this assessment area (Return to Play). Each question had an equal weighting to contribute to a potential total of 100% if all the correct answers were chosen.

* Indicates essential knowledge (Herring et al., 2006; McCrory et al., 2009)

In terms of the essential conclusion-related knowledge questions (Herring et al., 2006; McCrory et al., 2009) 7 coaches (13.7%) scored below 50%, 21 coaches (41.2%) scored between 50% and 74%, while 23 coaches (45.1%) scored above 75% out of a potential 100% given all the essential knowledge questions regarding return to play were answered correctly. There were no significant relationships between the coaches' level of experience in coaching rugby ($p = 0.334$), their training received ($p = 0.423$) or their medical responsibility next to the rugby field ($P = 0.261$) and their essential knowledge on the appropriate return to play guidelines for a concussed players.

From **Table 4.4.5** it is seen that the mean score for paramedics regarding return to play decisions after concussion was 64.1% ± 18.6 (median 66.7%). Just over a quarter (25.6%) of the coaches knew that players of all ages should not adhere to the same return to play guidelines, as children take longer to return to sport after a concussive injury than other rugby players. As noted before, 35.9% of the paramedics were aware of the fact that Neuropsychological testing allows for pre- and post-concussion performance. Only eleven of the paramedics (28.2%) knew that before returning to play following a concussion a child should be cleared by a doctor with sport-related concussion experience and be free of concussion symptoms (e.g. dizziness) during rest as well as during activity.

With regards to the questions that are considered to be essential concussion-related knowledge (Herringet al., 2006; McCrory et al., 2009) 14 paramedics (35.9%) scored below 50%, 12 paramedics (30.8%) scored between 50% and 74%, with 13 paramedics (33.3%) scoring above 75% out of a potential 100% given all the essential knowledge questions regarding return to play were answered correctly.

From **Table 4.4.5** it is seen that the mean score for doctors regarding return to play decisions after concussion was 79.6 ± 10.8 (median 79.2%). Just over a third (35.0%) of the doctors knew that players of all ages should not adhere to the same return to play guidelines, as children take longer to return to sport after a concussive injury than other rugby players. As noted before, just more than half of the doctors (55.0%) were aware of the fact that Neuropsychological testing allows for pre- and post-concussion performance. All of the doctors (100%) knew that a player should not return to play if he reports any lingering signs of concussion, even if he appeared normal on standardised methods of concussion testing (e.g., SAC, BESS, neuropsychological testing).

When looking at the questions that are considered to be essential concussion-related knowledge (Herring et al., 2006; McCrory et al., 2009) none of the doctors (0.0%) scored below 50%, 7 doctors (35.5%) scored between 50 and 74%, while 13 doctors (65.0%) scored above 75% out of a potential 100% if all the essential knowledge questions regarding return to play were answered correctly.

Doctors displayed significantly better knowledge and essential knowledge on RTP guidelines when compared to both the coaches ($p = 0.002$ and $p = 0.007$ for general and essential knowledge respectively) and paramedics ($p = 0.002$ and $p = 0.003$ for general and essential knowledge respectively), while there was no difference in the RTP knowledge between coaches and paramedics for the general ($p = 0.189$) and essential ($p = 0.102$) RTP knowledge.

4.4.6 Overall essential knowledge

To get an overall impression of each group's essential knowledge, a total essential knowledge score over all the different topic areas is given below in **Table 4.4.6**.

Table 4.4.6 Essential knowledge scoring for coaches, paramedics and doctors as a group

	Essential knowledge scoring
Coaches	71.44 ± 12.03%
Paramedics	67.01 ± 12.29%
Doctors	76.67 ± 6.56%

Essential knowledge (Herring et al., 2006; McCrory et al., 2009)

Although the coaches and paramedics often had comparable scores to the doctors in general knowledge on various topic areas relating to concussion, the doctors scored significantly better compared to both the coaches ($p = 0.023$) and paramedics ($p = 0.002$) when isolating the items regarded as being essential knowledge for the safe recognition, management and RTP decision making of a concussed child, including knowledge on the consequences of a sustained concussion.

CHAPTER 5
DISCUSSION

5.1 INTRODUCTION

Concussion remains one of the most common neurological injuries associated with contact sport (Grady, 2010; Pearce, 2008; Theye & Mueller, 2004). Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces (McCrory et al., 2009). It is imperative that a concussion should be recognised and managed appropriately. Despite a proliferation in research on sports concussion, focus has fallen primarily on the young adult athlete and the role players involved in the medical management of the young adult athlete. As far as could be established, this was the first study in South Africa to investigate the knowledge and practice among role players regarding concussion in rugby at primary school level.

The primary aims of this study were to report on the:

(1) knowledge to be able to recognise a concussion by role players potentially involved with a concussed primary school rugby player in the North West Province,
(2) knowledge and practices of role players regarding the prevention of concussion in the rugby playing child,
(3) knowledge and practices of role players regarding the management of a suspected concussion,
(4) knowledge and practices of role players regarding Return to Play (RTP) decision making following a concussion, and
(5) knowledge and practices of role players regarding the consequences of concussion in the rugby playing child.

A self-administered questionnaire was compiled to assess the knowledge and practices of primary school rugby coaches, paramedics and doctors in the Klerksdrop, Orkney, Stilfontein and Hartbeesfontein (KOSH) area. The contents of the questionnaire were based on the 3rd Consensus Statement on Concussion in Sport (McCrory et al., 2009) and a consensus statement for team physicians (Herring et al., 2006). The structure of the questionnaire drew heavily from other questionnaires used in similar research on different population groups who divided

the assessment areas into (1) knowledge, (2) prevention, (3) management and (4) RTP when analysing the results (Cusimano, 2009; Guilmette et al., 2007; O'Donoghue et al., 2009). Where possible, child-specific guidelines were inherent to the questions asked to assess the role players' child-specific concussion knowledge and practices. Although inferences made from literature regarding the knowledge viewed as being *essential* for safe practice are aimed specifically towards doctors (Herring et al., 2006; McCrory et al., 2009), the coaches' and paramedics' data were also scrutinised further to evaluate how much of this essential knowledge they possessed, given that they are often the persons responsible for medical decision making next to the rugby field (**Figures 4.1.5 and 4.2.4**).

Results were summarised using frequencies, percentages, means, medians and standard deviations (**Section 3.7**). To avoid Type 2 errors due to small sample sizes, differences and relationships where further division of sub-categories were needed were not determined for the paramedics and doctors. Where relationships between different variables for the coaches or differences between all three groups as a whole were explored, significance was set at $p < 0.05$ with 95% confidence intervals.

5.2 DEMOGRAPHICS

A total of 51 primary school rugby coaches, 39 paramedics and 20 doctors participated in this study. The majority (62.0%) of the coaches had more than 10 years of experience coaching rugby, while 12.0% had been coaching 6 to 9 years. The sample group also consisted of coaches who had less than 6 years experience in coaching rugby and 2 (4%) who are first time coaches (**Figure 4.2.1**).

Of these coaches, 53% have never coached children beyond primary school level. Twenty five percent of the coaches indicated that they had coaching experience at provincial level. Only 4% of the coaches indicated that their highest level of coaching experience was at Bulletjie Rugby level (**Figure 4.1.1**), which may be attributed to the fact that the questionnaires were only distributed among coaches who were teaching at the primary schools, while anecdotally Bulletjie Rugby is mostly coached by parents.

A mere 10% of the paramedics who participated in this study were qualified critical care assistants (highest qualification level), while 46% were ambulance emergency assistants and 44% were only basic ambulance assistants (lowest qualification level) (**Figure 4.2.1**). The participating doctors were all general practitioners who were members of the KOSH Independent Practitioners Association attending a Continuous Medical Education (CME) meeting. None of the doctors were qualified Sports Physicians.

5.3 MEDICAL RESPONSIBILITY

A wide range of health care professionals are usually involved in the care of an athlete to recognise and manage a concussion, including doctors and paramedics. In an ideal world they would function as the core medical support team next to the rugby field. However, access to immediate assessment in children's sport is scarce since the attendance of trained medical personnel on the side-line to assess and manage concussion is rare, leaving the medical responsibility to other non-medical role players such as coaches (Butler et al., 2005; Davis et al., 2009; Guilmette et al., 2007; O'Donoghue et al., 2009). Results from this study suggest that coaches are generally the most senior person responsible for medical decision making instead of a doctor or paramedic. In this study more than half of the coaches were the person responsible for medical emergencies more than 50% of the time. Nineteen (38.0%) of the coaches reported that they were the most senior person responsible for medical decision making 80-100% of the time, while 10 (20.0%) of the coaches were responsible for medical decision making 50%-79% of the time. Only ten (20.0%) of the coaches said that they were never responsible for medical emergencies at a rugby game (**Figure 4.1.5**). Due to the anonymity of the completed questionnaires, it could not be determined whether these coaches were from the same school in order to gage whether a school's attitude towards the need for medical personnel next to the rugby field is an underlying factor to these results. Future research should investigate which factors determine the availability of medical support next to the rugby field in order to identify possible modifiable factors which will be in the best interest of the rugby playing child.

Twenty seven (69.0%) of the paramedics reported that they were the most senior person responsible for medical decision making more than 50% of the time (**Figure 4.2.4**). Considering that literature have suggested coaches to have sports medicine competencies similar to a "First Responder" paramedic (Butler et al., 2005), in

conjunction with the distribution of qualification level among the paramedics (**Figure 4.2.1**), the medical responsibility profiles of the coaches and paramedics suggest that most primary school rugby games will have fairly basic medical cover. Only five (10.0%) of the paramedics reported that they were never the most senior person responsible for medical emergencies at a rugby game. This, in conjunction with the small number of doctors who were the most senior person at rugby games suggests that, not only were very few doctors attending rugby games in a professional capacity, but also that the medical responsibility fell on someone other than doctors which is in line with what is found in the literature (Davis et al., 2009; Guilmette et al., 2007; O'Donoghue et al., 2009, Pleacher & Dexter, 2006). This finding is, by implication, in agreement to the study of Meehan et al (2012) where a doctor was on site at the time of a sustained concussion in the case of only 7.7% of concussed high school pupils, although these figures may potentially be even lower among the primary schools in the KOSH area considering that none of the doctors from this study have ever attended a primary school rugby match in a professional capacity (**Figure 4.3.4**). The level of medical responsibility which, by implication, rest on the shoulders of the coaches is rather concerning, considering that other serious injuries such as cervical spine injuries or cranial fractures, although rare, may accompany a concussion (Herring et al., 2006; Kirkwood et al., 2006; Patricios 2009). Therefore, it is imperative that coaches be astutely aware of the signs and symptoms of concussion as part of the basic sports medicine competencies expected of them (Butler et al., 2005), seemingly being charged with the responsibility of initial concussion identification and management (O'Donoghue et al., 2009; Pleacher & Dexter, 2006; Provvidenza & Johnston, 2009) to the same extent as paramedics and doctors.

5.4 CONCUSSION PREVENTION

As no infallible method exists for preventing concussion in sports (Herring et al., 2011), the most important aspect of preventing concussion is educating doctors and other role players involved with the care of athletes with regard to on-field and off-field recognition of a concussive injury and the application of appropriate guidelines in returning athletes to sport safely to prevent re-injury (McIntosh & McCrory, 2001; Patricios et al., 2013; Provvidenza et al., 2013). In this study, 68.6% of the coaches and 100% of the doctors were aware that being educated about concussion is the most effective way to reduce the risk of sustaining a concussion. In sharp contrast, 97.4% of the paramedics were not aware of this fact. The coaches (58.8 ± 18.6%),

paramedics (59.0 ± 21.8%) and doctors (66.3 ± 16.8%) had similar (p = 0.316) average topic area scores when comparing their overall knowledge on the prevention of a concussion (**Table 4.4.1**).

Since the beginning of 2011 everyone that coaches rugby should be *BokSmart* certified (SARU, 2010). This is a compulsory course that all coaches and referees in South Africa must attend on a biennial basis and is driven by SA Rugby. In the first 2-and-half years, *BokSmart* has trained roughly 38 500 coaches and referees (Viljoen & Patricios, 2012). Of the coaches that participated in this study, 64.7% received information regarding concussion since the founding of *BokSmart*, of which 39.2% specifically attended the *BokSmart* training. This, together with the fact that almost a quarter of the coaches (22%) did not receive information regarding concussion in the past 10 years, indicates that a substantial portion of the coaches were not *BokSmart* certified and therefore not complying with the South African Rugby Union's rules. Concerns are raised that the schools do not stringently adhere to the rules that all coaches must be *BokSmart* certified. Further research should investigate the adherence to these rules on a national level and feed the information to governing bodies such as SA Rugby as a matter of urgency.

Similar to the coaches, most of the paramedics (61%) indicated that they received information regarding concussion in the past 3 years. However, 50.0% of the doctors reported that it had been more than ten years ago since they received sport related concussion information. Lebrun (2013) reported that 65% of Canadian doctors received information regarding concussion via CME meetings (Lebrun et al., 2012). In our study most of the doctors (56.5%) received their information on concussion from CME meetings as well. From these findings it is clear that CME meetings are an important avenue to disseminate concussion related information and should be utilized since education of health care workers forms an integral part of concussion prevention (Harmon et al., 2013; McCrory et al., 2009; McKeever & Schatz, 2003). It is advised that *BokSmart* are made aware of the tendency of doctors to seek their information from these meetings to ensure more doctors receive updated information on concussion, not only those who voluntarily attend the *BokSmart* training.

From the results of this study it was seen that 80.4% of coaches knew that concussion most often occur during the tackle phase. Over the last few decades, continuous rule changes came into being to minimise dangerous behaviour in rugby.

These include the outlaw of the high tackle and spear tackle with the aim of reducing the incidence of injuries (Posthumus & Viljoen, 2008; Scorza et al., 2012; Viljoen & Patricios, 2012). Although almost two thirds of the paramedics (62.9%) were well aware that concussions most often occur during the tackle phase in rugby, they are potentially misinformed with the amount of protection provided by a helmet, as only 18.00% of the paramedics knew that not only does a helmet not prevent a concussion (Finch et al., 2001; Herring et al., 2011 ; McIntosh & McCrory, 2001), but wearing a helmet may lead to risky behaviour of the players which, in turn, may increase their risk for sustaining a concussion (McCrory et al., 2004; Pettersen, 2002). Similar to the paramedics, 75.0% of doctors were aware that concussions most often occur in the tackle, but only 10.0% of the doctors were aware that wearing a helmet did not protect a player from concussion. As there is no evidence that an effective head protector or helmet suitable for rugby exists (Finch et al., 2001; Herring et al., 2011; McIntosh & McCrory, 2001), it is clear that the participants from this study were misinformed as evidenced by the fact that only one (2.0%) of the coaches was aware that wearing a helmet may increase the risk of injury through the associated risky behaviour. This is in contrast to what Pettersen (2002) found in a study conducted among coaches in Canada where most of the coaches felt that headgear could indeed lead to more risky play patterns under athletes. The findings from this study raise concerns that the coaches may have a false sense of security when their players wear headgear and receive trauma to the head, thinking that the child were protected by the headgear and not considering a possible concussion (Pettersen, 2002).

