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FACTORS ASSOCIATED WITH LOWER LIMB INJURIES IN HIGH SCHOOL RUGBY PLAYERS

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A research report submitted to the Faculty of Health Sciences,
University of the Witwatersrand,
in partial fulfillment of the requirements for the degree
of
Master of Science (Physiotherapy)

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DECLARATION

I, Noelle Griffiths declare that this research report represents my own work. It is being submitted for the degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

…… (Signature of the candidate) …. day of……., 2012

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ABSTRACT

Background and purpose of research: The number of individuals playing rugby union is increasing every year particularly amongst adolescence at a school level. With the increase in participation an increase in injuries arises. The purpose of this study was to document the lower limb injuries previously sustained in the 2009 rugby season as well as the injuries sustained over a six week period in 2010 and to identify the risk factors associated with these injuries.

Method: A prospective cohort design was used. Sixty-five participants from three high schools on the West Rand completed an injury questionnaire and participated in pre-season testing of lower limb muscle length, muscle strength and balance. Lower limb injuries were documented throughout the season. Descriptive statistics were used to describe the data and a univariate analysis was done to determine if there were any associations between various risk factors and sustaining an injury.

Results: Six lower limb injuries were documented in 2010. Knee and ankle injuries accounted for 25 out of the 35 (71%) injuries sustained over the 2009 and 2010 rugby seasons. The risk factors for lower limb injuries included good flexibility of the hamstring muscle group and logistic regression also showed an association between a right lower limb injury and right sided muscle strength of the ankle dorsiflexors ($p=0.04$) and knee extensors ($p=0.05$).

Conclusion: The risk factors associated with these lower limb injuries were good flexibility of the hamstring muscle group as well as right sided quadriceps and tibialis anterior muscle strength.

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CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

Rugby is a sport played more predominantly by males. Each of the two teams competing consists each of 15 players, eight forwards and seven backs (Junge et al., 2004). Rugby consists of passing and running with an oval ball to cross the opponents' goal line to attain as many points as possible through tries, and by kicking the rugby ball over the goal posts within two 40-minutes periods of play. The opposing team will tackle a player to try and win the ball. Rugby is defined as a contact sport (Quarrie et al., 2001) and is associated with a high number of injuries occurring (Junge et al., 2004; Morgan and Oberlander, 2001) especially during the tackling phase of the game (Garraway et al., 2000). This results in rugby being a full-contact sport (Quarrie et al., 2001) with many physical collisions which in-turn is the reason for many musculoskeletal injuries (Gabett, 2004).

Rugby is played extensively in countries such as Australia, Britain, France, New Zealand (Quarrie et al., 2001), the USA (Collins et al., 2008) and South Africa. After the 1995 Rugby World Cup, rugby became a professional sport (Puren et al., 2007). Together with the financial remuneration came an increase in the number of individuals playing rugby (Bathgate et al., 2002), especially amongst the youth at an amateur and school level. With the increase in participation came an increase in injuries (McManus and Cross, 2004).

Injuries frequently associated with rugby in high school players are injuries to the lower limb, specifically to the knee and the ankle (Collins et al., 2008; Hattingh and Spamer, 2004). Mahaffey et al (2006) also confirmed this and added that the most common type of injuries is ligament injuries to the lower limb caused by tackles. As in rugby, Emery et al (2005b) found that in other sports such as basketball and soccer the common injuries sustained by students were also to the lower limb. Risk factors for lower limb injuries in sport included previous injury (Meeuwisse et al., 2003), biomechanical factors, decreased flexibility (Witvrouw et al., 2000) and poor balance

(Plisky et al., 2006; McGuine et al., 2000). Previous identified injury risk factors for rugby players were a player's age (Haseler et al., 2010), position, body mass index (BMI), strenuous activity (Quarrie et al., 2001), higher level of participation (Lee and Garaway, 1996) and previous injuries (Quarrie et al., 2001).

To investigate and to predict factors that can have an influence on injuries is vital and valuable in a sports environment (McManus and Cross, 2004). Coaches or trainers can address these risk factors in the preseason and lower the risk of injury for players for the season ahead. Factors associated with injury amongst school rugby players have not been fully explored in the South African school rugby system and will lead to rising injury rates at this level unless precautionary actions are taken (Erasmus and Spamer, 2007).

1.2 PROBLEM STATEMENT

With the increased number of rugby players at both professional and school level, an increase in injuries has been noted. There is a need to determine the risk factors that can lead to injuries to prevent this occurrence. Limited research has been done on school boy rugby players determining baseline characteristics and injury risk factors especially in South-African populations.

1.3 RESEARCH QUESTION

What are the risk factors that are associated with lower limb injuries in high school rugby boys?

1.4 AIMS

To establish the factors associated with the incidence of lower limb injuries in high school rugby players.

1.5 OBJECTIVES

To determine pre-season baseline characteristics including the previous injuries of school boy rugby players.

To document the incidence of lower limb injuries during the Gauteng large schools rugby league.
To determine the association between the various factors measured and the incidence of injuries sustained during a six week rugby league.

1.6 SIGNIFICANCE OF THE STUDY

The study will present important baseline data obtained from high school rugby boys and will also give some insight into the injuries that are sustained by high school rugby players over a season. Determining risk factors for injuries in a school boy rugby population may contribute to pre-season injury prevention programmes that may decrease the incidence of injuries and prevent future disability. Decreasing the incidence of injuries to school boys at high school level will increase their potential for a professional rugby career.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The literature related to lower limb injuries in sport with particular relevance to rugby, will be reviewed in this chapter. Factors related to these injuries have not been researched extensively in a rugby population. These factors need to be determined on every level of play, such as amateur and school rugby, to prevent serious and recurring injuries that may affect future participation in sport as well as a future career in rugby. A literature search was done using SCOPUS, SPORTDiscus and Google Scholar search engines. The articles searched were from 1980 to 2011. The keywords used were: injury, risk factors, rugby and school.

After the 1995 Rugby World Cup rugby became a professional sport (Puren et al., 2007). With the financial remuneration, the number of individuals playing rugby increased (Bathgate et al., 2002). The increase and growth of participation in rugby has resulted in an increase in and a concern for the risk of rugby-related injuries (Brooks and Kemp, 2008). Rugby has the highest injury rate compared with other team sports (Brooks and Kemp, 2008). Injuries were defined and categorized by McManus (2000) as minor, mild, moderate or severe. Minor injuries are defined as injuries where the injured player is able to return to the game or training in which the injury occurred. The term mild injury is used when the injured player misses one week of training and/ or games. Moderate injury is used when the player misses two weeks and the term severe injury is used when the player misses more than two weeks of training or games.

Gabett (2008) studied 80 rugby league players between the age of 17 and 19 over a period of four seasons translating to 1092 playing hours. He documented that shoulder injuries were the most common injury site. Collins et al (2008) reported on 98 boys' and 23 girls' rugby clubs over a period of two seasons. Of the 594 reported injuries only 77 were sustained by the girls. Collins et al (2008) did mention that the pattern of injuries were similar for the boys and the girls. They found the most regular

sites to be injured in high school players are the head (21.7%), the ankle (13.3%), the shoulder (12.8%) and the knees (11.1%). McManus and Cross (2004) reported that lower limb injuries were the most common injuries followed by head and neck injuries and shoulder injuries in their study of 44 boys over 26 weeks. Under the term lower limb these researchers included ankle, knee, leg, thigh and hip injuries (McManus and Cross, 2004). Gabett (2008) and Collins et al (2008) only included injuries that kept players off the field for a day or more and did not include minor injuries in their analyses. McManus and Cross (2004) found that 40% of all the injuries sustained were minor injuries and argued the inclusion of minor injuries in the analysis as that any injury may have an influence on future performances and injuries.

Gabett (2008) found sprains to be the most common type of injury. Collins et al (2008) however, found sprains to only be the third most common type of injury with fractures being the most common in junior club rugby followed by concussions. McManus and Cross (2004) did not mention the types of injuries. Many authors agree with Gabett (2008) that the major cause of injuries in rugby is the tackle, either being the tackler or being tackled by the opposing team's player (Collins et al., 2008; McManus and Cross, 2004). In order to understand the reasons for lower limb injuries amongst school rugby players and to develop appropriate injury prevention programmes, it was suggested that factors associated with these injuries should be explored (Gabett, 2008; McManus and Cross, 2004).

2.2 INJURIES AND THE INFLUENCE OF AGE AND LEVEL OF PLAY

Studies have shown that in youth rugby higher age groups will have not only more injuries but more severe injuries than the younger age groups (Haseler et al., 2010; Lee and Garraway, 1996). Lee and Garraway (1996) stated that younger boys have decreased strength because of their smaller body structure and thus, with a collision, the injuries will be fewer and less serious. This correlates with Haseler et al (2010) who explained that older boys who have proceeded through their growth spurt and are developing muscle bulk prior to gaining full musculoskeletal development are more at risk for injury.