Clear evidence exist that a previous concussion predisposes an athlete to sustain another concussion as the effect(s) of a concussion is cumulative (Saulle & Greenwald, 2012). The majority of role players were aware of this fact, as 84.3% of the coaches, 89.7% of the paramedics and 80.0% of the doctors reported that they knew a previous sport-related concussion may put a player at risk for a subsequent concussion. Although these figures seem quite reassuring, it should be taken into account that the 15.7% of coaches, 9.3% of paramedics and 20.0% of doctors who were unaware of this fact will possibly not be cautious to RTP a player too soon as they see not real risk involved.

5.5 RECOGNITION AND INITIAL MANAGEMENT

The timeline for the initial assessment of concussion begins with the onset of the injury (Stewart et al., 2012). With participation in school sports continuing to increase, teachers are often being relied upon to act as coaches for the school sports. Very often, doctors are not available at the field side, and the only medical assistance next to the rugby field is either a paramedic or the coach (Cantu & Mueller, 2009; Meehan et al., 2012; Saunders et al., 2013), as seen in Section 5.3.

5.5.1 Recognition of signs and symptoms of a concussion

One of the most challenging aspects of a concussion is recognising it, especially in athletes that do not show obvious signs and symptoms of a typical concussion (Guskiewicz & Bruce, 2004). A common reason for a concussion going unreported is the lack of knowledge to be able to recognise a concussion (McCrea, 2005). An inability to recognise all the possible signs and symptoms of a concussion will most likely lead to a concussion being missed at some stage (Patricios, 2009; Wiebe et al., 2011). It is therefore of utmost importance that those who are involved with potentially concussed athletes should know what the signs and symptoms of a concussion are to be able to recognise a concussion and know what the appropriate initial management entails.

The coaches (74.5 ± 19.7%), paramedics (78.8 ± 15.1%) and doctors (81.8 ± 16%) had similar ($p = 0.239$) average topic area scores when assessing their knowledge on the signs and symptoms of a concussion (**Table 4.4.2**). These scores are comparable to literature where 67.3% of coaches or coaches in formal training could identify more than 75.0% of the signs and symptoms of a concussion (Saunders et al., 2013). Considering that the majority of coaches from this study received concussion-related knowledge within the last 2 years, it is surprising that their ability to recognise a concussion seems to be comparable to the coaches from the study of Saunders et al. (2013) whose training curriculums reportedly did not address sport-related concussion (Saunders et al., 2013), drawing into question the efficacy of the concussion-specific training the coaches in this study received.

The vast majority of role players (92.3 to 100%) could identify a headache and feeling in a daze or in a “fog” as symptoms of a sustained concussion. This is not entirely unexpected as these symptoms are frequently present in the concussed

athlete (Guskiewicz & Cantu, 2004) and agrees with the symptoms reported in other studies as being most commonly recognised as symptoms of concussion (Saunders et al., 2013). Amnesia was also one of the most commonly recognised symptoms among all role players in this study, compared to an American study (Saunders et al., 2013) where amnesia stood out as one of the least recognised symptoms of a concussion. The participants' increased ability to identify these specific signs may potentially stem from the conventional approach of grading concussions based on the concussed person's level of confusion or disorientation, loss of consciousness (LOC) and the absence or presence of amnesia (Leclerc et al., 2001).

While more than 85% of the doctors associated insomnia, concentration problems and convulsions with concussion, these signs and symptoms were clearly less familiar to both the coaches and paramedics (**Table 4.4.2**). Compared to the 55.3% of the professionally trained coaches in the study from Saunders et al. (2013) and all the doctors from this study that recognised sleep disturbances as a symptom of concussion, 76.5% of the coaches and 94.9% of the paramedics were unaware that a concussed child may have difficulty falling asleep. Recognition of these specific signs and symptoms to a greater extent by the doctors may possibly results from the medical training they had, most likely giving them more insight into the neurological side-effects associated with the pathophysiology of a concussion (Greve, 2009; Halstead & Walter, 2010).

Other signs and symptoms which stood out as being less commonly known by the coaches, paramedics and doctors were feelings of euphoria and increased irritability, indicating a tendency that the role players were less cognisant of the cognitive signs and symptoms of a concussion. Role players involved with a concussed child should be aware that sport concussion can evoke signs and symptoms in four different areas; (1) physical, (2) cognitive, (3) emotional and (4) sleep disturbances (Halstead & Walter, 2010). It is insufficient to have good knowledge in only some of these areas as the signs and symptoms of a concussed child may possibly present in a single area unfamiliar to the person responsible for medical decision making.

In a study by McLeod (2007), a substantial portion (42%) of youth sports coaches believed LOC is the hallmark of concussion (McLeod, 2007). In contrast, this study found that 88.2% of the coaches and 87.2% of the paramedics surveyed knew that a player doesn't have to lose consciousness to have a concussion, as LOC is not

needed for the diagnosis of concussion (Davis et al., 2009; Halstead & Walter, 2010) and LOC has limited value in gauging injury severity of concussion (Herring et al., 2011; McCrory et al., 2009). Considering that a suspected concussion will most likely be referred to a doctor for confirmation/diagnosis, it is worrying that 10.0% were under the impression that a concussion has to be accompanied by LOC. This finding implies that some concussed patients may potentially be misdiagnosed by a small portion of doctors on the premise of not having had a history of LOC following trauma to the head, possibly contributing to the fact that several concussions go unreported each year (Langlois et al., 2006; McCrea et al., 2005).

Considering all the signs and symptoms needed to recognise a concussion as a whole, not a single participant was able to correctly identify all of the signs and symptoms. This incomplete knowledge to recognise concussion symptoms among the coaches is in agreement to other research among Italian soccer coaches at club level where only a small portion of the coaches could identify the symptoms that are associated with concussion (Broglio et al., 2010). A strong positive relationship ($p = 0.002$) was noted between the amount of years rugby coaching experience and the coaches' knowledge on concussion recognition. Interestingly, there was no relationship ($p = 0.162$) between the time since the coaches last received concussion-related information and whether they received their concussion-related information from a recognised programme ($p = 0.338$) such as *BokSmart* with their knowledge on concussion recognition. This brings into question the efficacy of the available concussion training programmes and raises suspicion that the coaches may possibly attend the *BokSmart* workshops with the sole motivation of becoming certified without retaining the information. It is recommended that further research is done to assess how much information is retained by comparing pre- and post-workshop knowledge among coaches attending the *BokSmart* training.

The inability of the paramedics and doctors to identify all the possible signs of a concussion may have serious implications for a concussed child, considering that paramedics are often relied upon to make a decision whether it is necessary to refer a child to a doctor or not, based on their opinion whether the child has sustained a concussion or not. Despite doctors being the preferred health care providers for diagnosing and managing a concussion according to the Zurich consensus statement (McCrory et al., 2009), a referral to a doctor who nevertheless misdiagnoses the concussion due to a lack in knowledge needed to recognise a concussion will most likely result in the child being sent home without his concussion

being managed appropriately and his recovery process medically supervised according to international guidelines (McCrory et al., 2005; McCrory et al., 2009). Future research should be aimed towards the education of potential role players on the comprehensive list of signs and symptoms indicative of a concussion, as well as address common misconceptions such as the requirement to lose consciousness during a concussive event.

5.5.2 Signs and symptoms of a worsening concussion

Following a suspected or confirmed concussion, the athlete should not be left alone. Instead, serial monitoring for deterioration of symptoms after injury should be initiated (McCrory et al., 2009) as rapidly declining consciousness may indicate a life threatening situation (Lovell et al., 2004). The majority coaches, paramedics and doctors correctly identified a worsening headache as an indication that a child's concussion may be getting worse. A slower reaction time, unusual or irritable behaviour and being sleepy all the time was recognised consistently by 85.0% of the doctors, implying that 15.0% of the doctors may not be able to recognise signs of declining consciousness if they were confronted with a worsening concussion. These signs and symptoms were even less familiar to the coaches and paramedics (with the exception of being sleepy all the time which was recognised by 87.2% of the paramedics) who may, by implication, delay the process of referring a child with a serious medical condition for medical care and hinder secondary prevention measures (Tator et al., 2012) (Section 2.13). Considering the seriousness of declining consciousness, concussion education programmes should emphasise the importance of recognising the signs and symptoms of a worsening concussion with explicit information on the possible consequences if a worsening concussion is misdiagnosed.

5.5.3 The use of concussion assessment tools

Performing and repeating neurological assessments, with particular emphasis on cognitive function and balance testing is imperative following a suspected or confirmed concussion (Herring et al., 2011). The Sport Concussion Assessment Tool 2 (SCAT2) has been developed as a clinical template for the assessment of acute concussion and implemented in adult athletes for concussion identification (Merkel & Molony, 2012; Patricios et al., 2012). However, the SCAT2 has not been validated in the primary school athlete (Merkel & Molony, 2012). Even though the

majority of coaches (64.7%) received concussion related information within the last 2 years prior to data collection and 20 (39.2%) of the coaches previously attended the *BokSmart* training programme, a mere 20% of the coaches knew what the SCAT2 actually was and none of the coaches used the SCAT2 with them when being next to the rugby field. Considering that *BokSmart* training was compulsory for all rugby coaches at the time of data collection and *BokSmart* advocated the use of the SCAT2 at that time, it is a noteworthy finding that none of the coaches followed this *BokSmart* guideline, despite 20.0% of the coaches admitting that they were familiar with the tool. Concussion assessment tools are usually freely available and can be administered at little or no cost (Patricios et al., 2012), suggesting that attitudes towards such tools may be an underlying factor to the disuse of concussion assessment tools such as the SCAT2. Future research should investigate why coaches are reluctant to use concussion assessment tools with the view of informing intervention programmes aimed at equipping role players with whatever means will assist their accurate evaluation of a possible concussion, in agreement with Meehan (2011).

As in the case of coaches, both paramedics and doctors were largely unfamiliar with evidence-based concussion assessment tools. Seventy seven percent of the paramedics and 70% of the doctors had never even heard of the SCAT2. Two (5.0%) paramedics and two (10%) doctors acknowledged that they were familiar with the SCAT2, but did not use it. Only a single paramedic (3.0%) and doctor (5.0%) used this tool when assessing a concussion. A possible reason for the lack in knowledge concerning the SCAT2 may possibly be attributed to the fact that neither doctors nor paramedics are required to attend concussion training such as *BokSmart* for the coaches. This alludes to the impeded dissemination of concussion knowledge and guidelines to the medical gatekeepers such as general practitioners who care for most amateur athletes (Meehan et al., 2012; Patricios et al., 2013).

5.6 MANAGEMENT OF A SUSTAINED CONCUSSION

Very little literature has been published on the involvement of coaches or other health care providers in caring for concussed athletes. Managing concussion in the developing brain is a distinct challenge (Halstead & Walter, 2010). One of the cornerstones of initial management of concussion is physical rest since physical activity change blood pressure and blood flow patterns which may exacerbate concussion symptoms during the acute healing phase (Giza & Hovda, 2001;

Halstead and Walter, 2010; Kontos et al. 2004; Leddy et al., 2007). Formerly, the idea of rest was limited to refraining from bouts of physical activity and contact sports, but recently this has been expanded to include rest from cognitive activities as well (McLeod & Gioia, 2010; Moser et al., 2012), as seen in international consensus statements (McCrory et al., 2005, McCrory et al., 2009). Cognitive rest entails that a concussed athlete should refrain from activities which involve mental exertion as it may also exacerbate symptoms and delay recovery (McLeod & Gioia, 2010; Moser et al., 2012; Valentine & Logan, 2012). This implies that children need to make a gradual transition back to school as part of the recovery process following a concussion (Kirkwood et al., 2006; McGrath, 2010; McLeod & Gioia, 2010) since the symptoms of a sustained concussion may result in learning problems and poor academic performance (McGrath, 2010).

The coaches play a key role in the management of the concussed child, not only to assist safe RTP back onto the field, but also to monitor the child for any post-concussion signs and symptoms during return to cognitive activity (Guilmette et al., 2007; O'Donoghue et al., 2009; Pleacher & Dexter, 2006). The coaches, as teachers, work with the concussed child on a regular basis and possess a wealth of knowledge on the child's behaviour and usual ability to function within the academic setting, which is directly relevant to the assessment of any post-concussion symptoms. Coaches should be aware of the side effects of concussion that may be apparent in the classroom, reduce academic stressors and if necessary provide assistance to the concussed child to deal with the symptoms (McGrath, 2010). The coaches from this study, who were all teachers, were well aware of the fact that the child with concussion should refrain from physical activity, but the majority of the coaches (74.5%) did not know that a child suffering from concussion should also refrain from activities requiring concentration. There were no relationships between the coaches' experience in coaching rugby ($p = 0.087$), their medical responsibility profile next to the rugby field ($p = 0.787$), the time since they received their last concussion-related information ($p = 0.184$) or whether they attended a recognised concussion training programme ($p = 0.585$) and their knowledge on appropriate concussion management. Being ideally positioned to advocate a gradual transition back into school among their fellow teachers (McGrath, 2010), future research should investigate why the coaches had a lack in knowledge on the cognitive management of a concussion despite the fact that 64.7% of the coaches had exposure to concussion related information within the last 2 years when international

consensus has already been achieved on the importance of cognitive rest in the management of a sustained concussion.

Despite being aware that a concussion is an injury to the brain (**Table 4.4.2**) and a second blow to the head may result in fatal brain oedema (**Table 4.4.4**), 41.0% of the paramedics and 35.0% of the doctors did not think it is necessary for a child under treatment for a concussion to refrain from participation in any physical activities (**Table 4.4.3**). Interestingly, when asking whether a child showing concussion related symptoms should be allowed to participate in sporting activities, including socially during school breaks, approximately 20.0% more paramedics and doctors indicated that they would not allow the child to do so (**Table 4.4.3**). This inconsistency indicates a possible misconception that a child is only at risk for sustaining another blow to the head when participating in sporting activities, and not when engaging in leisure activities (Meehan, 2010). Similarly to the coaches, 74.4% of the paramedics and 70.0% of the doctors did not know that a concussed child should also refrain from activities requiring concentration, which is in agreement to a study by Lebrun (2012) where most Canadian (83.8%) and American (75.5%) physicians always recommended physical rest, but neglected to advise cognitive rest; only 47.5% of Canadian doctors and 28.4% of American doctors advised cognitive rest to their concussed patients (Lebrun et al., 2012). This is far less than the 77.0% of doctors from the study of McCarthy and O'Hara (2010) who reported that they recommend their patients to go home if they experience any cognitive symptoms while being at school (McCarthy & O'Hara, 2010). In keeping with the recommendations from Harmon (2013), findings from this study also suggests that research into effective methods to train doctors on the appropriate management of a sustained concussion, especially cognitive rest (Stewart et al., 2012) is certainly warranted (Harmon et al., 2013).

Interestingly, 13.7% of the coaches and 12.8% of the paramedics indicated that they do not see it necessary to inform a child's parent(s) if the child has sustained a concussion, indicating a lack in knowledge on the appropriate management of a concussed child (McCrory et al., 2009). Even more doctors (35.0%) were of the same opinion. Besides the obvious reasons why this is inappropriate practice, this undermines the role a parent can play in the monitoring of the child for delayed onset of symptoms or signs of a worsening concussion (Section 5.4.2). Possible reasons for this concerning approach remain speculative, but may potentially be attributed to the Children's Act 38 of 2005 (as amended from the Children's

Amendment Act 41 of 2007) which came into use on the 1st of April 2010. According to this act, a child may consent to his or her own medical treatment from the age of 12, if they have sufficient maturity (Strode et al., 2011). Section 13 of this act also states that "information on a child's health status or the health status of the child's parent, caregiver or family member must be kept confidential". However, it is further stated that such confidentiality may be breached if the confidentiality is not in the best interests of the child (Mahery et al., 2010), as is the case with concussion. Therefore, this reluctance to inform the parents may potentially indicate a misconception among the doctors regarding their responsibility relating to patient confidentiality, or expose a lack in knowledge and understanding of the need for continuous monitoring of the concussed child (McCrory et al., 2009) by significant role players closest to the concussed child (Patricios et al., 2013). Further research into the attitudes of doctors on the view of parents as significant role players closest to the concussed child should be done with the aim of exposing a possible lack in knowledge on the appropriate management of the concussed child and inform future intervention programmes.

Literature deems it essential that a child who has hit his head severly during a rugby game should stop playing immediately and tell the coach (Herring et al., 2006). Considering that children see coaches as a primary source of concussion information (Provvidenza & Johnston, 2009; Sye et al., 2006), the players of 17.8% of the coaches would, by implication, not be advised to report a potential concussion which may have serious repercussions. The majority of coaches (92.2%) and doctors (95.0%) were aware that a child who had trauma to the head should not be allowed to play for the rest of the day and monitored for possible delayed symptoms (McCrory et al., 2009). The paramedics were not as knowledgeable of this fact, evidenced by the 23.1% of the paramedics who indicated that they do not see it necessary to withhold a child from play for the rest of the day following trauma to the head.

The coaches (73.2 ± 14.3%), paramedics (68.1 ± 15.7%) and doctors (74.3 ± 13.0%) had similar ($p = 0.176$) average topic area scores when comparing their overall knowledge on the management of a concussion (**Table 4.4.3**).

5.7 CONSEQUENCES OF CONCUSSION

Sustaining a concussion can have pronounced consequences for the involved athlete. Many of the serious consequences result from incidences where the concussion was not recognised, managed inappropriately or the athlete was cleared to RTP before the concussion has fully cleared (Guskiewicz et al., 2003; Standaert et al., 2007). However, other consequences are probable or even inevitable even though the concussion is managed appropriately. In order to respond appropriately to certain consequences and not mistaken it for something else than a consequence of concussion, a person should know what can be expected from an athlete who has sustained a concussion. The paramedics (50.1% ± 19.2%) had a significantly poorer average topic area score on the consequences of a concussion compared to both the coaches (62.1 ± 20.8%; $p = 0.006$) and doctors (66.5 ± 15.4%; $p = 0.002$). The knowledge of the coaches and doctors on the consequences of concussion was similar ($p = 0.390$) (**Table 4.4.4**).

5.7.1 Expected consequences of sustaining a concussion

When assessing the consequences of a concussion relating to the importance of recognising a concussion, 82.3% of the coaches, 69.2% of the paramedics and 85.0% of the doctors acknowledged that it is important to recognise a concussion since it will influence when the child can pay sport again. Furthermore, 72.5% of the coaches and 90.0% of the doctors thought it was important to recognise a concussion since a concussion may have an impact on a child's school work. Considering that primary school rugby coaches are also teachers, it is concerning that 27.5% of the coaches were unaware that a sustained concussion may influence a child's school work. As mentioned in Section 5.5, coaches who are also teachers are in the ideal position to inform their colleagues of the consequences of a concussion on a child's academic performance. However, the findings seem to suggest that many coaches did not have the knowledge to fully engage in this advisory role. Similar to the lack in knowledge on the cognitive management of a concussed child, the majority (51.3%) of the paramedics did not see the importance of recognising a concussion in order to anticipate that the child's school work may be impacted by the concussion and advice the child, his parents or his coach of this fact.

Considering that the majority of both the coaches and doctors did not know that the appropriate management of a concussed child entails that children should refrain from activities requiring concentration (**Table 4.4.3**), yet knew that a concussion may impact their school work (**Table 4.4.4**), suggest that both coaches and doctors think it is appropriate not to withheld a child from school work during recovery following a concussion, despite the possibility that their school work may be affected.

The gross lack in knowledge on all areas of concussion pertaining to cognitive factors among the paramedics, despite the fact that the majority paramedics received concussion-related information within the last 7 years prior to data collection, indicates that their training as health care providers are lacking or not aligned with the latest international consensus guidelines. On a more positive note, 98.0% of the coaches, 84.6% of the paramedics and 80.0% of the doctors acknowledged that a concussion should always be considered to be a serious injury which may cause long term problems. It is interesting and concerning to note that 20.0% of the doctors, being medically trained, did not see the importance of recognising a concussion as a serious injury which may have long term consequences.

5.7.2 Consequences of early Return to Play

When assessing the role players' knowledge on the possible consequences of a child playing to soon after suffering a concussion, 17.7% of the coaches, 38.5% of the paramedics and 15.0% of the doctors did not know that it may possibly result in death if another concussion were sustained. As indicated by Herring et al. (2006) and McCrory et al. (2009), this is essential knowledge for the safe management of a child who has sustained a concussion (Herring et al., 2006; McCrory et al., 2009). Failure to apply this essential knowledge consistently may have fatal consequences. It is therefore concerning that 15.0% of the doctors who should, by their own admission, be the person responsible to clear a child to RTP (**Table 4.4.5**) were not aware of the danger of clearing a child to RTP too soon.

Returning a concussed child to play too soon my result in a persistence of the concussion-related symptoms for a prolonged period of time (De Beaumont et al., 2007; De Beaumont et al., 2009; Guskiewicz et al., 2003; Iverson et al., 2004). Of the role players participating in this study, 11.8% of the coaches, 30.8% of the

paramedics and 15.0% of the doctors were unaware of this fact. In addition, 56.9% of the coaches, 69.3% of paramedics and 20.0% of doctors were unaware of the fact that a child who is returned to play too soon is at risk for performing poor at school (McGrath, 2010; McKinlay et al., 2010; McLeod & Gioia, 2010). Concussion may results in long term learning and personality problems (McKinley et al., 2002; McKinley et al., 2010), but 31.4% of the coaches, 46.2% of the paramedics and 25.0% of the doctors were unaware of this fact.

5.7.3 Second Impact Syndrome

Injury to the developing brain of a young athlete can be catastrophic (Herring et al., 2011). Failure to recognise concussion in the athlete can lead to serious sequelae. Although rare, Diffuse Cerebral Oedema or Second Impact Syndrome (SIS) is an acute brain swelling that may lead to death (Cantu & Gean, 2010) which typically occur in young athletes after receiving trauma to the head without having recovered from the previous concussion (Cobb & Battin, 2004). While the majority of role players knew what SIS was (**Table 4.4.4**), it is still concerning that substantial proportions of the coaches (28.4%), paramedics (41.0%) and doctors (20.0%) did not associate SIS with subsequent trauma in the presence of an unresolved concussion. This was also seen in a study among neurology and neurosurgeon resident doctors who did not recognise chronic traumatic encephalopathy or SIS as possible consequences of repetitive concussive injury (Boggild & Tator, 2012). Virtually no one knew that SIS is mostly seen in children under the age of 18 years (Cantu & Gean, 2010); 89.2% of the coaches, 89.7% of the paramedics and 100% of the doctors were unaware that SIS is more common in children.

5.8 RETURN TO PLAY

Most sport related concussions resolve within a few days or weeks (Guskiewicz et al., 2003; Iverson et al., 2006; McCrory et al., 2009). There are, however, patients in whom symptoms are prolonged for several weeks or months, particularly when the child has suffered from two or more concussive injuries (Covassin et al., 2008; Field et al., 2003; Moser et al., 2005). Following a concussion, all athletes should be withheld from physical exertion until they are asymptomatic at rest (Harmon et al., 2013; Herring et al., 2011; McCrory et al., 2009; Reddy & Collins, 2009). When the brain has recovered with no residual signs or symptoms of concussion, an athlete

may engage in a progressive five-step RTP protocol (**Table 2.4**) (Guskiewicz & Bruce, 2004; Harmon et al., 2013; Herring et al., 2011; McCrory et al., 2009).

5.8.1 Return to Play decision making responsibility

It is recommended that the final decision to clear a concussed athlete to RTP should rest with a doctor (Harmon et al., 2013; Herring et al., 2011; Scorza et al., 2012). American legislation goes as far as to make it mandatory for a concussed athlete to be cleared by a medical doctor before being allowed to RTP (Almasi & Wilson, 2012). In agreement with this recommendation, all the doctors from this study were of the opinion that a doctor should clear an athlete to RTP. This finding is encouraging since Boggild and Tator (2012) found that 24.0% of neurosurgery residents did not think it was necessary for an athlete to see a doctor following a concussion (Boggild & Tator, 2012). However, considering the findings from Ferrara et al (2001) who found doctors to make the final RTP decision in as little as 52.0% of concussed athletes, as well as the fact that 17.7% of the coaches and 15.4% of the paramedics from this study were of the opinion that the final decision to RTP should not lie with a doctor, it has to be acknowledged that the opinion of the doctors may not always be what happens in practice (Ferrara et al., 2001). This is also in agreement to literature where at least 2.5% of high school athletes were returned to play by their coach (Meehan et al., 2012). Unfortunately, many parents, coaches and athletes still underestimate the importance of a medically supervised recovery following a concussion (Halstead, 2010).

While the majority of coaches from this study (82.3%) agreed that a doctor should clear a concussed athlete to RTP, 7.8% of the coaches believed that the decision should rest with a psychologist while 9.8% believed that the decision should rest with the parent. While this is not in keeping with current RTP guidelines and the practice of deferring the final decision to RTP a concussed to a parent should not be advocated at all, it should be taken into consideration that the energy crisis in the concussed brain and its associated symptoms may not be seen for 2 to 3 days after the injury (Greve, 2009; Halstead & Walter, 2010). Consequently a child cleared by a doctor to RTP within the first 72 hours following trauma to the head should be monitored carefully for a delayed onset of symptoms. While coaches can assist with this monitoring process at school, an observant parent would be an important role player in the RTP decision making process (Patricios et al., 2013) since changes in a child's demeanour and behaviour may also be indicative of an unresolved

concussion (McClincy et al., 2006). Children with pre-existing mental health disorders should be monitored carefully by their parents since the signs and symptoms of a concussion is similar to those of depression, anxiety and attention deficit disorder (Collins et al., 2003; Kontos et al., 2004; McCrory et al., 2009). Concussive symptoms should be reported by involved adults such as teachers, coaches and parents since the vocabulary of children aged 5 to 12 years is inadequate to form a reliable clinical picture (Gioia et al., 2009). It is therefore recommended that parents be recognised as significant role players in the RTP process and be included in future research assessing role players' knowledge on concussion.

The coaches (68.9 ± 15.9%) and paramedics (64.1 ± 18.6%) had similar ($p = 0.189$) average topic area scores when comparing their general RTP knowledge (**Table 4.4.5**). However, the doctors (79.6 ± 10.8%) scored significantly better compared to both the coaches ($p = 0.002$) and paramedics ($p = 0.002$) on their general RTP knowledge, indicating that the final decision to clear a concussed athlete to RTP should rest with a doctor as stated in literature (Harmon et al., 2013; Herring et al., 2011; Scorza et al., 2012), preferabbly a doctor with sport-related concussion experience (Patricios et al., 2013).

5.8.2 Criteria for Return to Play

O'Donoghue et al (2009) noted in their study that 43.1% of the coaches stated that they thought "all athletes recover at the same rate" (O'Donoghue et al., 2009). Since a dearth of literature exists to inform child-specific concussion guidelines, conservative management is advised (Collins et al., 2003; Halstead & Walter, 2010; Kirkwood et al., 2006; McCrory et al., 2009; Meehan & Bachur, 2009; Purcell, 2009). Conservative treatment includes adhering to the recommended RTP guidelines from the most up to date international consensus statement with an extended asymptomatic period and rest compared to adults (McCrory et al., 2009). In this study, 60.8% of the coaches, 64.1% of the paramedics and 65.0% of the doctors were unknowing of the fact that children should not adhere to the same RTP guidelines compared to adults. Considering that children take longer to recover following a concussion and return to sport than adult rugby players (Purcell, 2009), the findings from this study imply that young athletes will very likely be cleared to RTP before full recovery has taken place. This is in agreement with Yard and Comstock (2009) who found that 20% to 40% of concussed high school athletes in

the USA returned to sport too early (Yard & Comstock, 2009). Taking into consideration that children are neurologically vulnerable for consequences such as SIS and PCS if a concussion has not cleared fully and subsequent trauma is sustained (Kontos et al., 2004), it is concerning that the coaches, paramedics as well as doctors in this study were going to return the concussed child to play before he was free of concussive symptoms. For a child still experiencing concussive symptoms at rest, 23.5% of the coaches, 23.1% of the paramedics and 30.0% of the doctors did not know that the child should not RTP (**Table 4.4.5**). For a child still experiencing concussive symptoms during activity, 27.4% of the coaches, 30.8% of the paramedics and 20.0% of the doctors were not aware that the child should not RTP (**Table 4.4.5**). This is in contrast to Ferrara et al (2001) who reported that 99.0% of the respondents in their study said that they would not return an athlete still experiencing post-concussive symptoms to play (Ferrara et al., 2001). Considering that doctors, by their own admission (**Table 4.4.5**), should make the final decision regarding the clearance of an athlete with a suspected or sustained concussion, yet indicate a lack in knowledge of safe RTP guidelines, the results raises concern for the safe RTP of a concussed child. However, it was interesting to note that all the doctors agreed not to clear an athlete to RTP when sketching a scenario where post-concussive symptoms were more vividly expressed (*following a rugby game, a player had no loss of consciousness but present with posttraumatic amnesia for 1 minute, and the following day he reported post-concussion symptoms but appeared normal on standardized methods of concussion recognition*). Further research should investigate this inconsistency in the findings among the doctors with regards to clearing a child to RTP as premature RTP can have serious adverse consequences in the child (Anderson et al., 2004; Anderson et al., 2005; Garon et al., 2008; Giza & Hovda, 2001; Lovell & Fazio, 2008; McKinlay et al., 2002; McKinlay et al., 2010).