Lee and Garraway (1996) also showed the school players to have a lower risk of injury and fewer recurrent injuries compared to the club players of the same age up until they were 17 years old where there were no differences observed. The reason given by the authors for the higher incidence of injuries in the club players was, that in Scotland, rugby is part of the school syllabus which would mean that school boys have to participate in playing rugby without necessarily having the interest or love for the sport and thus the competitiveness for the sport in comparison with club players who chose to partake in the sport will be less (Lee and Garraway, 1996). This endorses the fact that a higher level of play will be associated with more injuries because the players show more competitiveness (Lee and Garraway, 1996). Unfortunately Lee and Garraway's (1996) study included a small sample of 17 and 18 year old boys, thus the cohort may not be representative of older school boys.

Collins et al (2008) studied the incidence and risk factors associated with injuries among a large cohort of United States school rugby players during the 2005 and 2006 seasons, by using an internet-based surveillance system. Each of the 121 participating clubs had to complete weekly exposure reports for injury occurrences. Observing the school boys, 517 injuries were recorded during the two seasons. The injured boys and girls had a mean age of 16.5 years but no analysis was done on age as a risk factor.

At school level the competiveness is increasing every year due to the professionalism of rugby and the future that it holds for young players. Most school coaches implement programmes to develop bigger, stronger, faster and more skilful players who can excel at their sport (Quarrie et al., 1996). Therefore the question has been asked if the elite senior school player has the anthropometric composition and physical and motor capacity demanded by the modern game (Quarrie et al., 1996) to compete without getting injured. Literature on the physical body composition of rugby players relative to injuries is explored in the following section.

2.3 THE INFLUENCE OF ANTHROPOMETRIC DATA ON INJURIES

The influence of anthropometric data and other factors on injuries is reviewed in this section. The anthropometric data included is BMI and the factors reviewed are:

playing position, balance, lower limb muscle length and muscle strength and core muscle endurance. Each factor is reviewed for its influence on lower limb injuries.

The World Health Organization (1998) defines the body mass index (BMI) as a simple index of weight-for-height that is commonly used to classify underweight, lean body composition, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2). Underweight is classified as a BMI equivalent to or less than 20 kg/m^2. Overweight is classified as a BMI equivalent to or more than 25 kg/m^2, and obesity as a BMI equivalent to or more than 30 kg/m^2 (King et al., 2005). The relevance of this information is that in the game of rugby there are obvious differences in body types between forward players and backline players due to the requirements of the game (Lee et al., 1997).
Lee et al (1997) classified rugby players' physique under the body mass index (BMI) and somatotype classification as either endomorphic (obese), mesomorphic (muscular) or ectomorphic (linear).

In a study of 1216 Scottish rugby players significant differences in BMI results were seen between the injured and the non-injured players (Lee et al., 1997). A higher BMI and an endomorphic body type classification were more likely than ectomorphic players to be injured in a match after adjustment for age. The researchers observed that a reason for the high injury rate in endomorphic players might be due to the specific role forwards play in a rugby match. Contrary to the above, Brewer and Davis (1995) said that body fat may actually protect the players from sustaining injuries.

Lee et al (1997) also suggested that somatotype classification is probably not the best way to classify senior rugby players, but that this classification could be used as a risk factor in school boy rugby because of their different physical development rates. Unfortunately a more objective somatotyping method would have been more accurate and valid (Lee et al., 1997). Spamer and De la Port (2006) and Spamer et al (2009) used baseline anthropometric data to classify under-16 and under-18 South African and New Zealand provincial rugby players in groups for further use in team selection and talent identification.

The use of BMI is a controversial method to use for rugby players. King et al (2005) found 56.3% of the forwards among professional players overweight and 42.2% as obese, 78% of the backline players were classified as overweight and 8.8% as obese according to the BMI. In a similar study Lundy et al (2006) observed rugby league players and found 96% of the players to be classified as overweight or obese on the BMI scale in contrast with their calculated body fat percentage. These results led Lundy et al (2006) and King et al (2005) to conclude that BMI is a valid measure for large population studies but misleading for athletic populations and that if anthropometric data is needed, BMI together with body fat percentage should be interpreted simultaneously. This is similar to Lee et al (1997) who stated that in rugby players a high BMI could imitate muscularity rather than obesity. No research was found in a school population amongst rugby players where somatotype classification, BMI and skin folds were recorded, compared and interpreted together with the risk that these factors may have on injuries.

Forwards are usually bigger and heavier and need to provide power and height in the scrums, line-outs and mauls. Backline players require speed and agility to run with the ball and to defend with tackling against the opposing team (Lee et al., 1997). Further information on the relation of these positions to injuries is given in the following section.

2.4 THE INFLUENCE OF POSITION ON INJURIES

Prospective cohort studies have been done to observe the risk factor for injury for playing a specific position (Nicol et al., 2010; Schneiders et al., 2009; Holtzhausen et al., 2006; Brooks et al., 2005a; McManus and Cross, 2004). These studies were done with large samples (271 to 546 participants) of rugby players from world cup participating nations. The exception was research done by McManus and Cross (2004), which only had 44 participants, and Holtzhauzen et al (2006) who had 75 participants.

Nicol et al (2010) observed injuries in children aged between 11 and 17 who were playing rugby. Their results showed that 59.4% of injuries occurred amongst the backline players and 40.6% of injuries occurred amongst the frontline players. The

wing was the most injured followed by the centre (Nicol et al., 2010). In a high school study done by McManus and Cross (2004) similar results were found. The players most at risk were the wings and the centres followed by the halfbacks and the flankers. The most injured players were the flanks, the number eight player, the wings and the hooker and the players who sustained the most severe injuries were the locks, centres and the halfbacks (McManus and Cross, 2004).

In two studies done on club players, one in New Zealand (Schneiders et al., 2009) and one in South Africa (Holtzhausen et al., 2006) similar results were found but their results differ from the studies done by Nicol et al (2010) and McManus and Cross (2004). Studies done in club players (Schneiders et al., 2009; Holtzhausen et al., 2006) found that the most injuries occurred amongst the centres, locks and full backs. This was in contrast to the studies done on children where the fullback position was one of the safest positions to play with regards to injuries (Nicol et al., 2010; McManus and Cross, 2004). Under the broad category of forwards and back many authors found no significant difference of injury rate between the two groups (Schneiders et al., 2009; Holtzhausen et al., 2006; Brooks et al., 2005a).

In summary the literature shows risk factors that predispose rugby players to injury, are BMI and a player's position (Quarrie et al., 2001). Many studies have proposed that poor balance is also a risk factor for injury in various sports (Plisky et al., 2006; Trojian and McKeag, 2006; McGuine et al., 2000; Watson 1999). This factor will be explored in the next section.

2.5 THE INFLUENCE OF BALANCE ON INJURIES

There is earlier evidence that shows that decreased static one leg balance is a risk factor for ankle sprain re-injury in soccer (Trojian and McKeag, 2006; McGuine et al., 2000) and there is research that suggests that decreased dynamic one leg balance will lead to injuries in sport (Riemann et al., 1999; Lephart et al., 1998). Emery (2003) defined balance as "the body's ability to maintain centre of gravity over its base of support with minimal sway or maximal steadiness". Emery et al (2005a) determined test-retest reliability of a static and dynamic unipedal balance test in 111 adolescents in Canada. The timed static balance test was done barefoot on a gym

surface floor with eyes closed and the timed dynamic test was done barefoot on an Airex balance pad once with eyes open and once with eyes closed. Emery et al (2005a) showed that timed eyes close static and timed eyes closed dynamic tests with a 180-second maximum limit were appropriate clinical measures for use in adolescents and concluded that previous lower limb injuries need to be taken into consideration as a key factor that can influence balance.

Trojian and McKeag (2006) did a single leg balance (SLB) screening test on 230 male and female high school and university athletes (football, soccer and volleyball players) during the preseason examination to investigate if the SLB test could predict ankle sprains. All athletes who chose to have their ankles taped, or with a history of ankle taping, were allowed to have their ankles taped. Trojian and McKeag (2006) reported a significant association between a failed SLB test and ankle sprains but did not find an association between previous ankle injuries and new ankle sprains in their study. The reasons for this occurrence were probably due to the fact that most athletes taped their previously injured ankle and had balance training after their ankle injury (Trojian and McKeag, 2006).

Plisky et al (2006) studied dynamic balance and had the objective to determine if the Star Excursion Balance Test (SEBT) can predict lower limb injuries in high school basketball male and female players. Prior to the basketball season 235 players performed the SEBT in the anterior, posteromedial, and posterolateral directions. SEBT reach distances and leg length measurements were taken for bilateral legs. To determine a true reach distance, reach distance was expressed as a percentage of leg length. This was calculated by dividing reach distance by leg length and then by multiplying the value by a hundred (Plisky et al., 2006). The results showed that a reach distance difference of 4cm or more between the left and the right leg's anterior reach distance was significantly associated with lower limb injury. The results that Plisky et al (2006) collected compare favourably with those reported by Trojian and McKeag (2006) and by McGuine et al (2000) who also reported a risk for ankle injuries in basketball players with poor static balance measured by using forced plate analysis.