Although the paramedics are not primarily responsible for RTP decision making, they are in the position to give advice regarding concussion to injured players or refer an athlete with a possible concussion to a doctor or not, based on their suspicion of a concussion. It is concerning that 30.8% of the paramedics did not know that a concussed rugby player should never RTP for the remainder of the day (McCrory et al., 2009). A lack in knowledge regarding the consensus that a concussed athlete should never RTP on the same day was also evident in 15.6% of the coaches and 20.0% of the doctors which raises concern that children, who are more vulnerable that adults to sustain SIS (Cantu & Gean, 2010), will also be

allowed to RTP on the same day following a concussion. While all of the doctors and 92.1% of the coaches agreed that a child should be cleared by a doctor and follow a graded RTP protocol before returning to play, 20.5% of the paramedics did not agree (**Table 4.4.5**). Interestingly, when being asked whether the participants think that a concussed child should be cleared by a doctor with sport-related concussion experience, more coaches (96.1% vs. 92.1%) and paramedics (97.4 vs. 79.5%) were of the opinion that this is appropriate practice. Interestingly, slightly less doctors (95.0% vs. 100.0%) thought that it was necessary that a doctor with sport-related concussion knowledge should clear a concussed child to RTP compared to the statement that a doctor per se should do so. This may possibly point to an underlying attitude among general practitioners who believe they have adequate knowledge to manage a concussed child and make appropriate RTP decisions to the same extent as a doctor with sport-related concussion experience. However, literature has indicated primary care physicians may not have sufficient insight and knowledge into current concussion management practices (Meehan et al., 2012). Therefore, considering that general practitioners play such a substantial role in RTP decision making, future research should investigate the perceived competence of general practitioners on concussion management and RTP guidelines with comparison to their actual knowledge on the latest concussion guidelines.

5.8.3 Role of neuropsychological testing within Return to Play

While the majority role players were aware of the fact that a normal brain scan does not exclude a concussion (Bazarian et al, 2006; Jagoda et al., 2008; McCrory et al., 2009), very few were aware of the role NP testing can play in the appropriate management and RTP decision making of a concussed child (**Table 4.4.3 and Table 4.4.5**). According to Theye and Mueller (2004), RTP decisions are primarily based on the experience of the team physician rather than objective evidence (Theye & Mueller, 2004). At present it is recommended that management and treatment of an athlete with concussion should be individualised and RTP decision be based on clinical judgement (McCrory et al., 2009). One of the aspects of individualised management of the concussed athlete involves the use of neuropsychological (NP) testing. NP testing can identify subtle cognitive impairments and assist monitoring of the recovery process (Makdisi et al., 2010; McCrory et al., 2009; Randolph et al., 2005). An individual pre-season neuropsychological profile is obtained for comparison with the post-concussion

profile. In order for an athlete to be cleared as being recovered, the post-concussion profile should be the same or better than the pre-season baseline (Moser et al., 2007). While neuropsychological testing is used as one of the corner-stones of RTP decisions (McCrory et al., 2009), it is seemingly not used in the KOSH area at the time of this research, evidenced by the fact that 60.8% of coaches, 64.1% of paramedics and 45.0% of doctors did not know what NP testing was. In a study by McCarthy and O'Hara (2010) among doctors in Connecticut, it was found that 74% of doctors were aware of neuropsychological testing, but only 30.0% utilized these tests (McCarthy & O'Hara, 2010). This is in agreement with other literature where only 33.4% of participants reported using a computerized neuropsychological test battery (Covassin et al., 2009) and only 16.0% of doctors had access to NP testing within the first week of a patient presenting with a concussion (Pleacher & Dexter, 2006). Although there are currently no NP testing protocol specifically standardised for primary school children, NP testing is still valuable when using normative age-matched data to assist interpretation of the results (Grady, 2010; Makdissi et al., 2001). Informing school principals and coaches regarding this helpful tool could assist in the detection and monitoring of the child recovering from a concussion. The financial costs, time and energy associated with NP testing in children have been questioned in the past (Kirkwood et al., 2009). However, until research has proven otherwise, it is advised that NP testing be used in accordance to the Zurich consensus statement, despite the financial and other logistical implications where possible.

One doctor reported to use other concussion assessment tools (e.g. Cantu Grading System for Concussion or American Academy of Neurology (AAN) while three doctors used the Sport Concussion Assessment Tool 2 (SCAT 2) for RTP decisions. There were also three doctors that used head CT or MRI scans as the method they rely on most to inform their decision regarding RTP following a concussion. However, head CT or MRI scans are not reliable methods to rule out or gage the severity of a concussion (Atabaki & Stiell, 2008; Herring et al., 2011; Jagoda et al., 2008; McCrory et al., 2009) since a negative scan cannot rule out an axonal injury associated with acute cognitive and motor difficulties following a concussion (Bazarian et al., 2006; Jagoda et al., 2008).

5.9 ESSENTIAL CONCUSSION-RELATED KNOWLEDGE

Although inferences made from literature regarding the knowledge viewed as being *essential* for safe practice are aimed specifically towards doctors (Herring et al., 2006; McCrory et al., 2009), the coaches' and paramedics' data were also evaluated further to see how much of this essential knowledge they possessed, given that they are often the persons responsible for medical decision making next to the rugby field (**Figures 4.1.5 and 4.2.4**). As far as could be established, no guidelines exist in literature to indicate how much of the essential knowledge a person should possess. However, considering that even the smallest gap in knowledge may result in misdiagnosis or mismanagement of a concussion, a score below 75.0% were considered as an indication of a clear lack in essential knowledge while interpreting the data from this study. Only a score of 100% were considered to be indicative of having adequate knowledge for consistently safe practice. Unfortunately, there is a dearth in comparative literature on the essential knowledge of potential role players to assist interpretation of the data from this study.

5.9.1 Essential knowledge for concussion recognition

Regarding the essential knowledge needed for the recognition of a concussion, 15.7% of the coaches, 2.6% of the paramedics and none of the doctors scored below 50.0%. A more even distribution of 25.5% of coaches, 25.6% of paramedics and 20.0% of doctors were noted for those who scored 50 to 74% for their essential knowledge on the recognition of a concussion. The fact that only 58.8% of coaches, 71.8% of paramedics and 80.0% of doctors scored above 75%, together with the fact that none of the participants were able to score 100% for their essential concussion recognition is indicative of an incomplete knowledge among all role players which will, almost inevitably, lead to a misdiagnoses concussion at some stage. Contrary to expectation, there were no relationships between the time since the coaches last received concussion-related information ($p = 0.379$) or the training they received ($p = 0.114$) with their essential knowledge on concussion recognition. These findings imply that the contents of the available concussion training programmes are inadequate to train the attendees on the essential knowledge needed to be able to recognise a concussion, or attendees do not retain the information and should be investigated in future research.

There was a strong positive relationship between the coaches' level of experience in coaching rugby (p = 0.002) and their essential knowledge to be able to recognise a concussion. This is in contrast to literature (Saunders et al., 2013) which found no relationship between the number of years a person has been coaching and their ability to correctly identify the signs and symptoms needed to recognise a concussion.

There were no relationships between the coaches' concussion-related training received (p = 0.114) or the amount of time they are responsible for managing medical emergencies next to the rugby field (p = 0.608) and their essential knowledge needed to recognise a concussion, which is in agreement with the findings of Saunders et al. (2013). When considering this items regarded as essential knowledge on the recognition of concussion, the coaches scored significantly worse compared to both the paramedics (p = 0.024) and doctors (p = 0.008), while there were no difference in the essential knowledge between the paramedics and doctors (p = 0.523).

5.9.2 Essential knowledge for concussion management

With regards to the questions that are considered to be essential knowledge on appropriate concussion management, 11.8% of coaches, 12.8% of paramedics and none of the doctors scored below 50.0%. A substantial proportion of participants still displayed a lack in knowledge on concussion management with 23.5% of coaches, 38.8% of paramedics and 45.0% of doctors scoring between 50.0 and 75.0%. Only 64.7% of coaches, 48.7% of paramedics and 55.0% of doctors scored above 75.0%, of which only 8 (15.7%) of the coaches, 3 (7.7%) of the paramedics and a single (5.0%) doctor scored 100% for the essential knowledge needed on concussion management. There were no significant relationships between the coaches' level of experience in coaching rugby (p = 0.230), the time since the last concussion related information received (p = 0.102), the type of training they received (p = 0.604) or their medical responsibility next to the rugby field (p = 0.788) with their essential knowledge on the management of a concussion. There was also no significant difference between the essential knowledge (p = 0.177) of coaches, paramedics and doctors on the management of concussion.

5.9.3 Essential knowledge on consequences of a concussion

As seen in **Table 4.4.4**, all the questions relating to the consequences of concussion are considered to be essential knowledge (Herring et al., 2006; McCrory et al., 2009). Of a potential 100% given all the essential knowledge questions regarding the consequences of a concussion were answered correctly, 19.6% of coaches, 43.6% of paramedics and 10.0% of doctors scored below 50%. Taking this, together with the fact that 52.9% of coaches, 46.2% of paramedics and 45.0% of doctors scored between 50.0 and 75.0%, it is clear that a substantial proportion of participants had a lack in essential knowledge on the consequences of a concussion. From the 27.5% of coaches, 10.2 % of paramedics and 45.0% of doctors who scored above 75.0%, only two (3.9%) of coaches were able to score 100% for their essential knowledge on the consequences of a concussion. The paramedics' knowledge on the consequences of concussion were significantly poorer compared to both the coaches ($p = 0.006$) as well as doctors ($p = 0.002$), while the knowledge of the coaches and doctors on the consequences of concussion were similar ($p = 0.390$).

5.9.4 Essential knowledge on Return to Play guidelines

Regarding the essential knowledge on appropriate RTP guidelines for the safe RTP of a previously concussed child, 13.7% of the coaches, 35.9% of the paramedics and none of the doctors scored below 50.0%, while 41.2% of the coaches, 30.8% of the paramedics and 35.0% of the doctors scored between 50.0 and 75.0%. Only 45.0% of the coaches, 33.3% of the paramedics and 65.0% of the doctors scored above 75.0% for their essential knowledge on RTP guidelines following a concussion. Only a single coach (1.9%), two paramedics (5.1%) and 2 doctors (10.0%) were able to score 100.0% and be considered to have adequate knowledge to safely RTP a concussed child.

There were no significant relationships between the coaches' level of experience in coaching rugby ($p = 0.334$), the time since they last received concussion-related information ($p = 0.453$), the concussion training they received ($p = 0.423$) or their medical responsibility next to the rugby field ($p = 0.261$) with their essential knowledge on the appropriate RTP guidelines for a concussed players. Doctors scored significantly better compared to both the coaches ($p = 0.007$) and

paramedics (p = 0.003) on their essential knowledge on RTP guidelines for a concussed child.

5.9.5 Overall essential knowledge

The only variable to show a relationship with the coaches' overall essential knowledge score was their experience in coaching rugby. Considering that there were no relationships between the time since the coaches had their last concussion-related training or the training they received with their overall essential knowledge score, the findings from this study imply that coaching experience is the single most important determinant for the essential knowledge on concussion in coaches, evidenced by the strong relationship (p = 0.001) between the amount of years they have been coaching rugby and their overall essential knowledge score.

Although the coaches and paramedics often had comparable scores to the doctors in general knowledge on various topic areas relating to concussion, the doctors scored significantly better compared to both the coaches (p = 0.023) and paramedics (p = 0.002) when isolating the items regarded as being essential knowledge for the safe recognition, management and RTP decision making of a concussed child, including knowledge on the consequences of a sustained concussion as a whole. It is clear that very few coaches did not have a lack in essential knowledge needed for safe practice when dealing with a concussed child. This may potentially be attributed to an acknowledged problem with the dissemination of concussion guidelines to the end-users dealing with concussed athletes (Patricios et al., 2013). A possible reason for this problematic dissemination of knowledge may be the tendency that updated concussion guidelines are specifically distributed throughout the Sports Medicine literature, and not as widely published in journals more commonly read by general practitioners (Meehan et al., 2011).

The fact that only 39.2% of coaches, 33.3% of paramedics and 66.7% of doctors scored more the 75.0% on their overall essential knowledge highlight a pronounced disparity between what is considered to be essential knowledge (Herring et al., 2006; Herring et al., 2011; McCrory et al., 2009) and what role players generally knew on the topic of concussion. By implication the findings from this study indicates that children suffering from a concussion may be at risk for receiving

inappropriate or insufficient medical care when sustaining a concussion which, in summary, is the most noteworthy finding from this study.

CHAPTER 6
CONCLUSION

6.1 INTRODUCTION

Children often engage in collisions sports such as rugby which, by its nature, has a higher incidence of concussions (Browne & Lam, 2006). The management of concussion has changed inarguably in the past decade, evidenced by the international interest among the medical community to reach consensus on the appropriate management of concussions among children. While the majority of concussion-related research to date has focussed on the recognition, management and Return to Play (RTP) trends within the adult athlete community, very little research has been done among concussion in children and the role players involved with potentially concussed children athletes. As far as could be established, no research to date has been done to assess the concussion knowledge of different role players involved with primary school rugby players in South Africa. Therefore, this study aimed to assess the concussion knowledge of primary school rugby coaches, paramedics and doctors in the Klerksdorp, Orkney, Stilfontein and Hartbeesfonten (KOSH) area.

6.2 LIMITATIONS OF THE STUDY

Limitations of the study included the small number of participants, especially for the paramedics and doctors. In order to preserve statistical power and avoid Type 2 errors due to small sample sizes, differences and relationships where further division of sub-categories were needed were not determined for the paramedics and doctors. Consequently, relationships between different demographic, concussion training and medical responsibility profiles with the participants' knowledge in different areas of concussion were only determined for the coaches. In addition, the small number of paramedics and doctors called for pronounced differences between the three groups of role players to exist for statistically significant differences to emerge. While every care was taken to limit possible measurement errors, the possible role of recall bias during completion of the self-administered questionnaire cannot be excluded. Since this study was restricted to role players in the North West Province, its results should be generalised to other regions with caution.

6.3 CONCLUDING REMARKS AND RECOMMENDATIONS

Within the limitations of this study, the data seem to suggest coaches are generally the most senior person responsible for medical decision making next to the primary school rugby field. A mere 20.0% of the coaches reported that they were never responsible for medical emergencies at a rugby game. Future research should investigate which factors determine the availability of medical support next to the primary school rugby field in order to identify possible modifiable factors which will be in the best interest of the rugby playing child.

Considering that primary school rugby coaches are also teachers, the general lack in knowledge on the effect of a concussion on a child's school work raises concerns that the coaches do not have the necessary knowledge to give accurate advice to their fellow teachers regarding the gradual return of a concussed child to exposure to academic and cognitive stressors. The results seems to imply that both coaches and doctors think it is appropriate not to withheld a child from schoolwork during recovery from a concussion, despite the possibility that their school work may be affected by the lack in cognitive rest. The knowledge of the paramedics on all areas of concussion pertaining to cognitive factors were clearly lacking, possibly indicating that their training as health care providers are not aligned with the latest international consensus guidelines. It is therefore advised that future intervention programmes aimed towards the improvement of role players' concussion knowledge with specific focus on the cognitive aspects of concussion management.

Even though the vast majority of coaches and paramedics, and all the doctors were of the opinion that a doctor should be the person responsible for the RTP decision making, the doctors were not aware of the dangers of clearing a child to RTP too soon and the role of NP testing in the RTP decision making process. Interestingly, an increased number of coaches and paramedics indicated that a child should be cleared by a doctor with sport-related concussion experience, compared to a small decrease in numbers of the doctors who thought this was necessary. This may potentially point to an underlying attitude among general practitioners who believe they have adequate knowledge to manage a concussed child and make appropriate RTP decisions to the same extent as a doctor with sport-related concussion experience such as a sports physician. Considering that general practitioners play a substantial role in RTP decision making, future research should investigate the perceived competence of general practitioners on concussion management and

RTP guidelines with comparison to their actual knowledge on the latest concussion guidelines. While the majority of coaches agreed that a doctor should clear a concussed athlete to RTP, 9.8% of coaches were of the opinion that this decision should rest with the parent. While this is not in keeping with current RTP guidelines and should not be advocated, the role of parents in the monitoring process following a concussion and communication with the doctor to inform the RTP decision should not be underestimated. It is recommended that future research include parents as significant role players assessing role players' knowledge on concussion.

It was concerning to note that a considerable proportion of coaches, paramedics and doctors were unaware of the fact that a child should be free from concussive symptoms not only during physical activity, but also at rest. The results from this study suggested that concussed children will very likely be cleared to RTP before full recovery has taken place. Considering that doctors, by their own admission, should make the final decision regarding the clearance of a concussed child to RTP, yet display a lack in knowledge on safe RTP guidelines, the results raise concerns regarding the safe RTP of a concussed child. Interestingly, when sketching a scenario where post-concussive symptoms were more vividly expressed, all the doctors agreed that they would not clear the athlete to RTP. Possible reasons for this inconsistency in findings remain unclear and should be investigated in future research as premature RTP can have serious adverse consequences in the child.

The role of concussion assessment tools within the management and RTP decision making process is clearly a foreign concept among all role players participating in this research. Despite being readily available at no cost, virtually none of the participants used the Sport Concussion Assessment Tool (SCAT2) when assessing an athlete for potential signs and symptoms indicative of a concussion. Interestingly, there were a few participants who acknowledged that they were familiar with this tool but did not use it, suggesting that attitudes towards such tools may be an underlying factor for the disuse of concussion assessment tools such as the SCAT2. Future research should investigate why coaches, having had *BokSmart* training (which addresses the issue of rugby safety from different angles such as appropriate technique, prevention and treatment), are reluctant to use concussion assessment tools with the view of informing intervention programmes aimed at equipping role players with whatever means will assist their accurate evaluation of a possible concussion.

Contrary to expectation, there was no relationship with the coaches' knowledge on any of the concussion topics or as a whole with the time since coaches last received concussion-related information. In addition, there was no relationship with the coaches' knowledge on any of the concussion topics or as a whole and whether they attended a recognised training programme such as *BokSmart*. This brings into question the efficacy of available programmes such as *BokSmart* and raises suspicion that the coaches attend these programmes with the intention of becoming certified without retaining or applying the information. Further research is recommended to assess how much information is retained by comparing pre- and post-workshop knowledge among coaches attending the *BokSmart* training. The only variable to have any predictive value on the concussion knowledge of coaches, were the amount of years they have been coaching rugby, evidenced by the strong relationships found between their coaching experience and their knowledge on concussion recognition and overall essential knowledge needed for safe practice.

A couple of misconceptions were noted among the participants, the most pronounced being the belief that a concussion has to be accompanied by a loss in consciousness, that a child is not at risk for sustaining a concussion when engaging in leisure activities and the belief that headgear protects a player against a concussion. The latter was true especially among the coaches, raising concerns that coaches may have a false sense of security when their players wear headgear and receive a blow to the head, thinking that the child were protected by the headgear and not considering a possible concussion. Considering that concussion education is one of the most effective ways to prevent concussion, it is concerning to see that 60.8% of the coaches were not *BokSmart* certified at the time of data collection which is a direct violation of the rules set out by the South African Rugby Union. Further research should investigate adherence to the requirement that all rugby coaches should be *BokSmart* certified at a national level to inform appropriate interventions.

It became clear that Continuous Medical Education (CME) meetings are an important avenue to disseminate concussion related information to general practitioners. It is advised that these meetings should be targeted by *BokSmart* as a focus point to deliver concussion information to health care workers who are probably more likely to attend CME meetings than voluntary attending the *BokSmart* training.

More than a third of the doctors indicated that they do not think it is necessary to inform a child's parent(s) if the child has sustained a concussion, indicating a lack in knowledge on the appropriate management of a concussed child. This reluctance to inform the parents may potentially indicate a misconception among the doctors regarding their responsibility relating to patient confidentiality, or expose a lack in knowledge and understanding of the need for continuous monitoring of a concussed child by significant role players closest to the concussed child. Further research into the attitudes of doctors on the view of parents as significant role players closest to the concussed child should be done with the aim of exposing a possible lack in knowledge on the appropriate management of the concussed child and inform future intervention programmes.

The coaches, paramedics and doctors had similar average scores on their general concussion-related knowledge pertaining to the signs and symptoms of a concussion, the management of a concussion and the prevention of concussion. The paramedics scored significantly poorer on their general knowledge pertaining to the consequences of a concussion, while the doctors scored significantly better on their general knowledge on RTP guidelines following a concussion. However, when isolating the items that are considered to be essential knowledge in the safe practice of dealing with concussed children, the only item to show no difference between any of the role players was the essential knowledge on concussion management. The coaches scored significantly worse on the essential knowledge on signs and symptoms needed for the recognition of a concussion, the paramedics scored significantly worse on the essential knowledge on the consequences of a concussion, and doctors scored significantly better on the essential knowledge on RTP guidelines. Despite the fact that the doctors scored significantly better compared to the coaches and paramedics on their overall essential knowledge score (all of the essential knowledge items combined), very few doctors did not present with considerable gaps in their essential knowledge needed for safe practice when dealing with a concussed child. These findings highlight a pronounced disparity between what is considered to be essential knowledge and what role players generally knew on the topic of concussion. By implication the findings from this study indicates that children suffering from a concussion may be at risk for receiving inappropriate or insufficient medical care when sustaining a concussion which, in summary, is the most noteworthy finding from this study. These findings should be communicated to sport governing bodies such as SA Rugby as well as governing bodies of other contact sports, and further research should be undertaken

to address the lack in knowledge among role players potentially dealing with concussed athletes as a matter of urgency.

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APPENDIX A

DEPARTMENT OF EDUCATION APPROVAL LETTER

education
Lefapha la Thuto
Onderwys Departement
Department of Education
NORTH WEST PROVINCE

Alabama Secondary School Hostel
1 Nieuwenhoudt Street,
Alabama 2577
Klerksdorp
Private Bag A23, Klerksdorp
Tel. No.: (018) 467-9300
Fax No.: (018) 467-9309
e:mail: mot@lantic.net

DR KENNETH KAUNDA DISTRICT

MATLOSANA AREA OFFICE

TO : **PRINCIPALS OF PRIMARY SCHOOLS**

FROM: **MATLOSANA AREA MANAGER**

DATE : **28 JULY 2010**

SUBJECT: **PERMISSION GRANTED TO TAKE PART IN A SURVEY**

Hereby permission were granted to take part in the survey of M Jansen van Rensburg, if you choose to do so.

The study title is '**Concussion knowledge and practice among role players in primary school rugby in the North West Province.**'

This permission is granted under the following conditions:

- That no teaching time will be used
- That it must be kept confidential
- That participation is voluntary

Yours faithfully

DR SP VAN DER LITH
CM –JC MOTAUNG

"Together, through Education, doing more, better!"

education
Department of Education
FREE STATE PROVINCE

Enquiries: Mafimane M
Reference: 1814/1/M4-2010
Tel: 051 404 8662
Fax: 051 447 7318
E-mail: mafimane@edu.fs.gov.za

2010 -- 09 – 28

DR. M JANSEN VAN RENSBURG
UNIVERSITY OF THE FREE STATE
BLOEMFONTEIN

Dear Dr Van Rensburg

REGISTRATION OF RESEARCH PROJECT

1 This letter is in reply to your application for the registration of your research project.

2 Research topic: **Concussion knowledge and practice among role players in primary school rugby.**

3 Your research project has been registered with the Free State Education Department.

4 Approval is granted under the following conditions:-

4.1 Educators who are rugby coaches participate voluntarily in the project.

4.2 The names of the participants and the schools involved remain confidential.

4.3 The questionnaires are completed and the interviews are conducted outside normal tuition time.

4.4 This letter is shown to all participating persons.

4.5 A bound copy of the report and a summary on a computer disc on this study is donated to the Free State Department of Education

4.6 Findings and recommendations are presented to relevant officials in the Department

5 The costs relating to all the conditions mentioned above are your own responsibility.

6. **You are requested to confirm acceptance of the above conditions in writing to:**

The Head: Education, for attention: DIRECTOR : QUALITY ASSURANCE
Room 401, Syfrets Building, Private Bag X20565, BLOEMFONTEIN, 9301

We wish you every success with your research.

Yours sincerely

FR SELLO
DIRECTOR: QUALITY ASSURANCE

Directorate: Quality Assurance, Private Bag X20565 Bloemfontein 9300
Syfrets Center, 65 Maitland Street, Bloemfontein
Tel: 051 404 8750 / Fax: 051 447 7318 E-mail: quality@edu.fs.gov.za

education
Department of Education
FREE STATE PROVINCE

Enquiries : IM Malimane
Reference no. : 16/4/1/44-2010

Tel: 0814048662
Fax: 051 4477318

2010-09-28

Mr MJ MOTHEBE
Director: Motheo Education District
Room 413
Jubilee Building
Bloemfontein

Dear Mr Mothebe

NOTIFICATION OF A RESEARCH PROJECT IN YOUR DISTRICT

Please find attached copy of the letter giving **DR. M JANSEN VAN RENSBURG** permission to conduct research in a sampled school in the Motheo Education District. Dr. MJ Van Rensburg is an M. Sports Medicine student at the University of the Free State.

Yours sincerely

FR/SELLO
DIRECTOR: QUALITY ASSURANCE

Directorate: Quality Assurance
Private Bag X20565, Bloemfontein, 9300
Sylvia Center, 65 Maitland Street, Bloemfontein
Tel: 051 404 8750 / Fax: 051 447 7318
E-mail: quality@edu.fs.gov.za
www.fs.gov.za

APPENDIX B

ETHICAL APPROVAL BY THE ETHICS COMMITTEE, FACULTY OF HEALTH SCIENCES, UNIVERSITY OF THE FREE STATE

UNIVERSITEIT VAN DIE VRYSTAAT
UNIVERSITY OF THE FREE STATE
YUNIVESITHI YA FREISTATA

Direkteur: Fakulteitsadministrasie / Director: Faculty Administration
Fakulteit Gesondheidswetenskappe / Faculty of Health Sciences

Research Division
Internal Post Box G40
☎(051) 4052812
Fax (051) 4444359

E-mail address: StraussHS@ufs.ac.za

Ms H Strauss

2010-06-10

DR M JANSEN VAN RENSBURG
SPORTS MEDICINE
UFS

REC Reference number: REC-230408-011

Dear Dr Jansen van Rensburg

ETOVS NR 90/2010
PROJECT TITLE: CONCUSSION KNOWLEDGE AND PRACTICE AMONG ROLE PLAYERS IN PRIMARY SCHOOL RUGBY IN THE NORTH WEST PROVINCE.

.

- You are hereby kindly informed that the Ethics Committee approved the above study at the meeting held on 8 June 2010 on condition that:

a) Permission letters received from the authorities have to be submitted to the Ethics Committee.

b) Permission letter received from the Dept of Education in the Free State has to be submitted to the Ethics Committee.

- Committee guidance documents: Declaration of Helsinki, ICH, GCP and MRC Guidelines on Bio Medical Research. Clinical Trial Guidelines 2000 Department of Health RSA; Ethics in Health Research: Principles Structure and Processes Department of Health RSA 2004; Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa, Second Edition (2006); the Constitution of the Ethics Committee of the Faculty of Health Sciences and the Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines.

- Any amendment, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

- The Committee must be informed of any serious adverse event and/or termination of the study.

- A progress report should be submitted within one year of approval of long term studies and a final report at completion of both short term and long term studies.