Sankey et al (2008) acknowledged the findings of Trojian and McKeag (2006) and McGuine et al (2000). Sankey et al (2008) observed that there are many successful proprioception intervention training programmes that has shown a decrease in ankle injuries in athletes (McGuine and Keene, 2006; Verhagen et al., 2004), but these programmes have all been implemented in non-contact sports. In contradiction Soderman et al (2000) did not find that balance training had an influence on the prevention of injuries in female soccer players, but their study was compared to the one done by Caraffa et al (1996) and they concluded that their results could have been influenced by the fact that the athletes in their study were only observed for the limited time period of one season. Sankey et al (2008) stated that ankle proprioception training might not be appropriate for rugby players but contradicted this statement in their findings. Sankey et al (2008) found 35% of the ankle injuries, sustained over two rugby seasons, occurred in non-contact situations and 12% of the injuries occurred without a known reason. Therefore, Sankey et al (2008) suggested that proprioceptive intervention programmes can be valuable in rugby union players to reduce injury. Together with good proprioception, good muscle length and muscle strength are needed to achieve dynamic balance (Plisky et al., 2009). These two factors will be explored in the next sections.

2.6 THE INFLUENCE OF MUSCLE LENGTH ON INJURIES

Hamstring and quadriceps injuries are amongst the most common lower limb injuries sustained in sport (Brooks et al., 2005a, Orchard and Seward 2002). This was confirmed by Brooks et al (2005b) who observed rugby injuries occurring at rugby training sessions as well as by Gabett (2003) who reported that the most training injuries sustained were thigh muscle strains. Gabett (2003) did not define thigh muscle into hamstring or quadriceps muscles. Conflicting research is available with regards to the influence of muscle length on injuries. Many researchers showed that decreased muscle length could be associated with lower limb injuries or pain in the lower limb (Witvrouw et al., 2003; Witvrouw et al., 2000; Hartig and Henderson, 1999). Safran et al (1989) showed that when an athlete stretches a certain muscle the muscle-tendon unit of the specific muscle is the part that benefits the most from the stretch and proposed that the improved flexibility of the muscle-tendon unit reduces muscle strains. This statement was challenged by other researchers who

could not conclude whether inadequate flexibility or excessive suppleness were the predictor for injury (Harvey, 1998; Jones et al., 1993; Taimela et al., 1990). Hrysomallis (2009) concluded that decreased hip adductor flexibility could be a risk factor of lower limb injury in a sport like soccer but also concluded that decreased hip adductor muscle length was not related to injuries in sport like ice hockey or rugby league. Rolls and George (2004), Orchard et al (1997) and Meeuwisse and Fowler, 1988) reported that there were no statistically significant relation between decreased hamstring muscle length and injuries sustained to the lower limbs and concluded that hamstring muscle length does not appear to be the sole reason for hamstring muscle injuries in young, elite and club football players. Drezner (2003) concluded that decreased muscle flexibility might be the result of the injury and not necessary the cause.

In rugby, hamstring injuries were more common in backline players probably due to the demands that rugby put on backline players where they need to run at high speed with quick acceleration and deceleration (Brooks et al., 2005a). The high incidence of hamstring injuries is also said to be due to inadequate hamstring conditioning (Devlin, 2000) as well as decreased hamstring muscle length (Witvrouw et al., 2003). This was backed up by Hartig and Henderson (1999) and Krivickas and Feinberg (1996) when they stated that a stretching programmes may reduce general lower limb injuries. Only one study was found on quadriceps muscle length and the relation to injuries. Gabbe et al (2005) looked at risk factors for hamstring injuries and found quadriceps tightness, assessed by the modified Thomas test, to be a risk factor.

There are many tests available to measure hamstring muscle length: the sit-and-reach test (Baltaci et al., 2003; Orchard et al., 1997; Cornbleet and Woolsey, 1996); the modified sit-and-reach test (Hopkins and Hoeger, 1992); the straight leg raise test (Kendall et al., 1993); the active knee extension test (Gajdosik and Lusin, 1983); the passive knee extension (Fredriksen et al., 1997) and the sitting knee extension test (Butler, 1991). Of these tests the sit-and-reach test is commonly used in clinical settings. This test is easy to set up and easy to use (Lopez-Minarro and Rodriguez-Garcia, 2010; Baltaci et al., 2003) and has showed moderate validity and intratester reliability for measuring hamstring muscle flexibility (Davis et al., 2005; Jackson and

Langford, 1989). Jackson and Baker (1986) and Jackson and Langford (1989) showed the sit-and-reach-test to have moderate validity for measuring hamstring muscle flexibility but poor validity for assessing lumbar spine flexibility.

The Thomas test is a commonly used and important assessment tool in clinical settings to determine quadriceps muscle flexibility (Peeler and Anderson, 2008; Corkery et al., 2007). Although the modified Thomas test has only shown limited reliability (Peeler and Anderson, 2008), the face-validity of the Thomas test has been confirmed by its inclusion in a number of orthopaedic textbooks (Kendall et al., 2005; Magee, 2002; Prentice, 2003).

Krivickas and Feinberg (1996) stated that muscle injuries could be prevented if athletes have sufficient muscle strength to control the muscle length. Lower limb muscle strength will be explored in the next section.

2.7 THE INFLUENCE OF MUSCLE STRENGTH ON INJURIES

Muscle weakness has been believed to be a cause for lower limb injuries in different sports (athletics, ice hockey, Australian football league) where sprinting or changing of direction an important part of the sport is (Yeung et al., 2009; Tyler et al., 2001; Orchard et al., 1997). In Australian football league, Orchard et al (1997) suggested that decreased hamstring muscle strength is a risk factor for hamstring muscle strains. Tyler et al (2001) suggested that groin injuries in ice hockey players could be a result of hip adductor muscle weakness and as a result of decreased hip adductor muscle strength compared to hip abductor strength. They then implemented a preseason hip adductor muscle strengthening programme and concluded that increased hip adductor muscle strength can decrease groin injuries (Tyler et al., 2002). Hip strengthening training programmes have also showed a reduction in pain in patients with various musculoskeletal injuries after a few weeks (Ferber and Kendall, 2007). This correlates with Croisier et al (2008), Cameron et al (2003) and Knapik et al (1991) who reported that lower limb injuries could be due to strength and flexibility imbalances. These imbalances won't necessarily cause injury where the imbalance is but could cause injury anywhere in the lower limb (Knapik et al., 1991). There are also studies where no association between muscle strength and

injury could be found (Emery et al., 2005c; Worrel et al., 1991). No studies could be found that studied the influence of muscle strength on injury in rugby players.

A hand held dynamometer (HHD) is an inexpensive and easy to use tool to use for lower limb muscle strength testing (Kelln et al., 2008; Krause et al., 2007; Reinking 1996). A recent study done on healthy young physically active adults showed HHD testing to be a reliable procedure irrespective of the experience of the tester as long as the tester has the mechanical advantage over the participant and good strength to isometrically resist the participants' maximal contraction (Kelln et al., 2008; Lu et al., 2007). Reinking (1996) found that the tester might be a confounding variable when using the HHD for muscle strength tests and stated that HHD muscle testing should be performed only by one tester.

Mendiguchia and Brughelli (2011) said that decreased muscle endurance of the core muscles might be a bigger risk for sustaining an injury than muscle weakness. Core muscle endurance as a risk factor for lower limb injury will be explored in the next section.

2.8 THE INFLUENCE OF CORE MUSCLE ENDURANCE ON INJURIES

Stability of the lumbar spine is achieved by ligaments as well as the contraction of the following muscles: transverses abdominis, multifidus, internal oblique, external oblique, quadratus lumborum and rectus abdominis (Arokoski et al., 2001; McGill et al., 1999). Mendiguchia and Brughelli (2011) stated that, "core stability depends on the relationship between the passive structures, the ligaments, vertebral facets and the active neuromuscular controllers" and suggested that good contraction of all the core muscle fibres is needed to obtain and maintain stability of the trunk.

In rugby, players are subjected to contact situations. Players are in contact with other players during tackling and this puts the lumbar spine under stress (Bergmark, 1989) and can lead to injuries if there is a lack of core muscle endurance (Evans et al., 2007; Willson et al., 2005). Devlin (2000) reviewed the literature on rugby injuries and proposed that hamstring injuries can be the result when there is fatigue of the

trunk muscles and Sherry and Best (2004) stated that athletes who performed a core stability rehabilitation program had less hamstring injuries compared to the athletes who followed a muscle strength and stretch exercise programme. These studies proposed that core muscle endurance are an important factor to consider in the prevention of lower limb injuries.

To determine the risk for injury, core muscle endurance needs to be measured or tested. Various methods for testing trunk muscle endurance have been described in the literature. Electromyography (EMG) studies (Arokoski et al., 2001) and isokinetic testing (Willson et al., 2005) have been done, but these tests are expensive and time consuming. Timed isometric trunk muscle endurance tests are regularly used in a clinical setting because it is easy to administer and cost effective (McGill et al., 1999; Ito et al., 1996). The isometric tests are the lumbar extensor test, the lumbar flexion test and the side bridge tests (Evans et al., 2007; McGill et al., 1999). Good intra and inter-rater reliability has been shown for these tests (Evans et al., 2007; McGill et al., 1999).

2.9 CONCLUSION

Research done in school rugby populations showed that the lower limb is the most common site for injuries (Gabett, 2008; McManus and Cross, 2004). Previous injury risk factors identified for school rugby players are age, body mass index (BMI), playing position, balance, muscle length and muscle strength. Age showed to be a predictor for injury where older boys are more prone to injury because they start to develop muscle bulk before full musculoskeletal development have taken place (Haseler et al., 2010; Lee and Garraway, 1996). Controversial results have been showed for BMI as a predictor for injury, but Lee et al (1997) suggested that in school boy rugby the somatotype classification and BMI is an important tool to use to assess their developmental rates. The wing and centre position were the playing positions found to be most at risk for sustaining an injury with the flanks and the eighth man position that follows (Nicol et al., 2010; McManus and Cross, 2004). Decreased balance (Trojian and McKeag, 2006) and decreased muscle length (Witvrouw et al., 2003) were factors previously identified as risk factors for lower limb injuries in rugby boys. No literature was found on the effect that decreased lower

limb muscle strength has on lower limb injuries in rugby players, and other literature is inconclusive with research studies having conflicting results. Many studies have been done to explore factors that can have an effect or even cause injuries in rugby, but many more are needed to support the literature that has already been done.

CHAPTER 3

METHODOLOGY

This chapter explains the methods used to conduct the study. The procedure of how data collection was done as well as the ethical considerations related to the research report will be described in part one of this chapter. A description of the instrumentation and tools used in this study as well as the pilot study is provided in detail in part two of this chapter.

PART 1

3.1 METHODOLOGY

3.1.1 Study design

This study was a prospective cohort design. The objectives of the study were to determine school boy rugby players' pre-season baseline characteristics including previous injuries sustained as well as to document the lower limb injuries sustained during one season and to determine the association between the various factors measured and the incidence of injuries during the six weeks.

3.1.2 Study population

There are 28 high schools on the West Rand. Ten of these play rugby as a major sport. The schools are divided into different leagues, by the Lions Union, according to the number of boys in the school. These leagues are a medium, large and a macro school league. Only two schools are playing in the macro school league and the researcher is involved at one of the schools. The large school league consists of six schools of which four schools are located on the West Rand. These four schools were conveniently chosen for the study.

3.1.2.1 Sample selection

All four schools on the West Rand that participates in the Gauteng large high school rugby league were contacted to be part of the study. One of the schools declined.

3.1.2.2 Sample size

In this study eight potential risk factors were explored: Forward or backline players, previous injury, age, Body Mass Index, level of play, muscle strength, muscle length and balance. There were 80 participants calculated by a power calculation, ten participants per factor (Nunnally, 1978).

3.1.2.3 Inclusion criteria

Male participants between the ages of 16 and 18, that play rugby as their primary sport at their school for the under 16, second or first teams. In 2010 a player was allowed to play for an under 16 side if he was born in the year 1994. Although he might have turned 16 already, he will play for the under 16 side.

3.1.2.4 Exclusion criteria

Participants were excluded from the study if they were suffering from headaches or a cold on the day of data collection or if they had a chronic vestibular dysfunction. Participants with a history of a lower limb injury in the month prior to testing or with a history of a concussion within three months prior to the testing day were excluded due to the extent of the tests to be conducted.

3.1.3 Study tools

The study tools used in this study included: An injury questionnaire (appendix A), a rugby exposure form (appendix B), a data form to collect anthropometric data, leg length, balance scores, muscle length scores and muscle strength scores (appendix C) and a data form for injuries (appendix D). A full description of how these tools were used is given in part two of chapter three.

3.1.4 Study procedure

The rugby organizer of all four schools on the West Rand that participated in the 2010 Gauteng large school rugby league was contacted prior to the start of the season. Three schools agreed to participate in the study. A meeting was held with each of the three schools' rugby organizers. The aim of the study as well as the

procedure of the study was explained to the rugby organizers of each school. Information sheets and consent forms were given to the organizers to distribute to the scholars in the under 16, second and first rugby teams.

Consent forms had to be signed by the parents for each participant under the age of 18 and assent forms had to be signed by all participants. The injury questionnaire was completed by each participant. Each questionnaire was given a number to keep the information anonymous. Pre-season testing was done at the three schools. The testing was performed in a big class room at one of the schools and in the gymnasium hall at the other two schools. At each school stations were set up for each test done. The tests were not done in a specific order. Each participant received his own numbered data collection form that correlated to their injury questionnaire number. The participants were barefoot with all the tests.

Three testers conducted individual tests. All three testers were qualified physiotherapists trained to perform the various tests. Tester one conducted the following measurements and tests: height and weight (BMI), leg length, quadriceps muscles strength through knee extension and three of the four core muscle endurance tests: the lateral musculature tests and the trunk extensor test. Tester two conducted the remaining muscle strength tests: tibialis anterior muscle testing through dorsiflexion and gastrocnemius muscle testing through plantar flexion and gluteus medius muscle strength through hip abduction. Tester two also tested and measured the remaining core muscle endurance test: the trunk flexor test and the two muscle length tests: quadriceps and hamstring muscle length test. Tester three conducted the balance tests: the SLB test and the SEBT.

The key researcher contacted the coach of the respective rugby teams once a week to ask about injuries sustained. If there was an injury sustained, the researcher went to the school the same or the following day to assess the injuries and documented the injury details on the injury data form.

3.1.5 Ethical considerations

Ethical approval was obtained from the Human Research Ethics Committee of the University of the Witwatersrand and the Educational Department of Gauteng (appendix E). Informed consent was obtained from the headmaster of each participating school (appendix F), the parents or guardians where participant were under the age of 18 (appendix I) and assent was obtained from all participants prior to any testing (appendix J).

Together with the consent forms an information sheet (appendix G, appendix H) was given wherein the procedures of testing and data collection were explained. It was also explained that refusal to participate or withdrawal from the study would not in any way affect their school work or sport participation.

3.1.6 Pilot study

A pilot study was done on a comparable group of players (n=12) not involved in the main study. The pilot study was done to make sure of the comprehensibility of the school boy rugby players with regards to the questionnaire and the practicality of some of the tests. The questionnaire was changed as suggested by the participants which parts of the questionnaire were changed-include those here. Each participant completed each test three times. The single leg balance (SLB) test and the star excursion balance test (SEBT) were performed. For the single leg balance test the testing procedure was maintained as per protocol. The SEBT was done and the researcher found that the lines for the reach distances were too short (1.5m measuring tapes were used). New measuring tapes of three meters each were then used for the data collection of the study.

All the muscle strength and muscle length tests were done to test for practicality. Muscle testing was done and it was clear that the researcher conducting the knee extension tests was not strong enough to resist the school boys' muscle strength. Two changes were made: the position of the knee extension test was changed from the participant sitting over the side of a plinth and extending the knee to the participant lying prone with the knee flexed to 90˚ and then performing knee extension. The latter position gave the researcher the mechanical advantage over

the school boy. For the study another, stronger, researcher performed the knee extension strength tests. All the other tests were done without any complications.

3.1.7 Data analysis

Descriptive statistics of categorical variables was done using frequency distribution tables. The numerical variables were described by the use of means and standard deviations. t-tests were used to compare numerical variables across the groups. Univariate analysis (logistic regression) was done to determine if there were any associations between various factors (age, BMI, previous injury, player position, level of play, muscle strength, muscle length and balance) and sustaining an injury. t-tests, 95% confidence interval and p-values are presented in tables in Chapter four. The level of significance was $p \leq 0.05$.

PART 2

3.2 RESEARCH TOOLS

3.2.1 Injury questionnaire (Appendix A)

A questionnaire was used with the aim to establish exclusion criteria and players' demographic data as well as to establish possible factors that could be a risk for sustaining injuries on the rugby field. An already developed questionnaire for rugby players (Mellet, 2009) was adjusted after review by four qualified physiotherapists who work in the area of sports, school rugby coaches and by using relevant information from literature (Gabbe et al., 2004) to establish relevant information for rugby players and associated injury.

Part one of the questionnaire asked questions to determine exclusion criteria. Part two included general information about the player. Each participant had to fill in their respective date of birth, the position that they usually play as well as an alternative position if they had one and their preferred kicking leg. The participants had to differentiate between school level and provincial level for years, 2008 and 2009 with respect to their highest level of participation. The questionnaire provided an injury classification order where each participant had to describe the previous injuries that they had sustained in the 2009 season. The 2009 season included the league as well as other games and tournaments they played over a six month period. The injuries were classified according to site and severity, as well as the treatment received by the participants after sustaining the injury. On the questionnaire there was also a section regarding what other sport each participant played, apart from rugby, and the participation level in that sport as well as the frequency of training. This information was analyzed to see if they are risk factors for sustaining injuries.

To ensure that the questionnaire was easy to understand and to complete a pilot study was done on a comparable group of players not involved in the main study and changes were made as suggested by the participants. The changes were made for better understanding by the population group. Vestibular dysfunction was changed to 'dizziness' and cerebral concussion was edited to only state 'concussion'. The

researcher was available to answer questions during the answering of the questionnaire and players could ask questions if they were required to do so.