339, Bloemfontein 9300,RSA ☎ (051) 405 2812 StraussHS.md@ufs.ac.za
Republiek van Suid-Afrika / Republic of South Africa

APPENDIX C

SURVEY COVER LETTER

22 May 2010

To whom it may concern

I am a medical doctor and second year Masters Student (Student no. 2004137812) at the Department of Sports Medicine, University of the Free State. I am planning to conduct a research study to determine the knowledge and common practice regarding concussion of role players involved with primary school rugby players.

Thank you for the opportunity to present my envisaged research project for ethical approval. Please find attached my protocol and accompanying documentation to apply for ethical approval for my research study titled:

"Concussion knowledge and practice among role players in primary school rugby in the North West Province"

The role players include coaches, first aid personnel and general practitioners involved in primary school rugby.

I trust you'll find everything in order, but please do not hesitate to contact me immediately should you need any clarification or additional information.

Sincerely yours

Dr Magrietha Jansen van Rensburg
MBChB (Pret)
BSc Hons (Pharm) (PU vir CHO)
Dipl Child Health (SA)
Dipl Obestetrics (SA)
Dipl Family Medicine (Pret)
MBA (UFS)
Dipl Mental Health (SA)

PO Box 10576
Klerksdorp
2570
Tel. 072 334 0637

APPENDIX D(i)

INFORMATION SHEET / INFORMED CONSENT / SURVEY COACHES

UNIVERSITEIT VAN DIE VRYSTAAT
UNIVERSITY OF THE FREE STATE
YUNIVERSITHI YA FREISTATA

339 BLOEMFONTEIN 9300 REPUBLIEK VAN SUID-AFRIKA/REPUBLIC OF SOUTH AFRICA
REPHABLIKE YA AFRIKA BORWA

Please note that by completing this questionnaire you are voluntarily agreeing to participate in this research study. You will remain anonymous and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the questionnaire.

Questionnaire for Coaches

"Concussion knowledge and practice among role players in primary school rugby in the North West Province."

Dear Sir

Thank you for agreeing to partake in this research project. Your input is very valuable to us and therefore much appreciated. This questionnaire should take you no longer than 30 minutes to complete.

Please take your time to read the instructions appearing throughout the questionnaire, which will appear as bold, Italics text. It is of utmost importance that you answer all 30 questions as honestly as possible without taking any guesses.

When you have completed the questionnaire, please return it to the person who handed it to you immediately.

Thank you kindly

FOR THE FOLLOWING PART A (QUESTION 1 TO 18), PLEASE <u>TICK ONLY ONE</u> ANSWER AND COMPLETE FURTHER WHERE APPROPRIATE.

Symptom = indication or sign of disease

<u>Office use only</u>

<u>Question 1</u> ☐ 1

A concussion is:

a. ☐ An injury to the spinal cord
b. ☐ An injury to the brain
c. ☐ A scalp injury
d. ☐ I'm not sure

<u>Question 2</u> ☐ 2

Concerning the Sport Concussion Assessment Tool (SCAT):

a. ☐ I've never heard of it
b. ☐ I've heard of it but am not really familiar with it
c. ☐ I'm familiar with it but have never used it
d. ☐ I usually don't have it with me to be able to use it
e. ☐ I always have it ready and use it whenever I suspect a concussion

<u>Question 3</u> ☐ 3

A player has to lose consciousness to have a concussion:

a. ☐ Yes, for at least 5 seconds
b. ☐ Yes, for at least 1 minute
c. ☐ No, a player does not have to lose consciousness
d. ☐ I'm not sure

<u>Question 4</u>

A normal brain scan after a concussive injury means: ☐ 4

a. ☐ The child has no concussion and may return to sport
b. ☐ There is no skull fracture and so it is safe to play.
c. ☐ You no longer need to follow up with a doctor
d. ☐ The child still may have a concussion – a normal brain scan does not exclude a concussion

Office use only

Question 5 ☐ 5

In which phase of play does a concussion most often occur?

a. ☐ In a scrum
b. ☐ In a lineout
c. ☐ In a tackle
d. ☐ In a maul
e. ☐ In a ruck

Question 6 ☐ 6

If a child hits his head severely during a rugby game he should:

a. ☐ Keep playing, if he is feeling okay, but tell the coach afterwards
b. ☐ Doesn't need to tell anyone, given that he is feeling okay
c. ☐ Stop playing as soon as the ball is dead, the whistle blows and then tell the coach
d. ☐ Stop playing immediately (irrespective of how he feels) and tell the coach

Question 7 ☐ 7

When a child had a severe blow to the head, is it okay to continue playing?

a. ☐ Yes, as long as the player is careful
b. ☐ It depends on how important the upcoming game is
c. ☐ No, the player shouldn't continue playing at all for the rest of the day
d. ☐ He should rest a while, and if he feels better, he can play again
e. ☐ If he did not lose consciousness he can continue playing

Office use only

Question 8

An adult professional rugby player can return to play after a concussion: 8

a. For the same game, as long as he knows who he is
b. For the same game, as long as he has been assessed and cleared by someone medically trained
c. Once he has been assessed by a doctor and cleared, but never on the same day
d. If he only has a mild headache
e. For the next game, as long as it's at least 2 days later

Question 9

If a child has sustained a concussion, he can return to play after a concussion: 9

a. Immediately, as long as he knows who he is and what day it is
b. Within the same game, as long as he has been assessed and cleared by someone medically trained
c. On the same day, if he has been assessed by a doctor and cleared
d. If his headache is not bad enough to complain about the whole time
e. For the next game, as long as it is at least 2 days later
f. After he has been cleared by a doctor and has followed a graded return to play protocol.

Question10

Should players of all ages adhere to the same return to play guidelines? 10

a. Yes, everybody recovers at the same rate.
b. Yes, primary school rugby is just as important as adult rugby.
c. No, children take longer to return to sport than other rugby players.
d. No, professional players take longer to return than other players.

Office use only

Question 11

When should a child's parents be contacted following a severe blow to the head? 11

a. ☐ If the coach thinks the player needs to see a doctor
b. ☐ Not needed, the child will tell their parents himself
c. ☐ After the player has been cleared to return by medical personnel
d. ☐ When it is suspected that a player has a concussion

Question 12

Which activities should a player NOT participate in if they are still showing sport-related concussion symptoms? 12

a. ☐ Any level of sport activity related to competition sport
b. ☐ Competitions
c. ☐ Practice
d. ☐ Warm-up
e. ☐ Any level of sport activity including playing during school break

Question 13

The decision to return a child to sport after a concussion should rest with: 13

a. ☐ The coach
b. ☐ A neuropsychologist/psychologist
c. ☐ A doctor
d. ☐ The parents

Question 14

A helmet prevents a rugby player from getting a concussion: 14

a. ☐ Yes, it completely protects a player
b. ☐ No, it does not protect a player
c. ☐ It helps, but doesn't completely prevent one
d. ☐ No, it may even encourage risky behaviour in players

Office use only

Question 15

Which of the following puts a rugby player at risk to experience a concussion? 15

a. ☐ Having a poor sense of balance
b. ☐ Having had a previous sport-related concussion
c. ☐ Suffering from asthma
d. ☐ Participating in preseason exercise

Question 16

Neuropsychological testing (NP testing) is: 16

a. ☐ A test to determine the school readiness of a child
b. ☐ A test that allows comparison between pre- and post-concussion performance
c. ☐ A test to provide a clear picture of the psychological state of a child
d. ☐ All of the above

Question 17

What is the most effective way to reduce the risk of sport related concussions? 17

a. ☐ Being educated about concussion
b. ☐ Developing strong neck muscles in rugby players
c. ☐ Having injured players attend workshops about concussion
d. ☐ Proper stretching before and after exercise

Question 18

Have you ever been asked by a school to provide information to rugby coaches on concussion prevention and management? 18

a. ☐ Yes
b. ☐ No

Office use only

FOR THE FOLLOWING PART B (QUESTIONS 19 TO 25), PLEASE CHOOSE AND TICK <u>ALL</u> THE ANSWERS THAT APPLY

<u>Question 19</u>

Is it important to recognise concussion in paediatric rugby players?

a.	☐	No, it is not very important because concussion is a minor injury	☐	19
b.	☐	Yes. It will influence when the child can play sports again	☐	20
c.	☐	Yes. It may have an impact on the child's school work	☐	21
d.	☐	Yes. It is always a serious injury that may cause long-term problems	☐	22
e.	☐	It is not important at all. Concussion is part of rugby	☐	23

<u>Question 20</u>

Which sign(s) may indicate that a child's concussion is getting worse?

a.	☐	If his reaction time is getting slower	☐	24
b.	☐	He is getting thirsty	☐	25
c.	☐	Behaves unusually or seems confused and irritable	☐	26
d.	☐	Clammy skin	☐	27
e.	☐	A headache that is getting worse	☐	28
f.	☐	If he complains about feeling sleepy all the time	☐	29

<u>Question 21</u>

The risks of a child playing too soon after suffering a concussion include:

a.	☐	Death from a second blow to the head	☐	30
b.	☐	Persistence of concussion-related symptoms for a longer period	☐	31
c.	☐	Poor performance in class	☐	32
d.	☐	Concussion may result in long-term learning and personality problems	☐	33

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Question 22

Regarding Second Impact Syndrome:

a.	☐	It usually follows after a first concussion	☐	34
b.	☐	Is mostly seen in children under the age of 18 years	☐	35
c.	☐	Follows after a second blow on the head if the previous concussion has not resolved	☐	36
d.	☐	May lead to brain oedema and death	☐	37

Question 23

The following are signs and symptoms of concussion:

a.	☐	Headache	☐	38
b.	☐	Difficulty with urination	☐	39
c.	☐	Lowered pulse rate	☐	40
d.	☐	Feeling dazed or in a “fog”	☐	41
e.	☐	Difficulty falling asleep	☐	42
f.	☐	Difficulty concentrating	☐	43
g.	☐	Convulsions	☐	44
h.	☐	Inability to describe time and place	☐	45
i.	☐	Feelings of euphoria	☐	46
j.	☐	Chest pain	☐	47
k.	☐	Difficulty with memory	☐	48
l.	☐	Increased emotion/irritability	☐	49

Question 24

Before returning to play following a concussion a child should meet which of the following criteria?

a.	☐	Cleared by a doctor with sport-related concussion experience	☐	50
b.	☐	Be able to pass a classroom test	☐	51
c.	☐	Be free of concussion symptoms (e.g. dizziness) during rest	☐	52
d.	☐	Have had a brain scan	☐	53
e.	☐	Given prescribed medication	☐	54
f.	☐	Be free of concussion symptoms (e.g. dizziness) during activity	☐	55

			Office use only	
		Question 25 Which of the following activities can a child do when still being treated for concussion?		
a.		Watch television and play computer games, as long as they keep still		56
b.		Go back to playing rugby		57
c.		Participate in non-contact sport		58
d.		Refrain from any physical activity		59
e.		Refrain from any activity requiring concentration		60

FOR THE FOLLOWING PART C (QUESTION 26 TO 30), PLEASE <u>TICK ONLY ONE</u> ANSWER AND COMPLETE FURTHER WHERE APPROPRIATE.

<u>Office use only</u>

<u>Question 26</u>

When was the last time you received ***<u>information</u>*** regarding sports-related concussion? | 61

a. ☐ Less than a year ago
b. ☐ 1 year ago
c. ☐ Between 2 and 3 years ago
d. ☐ Between 4 and 7 years ago
e. ☐ Between 8 and 9 years ago
f. ☐ Longer than 10 years ago

<u>Question 27</u>

a. Have you ever received any ***<u>training</u>*** regarding concussion before? | 62

☐ Yes
☐ No

b. If "Yes", what level? _____ | 63-64

_____

c. If "Yes", how long ago? _____ Years _____ Months | 65-66

d. If "Yes", was it a recognised programme e.g. BokSmart? | 67

☐ Yes
☐ No

e. Which one? (if applicable)_____ | 68-69

_____

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Question 28

What was your highest level coaching rugby? **(Please tick one)** 70

- ☐ Provincial level
- ☐ Club level
- ☐ High school level
- ☐ Primary school level
- ☐ Bulletjie rugby

Question 29

How many years have you been coaching rugby? 71

a. ☐ This is my first year
b. ☐ 1 year
c. ☐ 2 years
d. ☐ 3 – 5 years
e. ☐ 6 – 9 years
f. ☐ 10 years and more

Question 30

How often are you the senior person at a rugby game or practice where you would be the person responsible for managing medical emergencies? 72

a. ☐ 80% to 100% of the time
b. ☐ 50% to 79% of the time
c. ☐ Less than 50% of the time
d. ☐ Never

This concludes the questionnaire. Thank you kindly for your time and effort to complete the questionnaire and participate in this research, it is much appreciated!

APPENDIX D(ii)

INFORMATION SHEET / INFORMED CONSENT / SURVEY PARAMEDICS

UNIVERSITEIT VAN DIE VRYSTAAT
UNIVERSITY OF THE FREE STATE
YUNIVERSITHI YA FREISTATA

339 BLOEMFONTEIN 9300 REPUBLIEK VAN SUID-AFRIKA/REPUBLIC OF SOUTH AFRICA
REPHABLIKE YA AFRIKA BORWA

Please note that by completing this questionnaire you are voluntarily agreeing to participate in this research study. You will remain anonymous and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the questionnaire.

Questionnaire for Paramedics

"Concussion knowledge and practice among role players in primary school rugby in the North West Province."

Dear Sir / Madam

Thank you for agreeing to partake in this research project. Your input is very valuable to us and therefore much appreciated. This questionnaire should take you no longer than 30 minutes to complete.

Please take your time to read the instructions appearing throughout the questionnaire, which will appear as ***bold, Italics*** text. It is of utmost importance that you answer all 29 questions as honestly as possible without taking any guesses.

When you have completed the questionnaire, please return it to the person who handed it to you immediately.

Thank you kindly

FOR THE FOLLOWING PART A (QUESTION 1 TO 18), PLEASE <u>TICK ONLY ONE</u> ANSWER AND COMPLETE FURTHER WHERE APPROPRIATE.