3.2.2 Rugby Training exposure form (Appendix B)

The coaches of all teams involved were given a form for training exposure to complete before the season started. This self-developed form gave insight on what type of training and how much training the coach planned for the players. Coaches were able to choose from rugby fitness training; rugby skill training; stretching before and after training; gymnasium work; balance training and other training. 'Other training' had to be specified. The coaches had to fill in the planned duration of training sessions, the frequency thereof and the training surfaces they use. This information was included and evaluated as extrinsic factors that played a role on injuries sustained throughout the season.

3.2.3 Anthropometric data, leg length, balance tests, muscle length and muscle strength data form (Appendix C)

After the injury questionnaire was completed and collected, each participant received a data collection form. Each section of the data collection form was completed by the relevant tester after each test was done. The participant then proceeded to the next station with his data collection form.

The data collection form consisted of the following sections:

3.2.3.1 Body mass index (BMI)

The World health Organization defines BMI as a standard index for evaluating overweight adults. BMI is calculated using the formula BMI index (BMI = kg/m^2), which is mass (kg)/height in metres squared (King et al., 2005).
Body weight was measured in kilograms using a WS 80 Microlife digital scale to the closest 100g. The scale was calibrated using a known weight. To ensure consistency with the height measurement, a cloth tape was anchored in one place and the same place was used consistently at each school. Each player's weight and height were recorded prior to the other tests.

3.2.3.2 Leg length

Leg length is the distance from the most distal part of the anterior superior iliac spine to the most distal part of the lateral malleolus of the respective side's ankle (Plisky et al., 2006). Leg length was measured in a supine position with a cloth tape measure. To align the pelvis the participant was asked to bend his knees and to lift his hips from the plinth. The researcher then passively straightened the participant's legs. The right leg was measured first and then the left leg. The measurement was taken to the closest millimeter. Two measurements were taken on each leg and the mean was used for further analysis (Gurney, 2002; Beattie et al., 1990). One tester, experienced in measuring leg length, was responsible for the leg length measurements. The tape measure method for measuring leg length has shown acceptable validity and reliability when used as a screening tool (Gurney, 2002; Beattie et al., 1990).

3.2.3.3 Balance testing

a) The single leg balance (SLB) test

The SLB test was used to determine static balance (Trojian and McKeag, 2006). The participants stood on one foot without shoes (first on the right and then on the left) with the contralateral knee flexed and not touching the weight bearing leg. Participants focused on a mark on the wall and then closed their eyes for ten seconds. An experienced physiotherapist that administered the test observed and reported movement of the weight bearing foot, touching on the floor with the non-weight bearing foot, touching of the legs and movement of the arms from the starting position. If there was any of these observations the SLB test was scored a failed test. Failed tests led to a second trial. The second trial's results were then documented and used for analyses (Trojian and McKeag, 2006). Harrison et al (1994) found the SLB test to be a reliable test if evaluated by a physical therapist, with moderate concurrent validity.

b) The modified star excursion balance test (SEBT)

The modified SEBT was used to test the participants' dynamic balance ability. Plisky et al (2009) used a modified form of the SEBT to test dynamic balance. Anterior, posterior lateral and posteromedial was the directions in which the balance test was

performed. The SEBT grid was precisely measured and taped to the floor at each school. Three cloth measuring tapes of 3m length each were secured to the floor in an upside down Y figure. The two posterior lines formed a 90° angle and were each positioned 135° from the anterior tape. The angle was precisely measured with a protractor.

The SEBT was performed with the participants standing in the middle of the grid formed by the three lines. The participant received verbal instructions and a visual demonstration of the test before the test was administered. The participants each had six practice trials on each leg in the three directions (anterior, posterior medial and posterior lateral) to account for any learning effect. The participants had three trials reaches with 15 seconds rest between reaches (Plisky et al., 2006). The participants had to lightly touch the furthest point on the line with their toes while keeping their balance and then had to return to the starting position. The examiner then measured the reach distance. The best of the three reaches for each leg in each of the three directions was documented. Reach distance was expressed as a percentage of limb length by using an equation also used by Gribble and Hertel (2003), [(reach distance/ leg length) x 100]. If the tester thought that the participant used his reach leg to obtain balance, lost control of the stance leg or lifted his weight bearing leg the trial was discarded and repeated. The SEBT has been shown to be a reliable and valid instrument for assessing dynamic postural control (Olmsted et al., 2002; Hertel et al., 2000).

3.2.3.4 Flexibility testing

a) Quadriceps muscle length

The modified Thomas test previously done by Peeler and Anderson (2008) is a common and easy to use assessment tool to evaluate rectus femoris muscle flexibility (Corkery et al., 2007). Quadriceps muscle length was measured while the participant was lying supine on the edge of the plinth with knees bent over the edge of the plinth. The participant was instructed to flex one knee to his chest and to keep his leg in that position. The quadriceps muscle of the non-flexed leg was the one tested. The test leg's hip and posterior thigh had to stay in contact with the plinth. Knee flexion was measured with a goniometer with the goniometer's rotation axis set

at the fibula head and the stationary arm directing towards the greater trochanter of the testing leg's femur and the moving arm directed towards the lateral malleolus of the fibula (Peeler and Anderson, 2008; Harvey, 1998). The test was scored a 'pass' or a 'fail' depending on the amount of knee flexion of the leg being tested. Knee flexion of 90° and above using a goniometer was scored a 'pass' and knee flexion less than 90° was scored a 'fail' (Peeler and Anderson, 2008; Harvey, 1998). The modified Thomas test has shown good reliability (Aalto et al., 2005; Harvey, 1998). One tester performed all the quadriceps muscle length measurements.

b) Hamstring muscle length

The sit-and-reach-test was performed to evaluate hamstring muscle length. The sit-and-reach test is commonly used as a field test to measure hamstring muscle length because it is easy to administer and require little skill (Lopez-Minarro and Rodriguez-Garcia, 2010). Hamstring muscle length was measured by the participant executing the sit-and-reach- test. A standard sit-and-reach box was used. The participant sat with one leg (first the right and then the left) extended and with the foot flat against the end of the box. The participant extended his arms forward, placing one hand on top of the other. With palms facing down, the participant reached forward as far as possible without bending the knee of the extended leg (Baltaci et al., 2003). Three measurements were taken for each leg tested and the best of the three readings was used for further analysis (Baltaci et al., 2003). Baltaci et al (2003) and Davies et al (2005) showed moderate intratester reliability and criterion-related validity for the sit-and-reach test.

3.2.3.5 Muscle strength testing

3.2.3.5.1 Lower limb muscle strength testing

Lower limb muscle strength was measured with a MicroFET2 hand held dynamometer (HHD) using the make test procedure where the participant applies a maximal force against the HHD held by the tester (Bohannon, 1988). The HHD has been shown to be a reliable and valid tool for measuring muscle force (Kelln et al., 2008). Tester one was responsible for all the quadriceps muscle strength tests, while tester two conducted all the muscle testing tests for gastrocnemius strength, tibialis anterior and gluteus medius strength. Each participant had three trials to score

maximal results on each leg for all muscle groups tested. The mean score was used for analyses (Kelln et al., 2008).

Quadriceps strength, gastrocnemius strength, tibialis anterior and gluteus medius strength was tested for the right and the left limb respectively. Testing positions were chosen to offer testers the greatest possible mechanical advantage over the participant (Kelln et al., 2008).The participant were required to reach a maximal effort after three to five seconds. No rest period was given between the tests (Bohannon, 1988). The mean of the three trials were calculated and used for analysis. The procedure of muscle testing was explained to all participants before the testing started. The procedures used for strength and endurance tests for each muscle group are explained in the following paragraphs.

a. Knee extensors (quadriceps)

The knee extensor muscles were tested with the participant lying prone, with the tested leg's knee flexed. The HHD was placed two centimeters above the lateral maleolus on the anterior surface of the leg. The participant extended the knee against the HHD. The participant's hips were stabilized by the coach or manager of the respective testing team by holding the hips down so that the participant cannot lift his hips of the bed while being tested (Kelln et al., 2008).

b. Ankle plantarflexors

The ankle plantar flexors were tested while the participant was lying supine on the plinth. The participant plantar flexed the ankle against the HHD that was held two centimeters proximal to the metatarsophalangeal joint on the plantar surface of the foot. The participant's leg was manually stabilized just proximal to the ankle by the tester's non dominant hand (Bohannon, 1986).

c. Ankle dorsiflexors

The ankle dorsiflexors were tested while the participant was lying supine on the plinth. The participant dorsiflexed the ankle against the HHD that was held two centimeters proximal to the metatarsophalangeal joint on the dorsal surface of the foot. The participant's leg was manually stabilized just proximal to the ankle by the tester's non dominant hand (Kelln et al., 2008).

d. Hip abductors

The hip abductors was tested with the participant lying supine on the plinth. The tested side's knee was kept extended while abducting the hip against the HHD that were placed two centimeters proximal to the lateral epicondyle of the femur on the lateral surface of the thigh (Kelln et al., 2008).The patient's non testing hip was stabilized by the testers free hand.

3.2.3.5.2 Core muscle endurance strength testing

Core muscles endurance strength was tested by executing four isometric tests. Reliability and validity of the four isometric tests was shown by Nesser and Lee (2009). Flexion, extension and right and left lateral flexion trunk tests were performed. The procedure of testing was explained to all participants before the testing started. Participants were encouraged to hold the test position until fatigue set in by receiving constant feedback on their body position. Tests were terminated if they could not maintain the correct holding position. The time that the participant was able to hold each isometric position was timed with a Mr Price Sport Maxed hand-held stop watch (McGill et al., 1999).

e. Trunk flexion test

The trunk flexion test was done with the participant positioned with his back against a wooden block that was angled at a 60°angle to the floor. The participant's knees had to be flexed to 90°, feet shoulder width apart and the arms folded across the chest with the hands on the opposite shoulder. To start the test, the jig was pulled back 10cm and the participant was to hold the position for as long as he could. The time was stopped when the participant moved out of the starting position (McGill et al., 1999).

f. Trunk extensor test

The trunk extension test was done with the participant lying prone on a plinth, while his pelvis and knees were secured to the plinth by broad Velcro strips. The participant supported his upper body, which was hanging freely from the plinth, on a step until the test commenced. With the start of the extensor test the participant

folded his arms across his chest with his hands on the opposite shoulder and extended his trunk to level with the plinth. The time was stopped when the participant's upper body dropped below the horizontal position (McGill et al., 1999).

g. Lateral flexor trunk test

Each participant was tested in a full side-bridge position. The participant laid on his right (and then the left) side, supported on his forearm and the other arm crossed over his chest, with his legs extended and feet on top of each other. The participant was then asked to lift his hips off the floor to create a straight line from head to toe. The time was stopped when the participants' hips touch the floor or when he lost the straight back position (McGill et al., 1999).

The above factors were evaluated as numerical variables and were included in the data analyses to determine if any of these factors were risk factors for sustaining an injury.

3.2.4 Injury sustained data form (Appendix D)

The form was used to document injuries that occurred during the 2010 rugby league season. The injury data collection form used in this study was developed by McManus (2000). The form categorized and defined the severity of injuries in four groups: The term minor injuries was used when the injured player was able to return to the game or training in which the injury occurred. The term mild injuries were used when the injured player missed one week of training and/ or game time. Moderate injuries were used when the player missed two weeks and the term, severe injuries, was used when the player missed more than two weeks' training or games.

Players' demographic data were collected when completing the form: a player's name, age and the position he played. The form included questions about the site and mechanism of injury, the phase of play were the injury occurred, if the phase of play were legal or not and the time when the injury occurred. The form also includes weather and field conditions that may play a role in injury occurrence. The injury sustained data-form was validated for content and criterion validity as well as inter-rater and intrarater reliability (McManus, 2000).

3.3 CONCLUSION

An injury questionnaire form to establish each player's demographic data as well as possible factors that could be a risk for sustaining injuries on the rugby field was used. A data collection form was used to document each player's body mass index (BMI), leg length, balance scores, quadriceps and hamstring muscle length, lower limb muscle strength and the core muscles endurance strength measurements. The injury data form was used to document injuries that occurred during the 2010 rugby season.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

Before the start of the 2010 rugby union league data were obtained from the three schools that gave consent. This chapter presents the main results found in this study. A description of the demographic data will be given as well as factors that were thought to influence the occurrences of injuries.

4.2 DEMOGRAPHIC DATA

There were 80 participants. Five participants reported lower limb injuries sustained in the month prior to the day of testing, three participants were complaining of illness or flu symptoms on the day of testing and one participant had a history of a recent concussion episode. These players were excluded and did not do the tests. Seventy one participants met the inclusion criteria and performed the various tests. Unfortunately six participants did not complete all the tests due to different reasons and were unable to complete the tests on a different day. Their data were not included for final data analyses.

The demographic data of the 65 participants that met all the inclusion criteria and completed all the tests are presented in Table 4.1 under the two major positions: forwards and backs.

Table 4.1 Demographic data (n=65)

DEMOGRAPHIC VARIABLES	**FORWARDS**	**BACKS**
n= 65	37 (57%)	28 (43%)
	MEAN *(SD)*	**MEAN *(SD)***
AGE	17.08 *(±0.77)*	17.16 *(±0.78)*
WEIGHT (kg)	83.99 *(±11.79)*	67.84 *(±9.55)*
HEIGHT (cm)	179.23 *(±6.71)*	176.05 *(±7.34)*
BMI(kg/m^2)	26.15 *(±3.37)*	21.83 *(±2.16)*
	n*(%)*	**n*(%)***
RIGHT LEG DOMINANCE	31 (84%)	25 (89%)
PROVINCIAL LEVEL	8 (22%)	6 (21%)

Of the participants 37 (57%) were forward players and 28 (43%) were backline players. In the previous season (2009) all the participants played rugby at school level with 8 (22%) of the forwards and 6 (21%) of the backline players competing at a higher (provincial) level as well.

4.3 PREVIOUS INJURIES

In the injury questionnaire the participants were asked to report their injuries that were sustained in the previous season (2009). Altogether there were 29 previous injuries reported. Table 4.2 presents the area distribution and the severity of the injuries sustained in the 2009 season.

Table 4.2: Distribution and severity of injuries sustained in the 2009 rugby season (n=29)

AREA OF INJURY	POSITION		SEVERITY OF INJURIES			
	FORWARDS n=16	BACKS n=13	MINOR n	MILD n	MODERATE n	SEVERE n
HIP	1	2	1	2		
GROIN	0	0				
QUADRICEPS	0	1		1		
HAMSTRINGS	0	1		1		
KNEE	7	4	4	3	3	1
CALF	0	0				
TIBIA / SHINS	1	2	1	1		1
ANKLE	6	3	4	1	3	1
FOOT	1	0				1
TOTAL:	16 (55%)	13 (45%)	10	9	6	4

The forward players sustained the most injuries [55% (16)]. The knee [38% (11)] and the ankle joint [31% (9)] were the locations were the most injuries occurred. The injuries reported were minor to moderate in severity for most of the players. Injuries were defined and categorized according to the definition given by McManus (2000). Minor injuries were injuries where the injured player was able to return to the game or training in which the injury occurred. The term mild injury was used when the injured player missed one week of training and/ or games after he had sustained an injury. The term moderate injury was used when the player missed two weeks and the term severe injury was used when the player missed more than two weeks of training or games.

4.4 INJURIES OCCURING DURING THE LEAGUE

Injuries that occurred during the six weeks of the 2010 rugby league were documented and the area distribution and the severity of these injuries are presented in Table 4.3.

Table 4.3: Distribution and severity of injuries sustained in the 2010 rugby season (n=6)

AREA OF INJURY	POSITION		SEVERITY OF INJURIES			
	FORWARDS n=2	BACKS n=4	MINOR n	MILD n	MODERATE n	SEVERE n
HIP						
GROIN						
QUADRICEPS		1	1			
HAMSTRINGS						
KNEE		2		2		
CALF						
TIBIA / SHINS						
ANKLE	2	1	1	1		1
FOOT						
TOTAL:	2	4	2	3	0	1

Of the forward players two players sustained injury and four of the backline players were injured. The most frequent injuries were to the ankle (3) and to the knee (2) with these injuries being classified as minor and mild injuries. Only one severe injury occurred where the player was unable to participate for longer than two weeks.

4.5 FACTORS ASSOCIATED WITH INJURIES

4.5.1 INTRODUCTION

Factors that could be associated with injuries and that were observed during the pre-season are presented in Table 4.4 to Table 4.10.

4.5.2 MUSCLE LENGTH

Hamstring muscle length and quadriceps muscle length were measured on both the right and the left leg. Table 4.4 – Table 4.6 shows the outcome of the tests. Hamstring length was measured in centimeters and quadriceps muscle length was given a “pass” or a “fail” result depending on the outcome of the Thomas test (Peeler and Anderson, 2008). Table 4.4 presents the results that show the difference in hamstring muscle length between the forward and the backline players’ right and left legs. These results were determined with a two sample t test with equal variances.

Table 4.5 presents the results, determined by a paired t test, that show the difference between the forwards' right and left hamstring length as well as the results for the backline players. Table 4.6 presents the results of the quadriceps muscle length testing. The results compare the quadriceps muscle length on the right leg of the forward players and the backline players as well as the quadriceps muscle length on the left leg of the forward players and the backline players.

Table 4.4: The difference in sided hamstring muscle length for forward and backline players (n=65)

POSITION OF PLAYERS								
		FORWARDS			BACKS			p-VALUE
n= 65		n=37 (57%)			n=28 (43%)			
MUSCLE LENGTH		**MEAN *(SD)***	**STD ERROR**	**95% CI**	**MEAN *(SD)***	**STD ERROR**	**95% CI**	
HAMSTRING	RIGHT	30.97cm (±8.17)	1.34	28.25 - 33.70	31.57 cm (±5.88)	1.11	29.29-33.85	0.74
HAMSTRING	LEFT	30.20 cm (±7.60)	1.25	27.67-32.74	31.16 cm (±6.42)	1.21	28.67-33.65	0.59

Table 4.5 presents the results, determined by a paired t test, that show the difference between the forwards' right and left hamstring length and the results for the backline players' right and left hamstring length.