Symptom = indication or sign of disease

<u>Office use only</u>

<u>Question 1</u> ☐ 1

A concussion is:

a. ☐ An injury to the spinal cord
b. ☐ An injury to the brain
c. ☐ A scalp injury
d. ☐ I'm not sure

<u>Question 2</u> ☐ 2

Concerning the Sport Concussion Assessment Tool (SCAT):

a. ☐ I've never heard of it
b. ☐ I've heard of it but am not really familiar with it
c. ☐ I'm familiar with it but have never used it
d. ☐ I usually don't have it with me to be able to use it
e. ☐ I always have it ready and use it whenever I suspect a concussion

<u>Question 3</u> ☐ 3

A player has to lose consciousness to have a concussion:

a. ☐ Yes, for at least 5 seconds
b. ☐ Yes, for at least 1 minute
c. ☐ No, a player does not have to lose consciousness
d. ☐ I'm not sure

<u>Question 4</u>

A normal brain scan after a concussive injury means: ☐ 4

a. ☐ The child has no concussion and may return to sport
b. ☐ There is no skull fracture and so it is safe to play.
c. ☐ You no longer need to follow up with a doctor
d. ☐ The child still may have a concussion – a normal brain scan does not exclude a concussion

Office use only

Question 5 ☐ 5

In which phase of play does a concussion most often occur?

a. ☐ In a scrum
b. ☐ In a lineout
c. ☐ In a tackle
d. ☐ In a maul
e. ☐ In a ruck

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If a child hits his head severely during a rugby game he should:

a. ☐ Keep playing, if he is feeling okay, but tell the coach afterwards
b. ☐ Doesn't need to tell anyone, given that he is feeling okay
c. ☐ Stop playing as soon as the ball is dead, the whistle blows and then tell the coach
d. ☐ Stop playing immediately (irrespective of how he feels) and tell the coach

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When a child had a severe blow to the head, is it okay to continue playing?

a. ☐ Yes, as long as the player is careful
b. ☐ It depends on how important the upcoming game is
c. ☐ No, the player shouldn't continue playing at all for the rest of the day
d. ☐ He should rest a while, and if he feels better, he can play again
e. ☐ If he did not lose consciousness he can continue playing

Office use only

Question 8

An adult professional rugby player can return to play after a concussion: 8

a. ☐ For the same game, as long as he knows who he is

b. ☐ For the same game, as long as he has been assessed and cleared by someone medically trained

c. ☐ Once he has been assessed by a doctor and cleared, but never on the same day

d. ☐ If he only has a mild headache

e. ☐ For the next game, as long as it's at least 2 days later

Question 9

If a child has sustained a concussion, he can return to play after a concussion: 9

a. ☐ Immediately, as long as he knows who he is and what day it is

b. ☐ Within the same game, as long as he has been assessed and cleared by someone medically trained

c. ☐ On the same day, if he has been assessed by a doctor and cleared

d. ☐ If his headache is not bad enough to complain about the whole time

e. ☐ For the next game, as long as it is at least 2 days later

f. ☐ After he has been cleared by a doctor and has followed a graded return to play protocol.

Question10

Should players of all ages adhere to the same return to play guidelines? 10

a. ☐ Yes, everybody recovers at the same rate.

b. ☐ Yes, primary school rugby is just as important as adult rugby.

c. ☐ No, children take longer to return to sport than other rugby players

d. ☐ No, professional players take longer to return than other players.

Office use only

Question 11

When should a child's parents be contacted following a severe blow to the head? ☐ 11

a. ☐ If the coach thinks the player needs to see a doctor
b. ☐ Not needed, the child will tell their parents himself
c. ☐ After the player has been cleared to return by medical personnel
d. ☐ When it is suspected that a player has a concussion

Question 12

Which activities should a player NOT participate in if they are still showing sport-related concussion symptoms? ☐ 12

a. ☐ Any level of sport activity related to competition sport
b. ☐ Competitions
c. ☐ Practice
d. ☐ Warm-up
e. ☐ Any level of sport activity including playing during school break

Question 13

The decision to return a child to sport after a concussion should rest with: ☐ 13

a. ☐ The coach
b. ☐ A neuropsychologist/psychologist
c. ☐ A doctor
d. ☐ The parents

Question 14

A helmet prevents a rugby player from getting a concussion: ☐ 14

a. ☐ Yes, it completely protects a player
b. ☐ No, it does not protect a player
c. ☐ It helps, but doesn't completely prevent one
d. ☐ No, it may even encourage risky behaviour in players

Office use only

Question 15

Which of the following puts a rugby player at risk to experience a concussion? ☐ 15

a. ☐ Having a poor sense of balance
b. ☐ Having had a previous sport-related concussion
c. ☐ Suffering from asthma
d. ☐ Participating in preseason exercise

Question 16

Neuropsychological testing (NP testing) is: ☐ 16

a. ☐ A test to determine the school readiness of a child
b. ☐ A test that allows comparison between pre- and post- concussion performance
c. ☐ A test to provide a clear picture of the psychological state of a child
d. ☐ All of the above

Question 17

What is the most effective way to reduce the risk of sport related concussions? ☐ 17

a. ☐ Being educated about concussion
b. ☐ Developing strong neck muscles in rugby players
c. ☐ Having injured players attend workshops about concussion
d. ☐ Proper stretching before and after exercise

Question 18

Please choose one of the following options: ☐ 18

a. ☐ I have *been asked by a school* to provide information to rugby coaches on Concussion prevention and management
b. ☐ I have *asked a sports physician* to provide me with information on Concussion prevention and management?
c. ☐ None of the above

Office use only

FOR THE FOLLOWING PART B (QUESTIONS 19 TO 25), PLEASE CHOOSE AND TICK <u>ALL</u> THE ANSWERS THAT APPLY

<u>Question 19</u>

Is it important to recognise concussion in paediatric rugby players?

a.	☐	No, it is not very important because concussion is a minor injury	☐	19
b.	☐	Yes. It will influence when the child can play sports again	☐	20
c.	☐	Yes. It may have an impact on the child's school work	☐	21
d.	☐	Yes. It is always a serious injury that may cause long-term problems	☐	22
e.	☐	It is not important at all. Concussion is part of rugby	☐	23

<u>Question 20</u>

Which sign(s) may indicate that a child's concussion is getting worse?

a.	☐	If his reaction time is getting slower	☐	24
b.	☐	He is getting thirsty	☐	25
c.	☐	Behaves unusually or seems confused and irritable	☐	26
d.	☐	Clammy skin	☐	27
e.	☐	A headache that is getting worse	☐	28
f.	☐	If he complains about feeling sleepy all the time	☐	29

<u>Question 21</u>

The risks of a child playing too soon after suffering a concussion include:

a.	☐	Death from a second blow to the head	☐	30
b.	☐	Persistence of concussion-related symptoms for a longer period	☐	31
c.	☐	Poor performance in class	☐	32
d.	☐	Concussion may result in long-term learning and personality problems	☐	33

<u>Question 22</u>

Regarding Second Impact Syndrome:

a.	☐	It usually follows after a first concussion	☐	34
b.	☐	Is mostly seen in children under the age of 18 years	☐	35
c.	☐	Follows after a second blow on the head if the previous concussion has not resolved	☐	36
d.	☐	May lead to brain oedema and death	☐	37

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Question 23

The following are signs and symptoms of concussion:

a.	☐	Headache	☐	38
b.	☐	Difficulty with urination	☐	39
c.	☐	Lowered pulse rate	☐	40
d.	☐	Feeling dazed or in a “fog”	☐	41
e.	☐	Difficulty falling asleep	☐	42
f.	☐	Difficulty concentrating	☐	43
g.	☐	Convulsions	☐	44
h.	☐	Inability to describe time and place	☐	45
i.	☐	Feelings of euphoria	☐	46
j.	☐	Chest pain	☐	47
k.	☐	Difficulty with memory	☐	48
l.	☐	Increased emotion/irritability	☐	49

Question 24

Before returning to play following a concussion a child should meet which of the following criteria?

a.	☐	Cleared by a doctor with sport-related concussion experience	☐	50
b.	☐	Be able to pass a classroom test	☐	51
c.	☐	Be free of concussion symptoms (e.g. dizziness) during rest	☐	52
d.	☐	Have had a brain scan	☐	53
e.	☐	Given prescribed medication	☐	54
f.	☐	Be free of concussion symptoms (e.g. dizziness) during activity	☐	55

Question 25

Which of the following activities can a child do when still being treated for concussion?

a.	☐	Watch television and play computer games, as long as they keep still	☐	56
b.	☐	Go back to playing rugby	☐	57
c.	☐	Participate in non-contact sport	☐	58
d.	☐	Refrain from any physical activity	☐	59
e.	☐	Refrain from any activity requiring concentration	☐	60

FOR THE FOLLOWING PART C (QUESTION 26 TO 28), PLEASE ANSWER AND COMPLETE FURTHER WHERE APPROPRIATE.

Office use only

Question 26

When was the last time you received ***information*** regarding sport related concussion? 61

a. ☐ Less than a year ago
b. ☐ 1 year ago
c. ☐ Between 2 and 3 years ago
d. ☐ Between 4 and 7 years ago
e. ☐ Between 8 and 9 years ago
f. ☐ Longer than 10 years ago

Question 27

a. Have you ever received any ***training*** regarding concussion before? 62

☐ Yes
☐ No

b. If "Yes", what level? _____ 63-64

_____

c. If "Yes", how long ago? _____ Years _____ Months 65-66

d. If "Yes", was it a recognised programme e.g. BokSmart? 67

☐ Yes
☐ No

e. Which one? (if applicable)_____ 68-69

_____

Question 28

How often are you the senior person at a rugby game or practice where you would be the person responsible for managing medical emergencies? 70

a. ☐ 80% to 100% of the time
b. ☐ 50% to 79% of the time
c. ☐ Less than 50% of the time
d. ☐ Never

Question 29

What us your highest qualification? 71

a. ☐ BAA
b. ☐ ANA
c. ☐ CCA

This concludes the questionnaire. Thank you kindly for your time and effort to complete the questionnaire and participate in this research, it is much appreciated!

APPENDIX D(iii)

INFORMATION SHEET / INFORMED CONSENT / SURVEY DOCTORS

UNIVERSITEIT VAN DIE VRYSTAAT
UNIVERSITY OF THE FREE STATE
YUNIVERSITHI YA FREISTATA

339 BLOEMFONTEIN 9300 REPUBLIEK VAN SUID-AFRIKA/REPUBLIC OF SOUTH AFRICA
REPHABLIKE YA AFRIKA BORWA

Please note that by completing this questionnaire you are voluntarily agreeing to participate in this research study. You will remain anonymous and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the questionnaire.

Questionnaire for Doctors

"Concussion knowledge and practice among role players in primary school rugby in the North West Province."

Dear Doctor

Thank you for agreeing to partake in this research project. Your input is very valuable to us and therefore much appreciated. This questionnaire should take you no longer than 30 minutes to complete.

Please take your time to read the instructions appearing throughout the questionnaire, which will appear as bold, Italics text. It is of utmost importance that you answer all 32 questions as honestly as possible without taking any guesses.

When you have completed the questionnaire, please return it to the person who handed it to you immediately.

Thank you kindly

FOR THE FOLLOWING PART A (QUESTION 1 TO 18), PLEASE <u>TICK ONLY ONE</u> ANSWER AND COMPLETE FURTHER WHERE APPROPRIATE.

Symptom = indication or sign of disease

<u>Office use only</u>

<u>Question 1</u> ☐ 1

A concussion is:

a. ☐ An injury to the spinal cord
b. ☐ An injury to the brain
c. ☐ A scalp injury
d. ☐ I'm not sure

<u>Question 2</u> ☐ 2

Concerning the Sport Concussion Assessment Tool (SCAT):

a. ☐ I've never heard of it
b. ☐ I've heard of it but am not really familiar with it
c. ☐ I'm familiar with it but have never used it
d. ☐ I usually don't have it with me to be able to use it
e. ☐ I always have it ready and use it whenever I suspect a concussion

<u>Question 3</u> ☐ 3

A player has to lose consciousness to have a concussion:

a. ☐ Yes, for at least 5 seconds
b. ☐ Yes, for at least 1 minute
c. ☐ No, a player does not have to lose consciousness
d. ☐ I'm not sure

<u>Question 4</u>

A normal brain scan after a concussive injury means: ☐ 4

a. ☐ The child has no concussion and may return to sport
b. ☐ There is no skull fracture and so it is safe to play.
c. ☐ You no longer need to follow up with a doctor
d. ☐ The child still may have a concussion – a normal brain scan does not exclude a concussion

Office use only

Question 5 ☐ 5

In which phase of play does a concussion most often occur?

a. ☐ In a scrum
b. ☐ In a lineout
c. ☐ In a tackle
d. ☐ In a maul
e. ☐ In a ruck

Question 6 ☐ 6

If a child hits his head severely during a rugby game he should:

a. ☐ Keep playing, if he is feeling okay, but tell the coach afterwards
b. ☐ Don't need to tell anyone, given that he is feeling okay
c. ☐ Stop playing as soon as the ball is dead, the whistle blows and then tells the coach
d. ☐ Stop playing immediately (irrespective of how he feels) and tell the coach

Question 7 ☐ 7

When a child had a severe blow to the head, is it okay to continue playing?

a. ☐ Yes, as long as the player is careful
b. ☐ It depends on how important the upcoming game is
c. ☐ No, the player shouldn't continue playing at all for the rest of the day
d. ☐ He should rest a while, and if he feels better, he can play again
e. ☐ If he did not lose consciousness he can continue playing

Office use only

Question 8

An adult professional rugby player can return to play after a concussion: 8

a. For the same game, as long as he knows who he is
b. For the same game, as long as he has been assessed and cleared by someone medically trained
c. Once he has been assessed by a doctor and cleared, but never on the same day
d. If he only has a mild headache
e. For the next game, as long as it's at least 2 days later

Question 9

If a child has sustained a concussion, he can return to play after a concussion: 9

a. Immediately, as long as he knows who he is and what day it is
b. Within the same game, as long as he has been assessed and cleared by someone medically trained
c. On the same day, if he has been assessed by a doctor and cleared
d. If his headache is not bad enough to complain about the whole time
e. For the next game, as long as it is at least 2 days later
f. After he has been cleared by a doctor and has followed a graded return to play protocol.

Question10

Should players of all ages adhere to the same return to play guidelines? 10

a. Yes, everybody recovers at the same rate.
b. Yes, primary school rugby is just as important as adult rugby.
c. No, children take longer to return to sport than other rugby players.
d. No, professional players take longer to return than other players.

Office use only

Question 11

When should a child's parents be contacted following a severe blow to the head? 11

a. ☐ If the coach thinks the player needs to see a doctor
b. ☐ Not needed, the child will tell their parents himself
c. ☐ After the player has been cleared to return by medical personnel
d. ☐ When it is suspected that a player has a concussion

Question 12

Which activities should a player NOT participate in if they are still showing sport-related concussion symptoms? 12

a. ☐ Any level of sport activity related to competition sport
b. ☐ Competitions
c. ☐ Practice
d. ☐ Warm-up
e. ☐ Any level of sport activity including playing during school break

Question 13

The decision to return a child to sport after a concussion should rest with: 13

a. ☐ The coach
b. ☐ A neuropsychologist/psychologist
c. ☐ A doctor
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Office use only

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Have you ever been asked by a school to provide information to rugby coaches on concussion prevention and management? ☐ 18

a. ☐ Yes
b. ☐ No

Office use only

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e.	☐	Difficulty falling asleep	☐	42
f.	☐	Difficulty concentrating	☐	43
g.	☐	Convulsions	☐	44
h.	☐	Inability to describe time and place	☐	45
i.	☐	Feelings of euphoria	☐	46
j.	☐	Chest pain	☐	47
k.	☐	Difficulty with memory	☐	48
l.	☐	Increased emotion/irritability	☐	49

Question 24

Before returning to play following a concussion a child should meet which
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a.	☐	Cleared by a doctor with sport-related concussion experience	☐	50
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c.	☐	Be free of concussion symptoms (e.g. dizziness) during rest	☐	52
d.	☐	Have had a brain scan	☐	53
e.	☐	Given prescribed medication	☐	54
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Question 25

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d.	☐	Refrain from any physical activity	☐	59
e.	☐	Refrain from any activity requiring concentration	☐	60

FOR THE FOLLOWING PART C (QUESTION 26 TO 31), PLEASE ANSWER AND COMPLETE FURTHER WHERE APPROPRIATE.

Office use only

Question 26

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a. ☐ Less than a year ago
b. ☐ 1 year ago
c. ☐ Between 2 and 3 years ago
d. ☐ Between 4 and 7 years ago
e. ☐ Between 8 and 9 years ago
f. ☐ Longer than 10 years ago

Question 27

a. Besides your MBCHB, have you received any post graduate training regarding concussion before?

☐ Yes ☐ 62
☐ No

b. If "Yes", what level? _____ ☐☐ 63-64

_____

c. If "Yes", how long ago? _____ Years _____ Months ☐☐ 65-66

d. If "Yes", was it a recognised programme e.g. BokSmart?

☐ Yes ☐ 67
☐ No

e. Which one? (if applicable)_____ ☐☐ 68-69

_____

Office use only

Question 28

a. Have you ever attended a rugby game as match doctor? ☐ 70

☐ Yes

☐ No

b. If "Yes", when was the last time? _____

c. If "Yes", at what level? ***(Tick ALL that apply)***

☐	Provincial level	☐ 71
☐	Club level	☐ 72
☐	High school level	☐ 73
☐	Primary school level	☐ 74
☐	Bulletjie rugby	☐ 75

Question 29 ☐ 76

Where did you get your last information regarding sport related concussion?

a. ☐ Continued Medical Education (CME)

b. ☐ Pre graduation

c. ☐ Post graduation (If so, please describe:)_____

Question 30

Please answer the following questions based on the following scenario: ☐ 77

Following a rugby game, your athlete had no loss of consciousness but had posttraumatic amnesia for 1 minute.

The next day:

The player was reporting post-concussion symptoms but appeared normal on standardised methods of concussion (e.g., SAC, BESS, neuropsychological testing). Would you return this player to competition? ***(Tick one only)***

a. Yes

b. No

c. Depends on the importance of an upcoming game

Office use only

Question 31

What is the ***single method*** you rely on the most in making decisions about return to play after concussion? ***(Tick one only)*** ☐ 78

a. ☐ Neuropsychological testing (computerised)
b. ☐ Neuropsychological testing (traditional)
c. ☐ Balance Error Scoring System (BESS)
D. ☐ Concussion grading scales (E.g. Cantu or AAN)
e. ☐ Standardised Assessment of Concussion (SAC)
f. ☐ Sport Concussion Assessment Tool 2 (SCAT 2)
g. ☐ Player self-report
h. ☐ Symptom checklist
i. ☐ Head CT/brain MRI
j. ☐ Return-to-play guidelines
k. ☐ Clinical examination
l. ☐ Other (Please specify _____)

Question 32

How do you classify concussion? ***(Tick one only)*** ☐ 79

a. ☐ I use the Cantu grading scale
b. ☐ I use the American Academy of Neurology (AAN) grading scale
c. ☐ I do not use any grading scale. Each case is treated individually
d. ☐ Other (Please specify) _____)

This concludes the questionnaire. Thank you kindly for your time and effort to complete the questionnaire and participate in this research, it is much appreciated!

APPENDIX E

MEMORANDUM

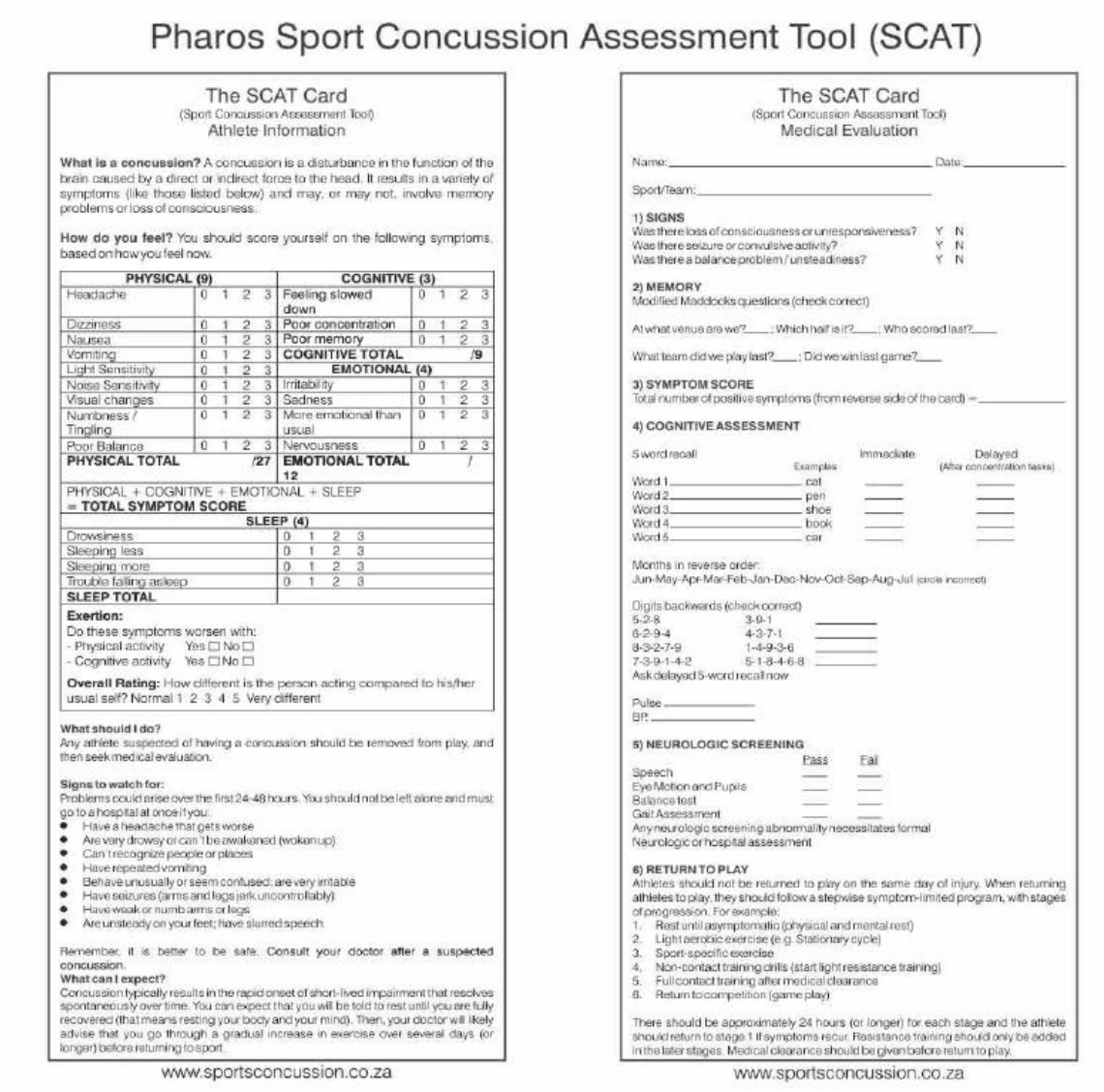
APPENDIX E

Question no.	Coaches	Paramedics	Doctors
1	b	b	b
2	A, **or** b **or** c, **or** d, **or** e (usage of instrument)	A, **or** b **or** c, **or** d, **or** e (usage of instrument)	A, **or** b **or** c, **or** d, **or** e (usage of instrument)
3	c	c	c
4	d	d	d
5	c	c	c
6	d	d	d
7	c	c	c
8	c	c	c
9	f	f	f
10	c	c	c
11	d	d	d
12	e	e	e
13	c	c	c
14	d	d	d
15	b	b	b
16	b	b	b
17	a	a	a
18	N/A	N/A	N/A
19	b c, d	b, c, d	b, c, d
20	a, c , e, f	a, c , e, f	a, c , e, f
21	a, b, c , d	a, b, c , d	a, b, c , d
22	b , c , d	b , c , d	a , c , d
23	a, d, e, f, g, h, i, k, l	a, d, e, f, g, h, i, k, l	a, d, e, f, g, h, i, k, l
24	a, c , f	a, c , f	a, c , f
25	d, e	d, e	d, e
26	N/A	N/A	N/A
27	N/A	N/A	N/A
28	N/A	N/A	N/A
29	N/A	N/A	N/A
30	N/A	N/A	b
31	N/A	N/A	N/A
32	N/A	N/A	N/A

APPENDIX F

PHAROS SPORT CONCUSSION ASSESSMENT TOOL (SCAT)

The original SCAT card has been modified for South African conditions (Jon Patricios, 2009)



Pharos Sport Concussion Assessment Tool (SCAT)

The SCAT Card
(Sport Concussion Assessment Tool)
Athlete Information

What is a concussion? A concussion is a disturbance in the function of the brain caused by a direct or indirect force to the head. It results in a variety of symptoms (like those listed below) and may, or may not, involve memory problems or loss of consciousness.

How do you feel? You should score yourself on the following symptoms, based on how you feel now.

PHYSICAL (9)		COGNITIVE (3)	
Headache	0 1 2 3	Feeling slowed down	0 1 2 3
Dizziness	0 1 2 3	Poor concentration	0 1 2 3
Nausea	0 1 2 3	Poor memory	0 1 2 3
Vomiting	0 1 2 3	**COGNITIVE TOTAL**	**/9**
Light Sensitivity	0 1 2 3	**EMOTIONAL (4)**	
Noise Sensitivity	0 1 2 3	Irritability	0 1 2 3
Visual changes	0 1 2 3	Sadness	0 1 2 3
Numbness / Tingling	0 1 2 3	More emotional than usual	0 1 2 3
Poor Balance	0 1 2 3	Nervousness	0 1 2 3
PHYSICAL TOTAL	**/27**	**EMOTIONAL TOTAL**	**/ 12**

PHYSICAL + COGNITIVE + EMOTIONAL + SLEEP
= **TOTAL SYMPTOM SCORE**

SLEEP (4)	
Drowsiness	0 1 2 3
Sleeping less	0 1 2 3
Sleeping more	0 1 2 3
Trouble falling asleep	0 1 2 3
SLEEP TOTAL	

Exertion:
Do these symptoms worsen with:
- Physical activity Yes ☐ No ☐
- Cognitive activity Yes ☐ No ☐

Overall Rating: How different is the person acting compared to his/her usual self? Normal 1 2 3 4 5 Very different

What should I do?
Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

Signs to watch for:
Problems could arise over the first 24-48 hours. You should not be left alone and must go to a hospital at once if you:
- Have a headache that gets worse
- Are very drowsy or can't be awakened (woken up)
- Can't recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused; are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on your feet; have slurred speech

Remember, it is better to be safe. Consult your doctor **after a suspected concussion.**

What can I expect?
Concussion typically results in the rapid onset of short-lived impairment that resolves spontaneously over time. You can expect that you will be told to rest until you are fully recovered (that means resting your body and your mind). Then, your doctor will likely advise that you go through a gradual increase in exercise over several days (or longer) before returning to sport.

www.sportsconcussion.co.za

The SCAT Card
(Sport Concussion Assessment Tool)
Medical Evaluation

Name: _____ Date: _____

Sport/Team: _____

1) SIGNS
Was there loss of consciousness or unresponsiveness? Y N
Was there seizure or convulsive activity? Y N
Was there a balance problem / unsteadiness? Y N

2) MEMORY
Modified Maddocks questions (check correct)

At what venue are we? ____; Which half is it? ____; Who scored last? ____

What team did we play last? ____; Did we win last game? ____

3) SYMPTOM SCORE
Total number of positive symptoms (from reverse side of the card) = _____

4) COGNITIVE ASSESSMENT

5 word recall	Examples	Immediate	Delayed (After concentration tasks)
Word 1 _____	cat	_____	_____
Word 2 _____	pen	_____	_____
Word 3 _____	shoe	_____	_____
Word 4 _____	book	_____	_____
Word 5 _____	car	_____	_____

Months in reverse order:
Jun-May-Apr-Mar-Feb-Jan-Dec-Nov-Oct-Sep-Aug-Jul (circle incorrect)

Digits backwards (check correct)

5-2-8	3-9-1	_____
6-2-9-4	4-3-7-1	_____
8-3-2-7-9	1-4-9-3-6	_____
7-3-9-1-4-2	5-1-8-4-6-8	_____

Ask delayed 5-word recall now

Pulse _____
BP _____

5) NEUROLOGIC SCREENING

	Pass	Fail
Speech	____	____
Eye Motion and Pupils	____	____
Balance test	____	____
Gait Assessment	____	____

Any neurologic screening abnormality necessitates formal Neurologic or hospital assessment

6) RETURN TO PLAY
Athletes should not be returned to play on the same day of injury. When returning athletes to play, they should follow a stepwise symptom-limited program, with stages of progression. For example:
1. Rest until asymptomatic (physical and mental rest)
2. Light aerobic exercise (e.g. Stationary cycle)
3. Sport-specific exercise
4. Non-contact training drills (start light resistance training)
5. Full contact training after medical clearance
6. Return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages. Medical clearance should be given before return to play.

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South African Modified Scat Card

APPENDIX G

MODIFIED MADDOCK'S QUESTIONS

Modified Maddock's questions (Patricios et al., 2011)
• Which ground are we at? • Which team are we playing today? • Who is your opponent today? • Which half is it? • How far into the half is it? • Which side scored last? • Which team did we play last week? • Did we win last week?