Table 4.5: The difference between a specific group's right and left hamstring muscle length (n=65)

HAMSTRING MUSCLE LENGTH								
		RIGHT			**LEFT**			
POSITION OF PLAYERS	**n= 65**	**MEAN *(SD)***	**STD ERROR**	**95% CI**	**MEAN *(SD)***	**STD ERROR**	**95% CI**	**p-VALUE**
FORWARDS	n=37 (57%)	30.97cm (±8.17)	1.34	28.25-33.70	30.20 cm (±7.60)	1.25	27.67- 32.74	0.22
BACKS	n=28 (43%)	31.57cm (±5.88)	1.11	29.29-33.85	31.16 cm (±6.42)	1.21	28.67-33.65	0.47

Table 4.6 presents the results of the quadriceps muscle length testing. The results compare the quadriceps muscle length on the right and left leg of the forward and backline players.

Table 4.6: Forward and backs quadriceps muscle length (n=65)

		POSITION OF PLAYERS n= 65			
MUSCLE LENGTH		**FORWARDS**		**BACKS**	
		n=37 (57%)		n=28 (43%)	
		n (%) pass	n (%) fail	n (%) pass	n (%) fail
QUADRICEPS	RIGHT	7 (19)	30 (81)	13 (46)	15 (54)
QUADRICEPS	LEFT	9 (24)	28 (76)	9 (32)	19 (68)

Table 4.4 showed the results when comparing one sided hamstring muscle length between the forward players and the backline players. No significant difference of muscle length was seen for either the right side (p=0.74) nor the left side (p=0.59). A paired t-test (Table 4.5) showed no significant difference between the forwards' left and right hamstring length (p=0.22) nor between the backs' left and right hamstring length (p=0.47). With the quadriceps muscle length test, specific to rectus femoris, less than 50% of the players passed the length test on either side.

4.5.3 MUSCLE STRENGTH

Muscle strength of the lower limb muscles was tested with a hand held dynamometer (HHD) and core muscle endurance was tested with four isometric tests: the trunk flexor test; the trunk extensor test and a left and a right lateral flexion trunk test (McGill et al., 1999). Table 4.7 shows the results of the HHD testing. Table 4.8 shows the results of the core muscle endurance tests. Only sixty-three participants completed the lateral flexion test on the right and left side as four participants complained of an injury of either the shoulder or the elbow.

Table 4.7: Forwards and backs muscle strength (n=65)

POSITION OF PLAYERS n=65								
		FORWARDS			**BACKS**			
		37 (57%)			28 (43%)			
HHD TESTING (N=Newton)		**MEAN *(SD)* *N***	**STD ERROR**	**95% CI**	**MEAN *(SD)* *N***	**STD ERROR**	**95% CI**	**p-VALUE**
MUSCLES								
QUADRICEPS	RIGHT	141.14 (±27.06)	4.45	132.12-150.16	131.97 (±20.75)	3.92	123.93-140.02	0.14
(knee extension)	LEFT	146.06 (±31.08)	5.11	135.70-156.43	130.69 (±23.34)	4.41	121.64-139.74	**0.03***
TIBIALIS ANTERIOR	RIGHT	75.64 (±10.87)	1.79	72.02-72.27	78.04 (±8.82)	1.67	74.61-81.46	0.35
(ankle dorsiflexion)	LEFT	70.12 (±15.29)	2.51	65.02-75.22	68.98 (±13.52)	2.55	63.74-74.22	0.76
GASTROCNEMIUS	RIGHT	93.62 (±12.30)	2.02	89.52-97.72	89.84 (±10.98)	2.07	85.58-94.09	0.20
(ankle plantar flexion)	LEFT	85.35 (±14.20)	2.33	80.61-90.08	83.10 (±10.41)	1.97	79.06-87.14	0.50
GLUTEUS MEDIUS	RIGHT	211.33 (±32.83)	5.40	200.39-222.28	208.91 (±42.64)	8.06	192.37-225.00	0.80
(hip abduction)	LEFT	167.96 (±34.50)	5.67	156.46-179.46	161.64 (±25.47)	4.81	151.76-171.52	0.42

Table 4.8: Forwards and backs core muscle endurance strength tests (n=65)

POSITION OF PLAYERS n=65							
	FORWARDS			BACKS			
	37 (57%)			28 (43%)			
CORE STRENGTH (Seconds=sec)	**MEAN *(SD)* *(sec)***	**STD ERROR**	**95% CI**	**MEAN *(SD)* *(sec)***	**STD ERROR**	**95% CI**	**p-VALUE**
MUSCLES							
RECTUS ABDOMINIS	319.05 (±161.40)	26.53	265.24-372.87	401.21 (±185.43)	35.04	329.31-473.12	0.06
QUADRATUS LUMBORUM	120.51 (±51.52)	8.47	103.34-137.69	143.25 (±57.56)	10.88	120.93-165.57	0.10
	FORWARDS			BACKS			
	36			27			
RIGHT INTERNAL OBLIQUE AND LEFT EXTERNAL OBLIQUE	64.03 (±27.84)	4.64	54.61-73.45	75.22 (±24.88)	4.79	65.38-85.07	0.10
LEFT INTERNAL OBLIQUE AND RIGHT EXTERNAL OBLIQUE	64.64 (±28.90)	4.82	54.86-74.42	73.96 (±25.25)	4.86	63.97-83.95	0.19

When the forward and backline players were tested for muscle strength differences only the left quadriceps strength showed a significant difference (p=0.03).

4.5.4 BALANCE

Two balance tests were conducted namely the star excursion balance test (SEBT) and the single leg balance (SLB) test. Tables 4.9 to 4.11 shows the results obtained for these balance tests. Table 4.9 presents the results that show the difference between the forwards and the backs reach distances for different reach directions calculated with a two sample t test with equal variances. Table 4.10 presents the results, determined with a paired t test, that show the difference between the right and the left stance for the forward players and the difference between the right and the left stance for the backline players for each different reach direction.

Table 4.9: SEBT reach distance: The difference between the right and the left stance for forward and backline players for each direction (n=65)

POSITION OF PLAYERS n = 65							
	FORWARDS			BACKS			
n= 65	37 (57%)			28 (43%)			
SEBT	**MEAN *(SD)* *cm***	**STD ERROR**	**95% CI**	**MEAN *(SD)* cm**	**STD ERROR**	**95% CI**	**p-value 0.05**
RIGHT STANCE							
Reach direction							
ANTERIOR	81.41 (±15.39)	2.53	76.34 - 86.60	82.51 (±8.32)	1.57	79.28 – 85.74	0.75
POSTERIOR MEDIAL	129.50 (±16.00)	2.63	124.17 - 134.83	131.40 (±17.30)	3.27	124.69 - 138.11	0.65
POSTERIOR LATERAL	115.46 (±13.80)	2.27	110.86 - 120.07	117.50 (±18.20)	3.44	110.45 - 124.56	0.61
LEFT STANCE							
Reach direction							
ANTERIOR	82.85 (±14.00)	2.30	78.18 - 87.52	83.32 (±12.20)	2.31	78.59 - 88.05	0.89
POSTERIOR MEDIAL	134.50 (±18.68)	3.07	128.27 - 140.73	136.12 (±14.62)	2.76	130.45 - 141.79	0.70
POSTERIOR LATERAL	117.15 (±15.98)	2.63	111.82 - 122.47	121.50 (±15.03)	2.84	115.66 - 127.32	0.27

Table 4.10: SEBT reach distance: The difference between a specific group's right and left reach distance for each direction (n=65)

		RIGHT STANCE			LEFT STANCE			
		MEAN (SD) (cm)	**STD ERROR**	**95% CI**	**MEAN (SD) (cm)**	**STD ERROR**	**95% CI**	**p-value 0.05**
ANTERIOR REACH								
FORWARDS	37	81.47 (±15.39)	2.53	76.34 - 86.60	82.85 (±14.00)	2.3	78.18- 87.52	0.35
BACKS	28	82.51 (±8.32)	1.57	79.28 - 85.74	83.32 (±12.20)	2.31	78.59- 88.05	0.70
POSTERIOR MEDIAL REACH								
FORWARDS	37	129.50 (±15.99)	2.63	124.17- 134.83	134.50 (±18.68)	3.07	128.27- 140.73	**0.005**
BACKS	28	131.40 (±17.30)	3.27	124.69- 138.11	136.12 (±14.62)	2.76	130.45- 141.79	**0.004**
POSTERIOR LATERAL REACH								
FORWARDS	37	115.46 (±13.80)	2.27	110.86- 120.07	117.15 (±15.98)	2.63	111.82- 122.47	0.26
BACKS	28	117.50 (±18.20)	3.44	110.45- 124.56	121.49 (±15.03)	2.84	115.66- 127.32	**0.03**

Two-sample t tests with equal variances were done and showed no significant difference between the backline players and forward players SEBT reach distance results (Table 4.9). Paired t-tests were done to compare the left and right limbs' reach distance for the same reach direction (Table 4.10). No significant difference was seen for the right and left anterior reach for either the forwards (p=0.35) or the backs (p=0.70) and no significant difference was seen for the forward players posterior lateral reach (p=0.26). The backs showed a significant difference between the left and right posterior lateral reach with a p-value of 0.03. For the posterior medial reach the forward players showed a p-value of 0.005 and the backs a p-value of 0.004.

Table 4.11: Forward and backs Single Leg Balance test results (n=65)

POSITION OF PLAYERS n=65		
SLB TEST	**FORWARDS**	**BACKS**
n= 65	37 (57%)	28 (43%)
RIGHT STANCE	n (%)	n (%)
Passed	28 (76)	23 (82)
Failed	9 (24)	5 (18)
LEFT STANCE		
Passed	30 (81)	19 (68)
Failed	7 (19)	9 (32)

The results of the SLB test showed that 76% (28) of the forward players and 82% (23) of the backline players passed the SLB test on the right leg and 81% (30) of forward players and 68% (19) of the backline players passed the SLB test on the left leg.

4.6 RISK FACTORS

Logistic regression analysis was used to determine the association of the different risk factors with lower limb injury. The results are summarized in Table 4.12.

Table 4.12: Factors associated with injury

VARIABLE	ODDS RATIO	STD ERROR	95% CONFIDENCE INTERVAL	P-VALUE
FORWARDS/BACKS	0.34	0.31	0.06- 2.02	0.24
PREVIOUS INJURY	0.63	0.57	0.11- 3.74	0.62
AGE	2.02	1.32	0.56- 7.31	0.23
BMI (Kg/m^2)	0.99	0.12	0.78- 1.25	0.93
LEVEL OF PLAY	4.36	3.8	0.77- 24.60	0.10
MM STRENGTH				
Knee ext right	1.03	0.01	1.00- 1.06	**0.05***
Knee ext left	1.02	0.01	1.00- 1.04	0.10
Ankle DF right	1.13	0.07	1.00- 1.27	**0.04***
Ankle DF left	1.02	0.03	0.97- 1.07	0.47
Ankle PF right	1.05	0.05	0.96- 1.15	0.25
Ankle PF left	1.03	0.03	0.97- 1.10	0.35
Hip abd right	0.99	0.01	0.97- 1.01	0.44
Hip abd left	0.98	0.02	0.95- 1.01	0.30
Trunk ext	1.00	0.01	0.98- 1.01	0.78
Trunk lateral flexion on the right	0.98	0.02	0.94- 1.02	0.31
Trunk lateral flexion on the left	1.00	0.02	0.96- 1.03	0.96
MM LENGTH				
Quadriceps right	0.88	0.80	0.15- 5.24	0.87
Quadriceps left	2.02	2.30	0.22- 18.62	0.53
Hamstring right	1.18	0.10	1.01- 1.39	**0.04***
Hamstring left	1.16	0.09	1.0- 1.35	**0.05***
BALANCE				
SEBT RIGHT stance				
Anterior	0.99	0.04	0.93- 1.07	0.85
Posterior-medial	1.01	0.03	0.96- 1.06	0.75
Posterior-lateral	1.00	0.03	0.95- 1.06	0.92
SEBT LEFT stance				
Anterior	1.00	0.03	0.94- 1.07	0.91
Posterior-medial	1.00	0.03	0.95- 1.05	0.92
Posterior-lateral	1.04	0.03	0.98- 1.11	0.21
SLB RIGHT	0.71	0.81	0.08- 6.60	0.76
SLB LEFT	3.54	3.10	0.64- 19.65	0.15

Logistic regression analysis shows an association between injury and knee muscle strength of the extensors (p=0.05) and ankle dorsiflexors of the right leg (p=0.04). The hamstring muscle length on the right (p=0.04) and on the left (p=0.05) were associated with lower limb injuries.

4.7 TRAINING METHODS

All the training methods of the different school teams were similar with regards to the proposed training the coaches planned to do with each team.

4.8 SUMMARY OF RESULTS

In the West Rand school boy rugby population no significant difference was seen in the injuries sustained, during the 2009 and 2010 seasons, between the forward and the backline players. Knee and ankle injuries accounted for more than 70% (25 out of 35) of the injuries occurring during both rugby seasons and most of these injuries were classified within the minor or mild categories. Only five (14%) severe injuries were noted during the 2009 and 2010 seasons and this constituted 14% of the total injuries reported.

A goniometer reading of 90˚ of knee flexion determined whether a player passed or failed the quadriceps length test. The results obtained showed that less than 50% of the players achieved a pass result during testing on the left or right limb. All injuries sustained by the participants were on their right side and five out of the six injured participants' sit-and reach test scores were above the mean for hamstring length. This result may indicate that good flexibility of the hamstring muscle group, tested by the sit-and-reach test, could lead to injuries.

In a comparison of differences in performance, by forward players opposed to backline players, in the star excursion balance test no statistical significant differences were found between the forward and backline players. However, the forwards (p=0.005) and the backs (p=0.004) showed differences between their right and left leg reaches for the posterior medial reach direction. The backs also showed

a difference between the right and left leg reaches for the posterior lateral direction (p=0.04).

The forward players showed greater and significantly different quadriceps muscle strength on the left leg compared to the backline players (p= 0.03). Logistic regression also showed an association between a predisposition to sustaining an injury and the muscle strength of the right sided ankle dorsiflexors (p=0.04) and right sided knee extensors (p=0.05).

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

Since rugby became a professional sport in 1995 it has become increasingly popular. A high number of injuries, especially lower limb injuries have been associated with the game. Limited literature is available on South African school boy rugby injuries. This study was done to determine the incidence of lower limb injuries and the risk factors associated with these injuries occurring in school boys. The results of the study will be discussed in this chapter and compared to similar studies.

5.2 INJURY PROFILE

The sample used in this study consisted of 37 (57%) forwards and 28 (43%) backs. The forwards had a mean age of 17 years, weight of 83.99kg and height of 179.23cm with a BMI of 26.15kg/m^2. The backline players had a mean age of 17 years, weight of 67.84kg and a height of 176.05cm with a BMI calculation of 21.83kg/m^2. These characteristics compare well with other studies done on the same age group for rugby players. Junge et al (2004) studied a group of school boy rugby players with a mean age of 17years, mean weight of 82.5kg and a mean height of 178cm with a BMI calculation of 25.9 kg/m^2. Spamer et al (2006) studied elite South African u/16 and u/18 school boy rugby players and had similar measurements for the height and the weight for this special age group. Both these studies were descriptive in nature.

Previous injury history of the 2009 season was collected by means of the injury questionnaire. The injury data for the season in which the study was conducted will be referred to as the 2010 data. The 2009 rugby season extended over a six month period. Out of 65 participants twenty nine lower limb injuries were documented. Apart from the four severe injuries, the total number of 25 lower limb injuries in the minor, mild and mild to moderate category documented using the 2009 questionnaire in this study compared with numbers reported in the study by McManus and Cross (2004).

McManus and Cross (2004), documented 26 lower limb injuries over a 26 week period in 44 elite junior (u/15s and u/16s) rugby players and used the same injury definitions. McManus and Cross' study in 2004 had a higher ratio of injuries to participants when compared to the 2009 injury data. The reduced injury results obtained in this study for 2009 could be because the players answering the injury questionnaire had to recall their injuries from the previous year and there were possibly a tendency to forget the smaller, minor injuries that occurred in that year. It is possible that they only recalled and remembered the major injuries that had kept that player out of the game for a period of time. As such forgetfulness could have impacted on the players' perceptions of the number and type of injuries they had and skewed the results towards an increased reporting of severe injuries over that of minor injuries. This is in contrast to the McManus and Cross (2004) study where information about the injury sustained was analyzed and documented immediately.

When observing the 2010 results the study's injury count are comparable with Haseler et al (2010). The latter researchers recorded 12 lower limb injuries out of a sample of 210 players over a period of nine months, while this study recorded six injuries out of 65 players over a six week period. An important difference between the rugby players interviewed for the 2010 data in this study and that of Haseler et al (2010) is that they studied a much bigger sample (n=210) and their study was over a period of nine months. In this study only six lower limb injuries were documented through the six weeks of the 2010 rugby school league. One possible reason for the small number of lower limb injuries documented in this study could be that very few injuries were actually reported to the coaches. The teams played two rugby games in a week and if a player was injured in the first game the chances of them playing the second game were reduced. Therefore players would have possibly avoided reporting an injury because of the risk of being excluded from the next game. Although there were no evidence to support this observation anecdotally this appears to be the case. Furthermore the teams did not have medical personnel to follow up on injuries every day and therefore it is possible that minor injuries could have been easily missed if the players did not report them.

Apart from missed injuries it is also possible that because this population is young they are maybe at a lower risk of injury. A similar conclusion was reached by Haseler

et al (2010) who also found that the few injuries sustained in their study were because their population was too young to have had serious injuries. Haseler et al (2010) concluded that previous injuries are a major risk factor for further injury and that their study population was too young and thus unlikely to have sustained previous injury. Risk factors for the population were examined and are discussed in section 5.3.

5.3 RISK FACTORS

Factors that were reported from the data obtained from this study were tested for association with injury. Players' position, age, BMI or level of play was not significantly associated with injury. Furthermore balance, quadriceps muscle length, muscle strength of the hip abductors, ankle plantar flexors, left ankle dorsiflexors and left knee extensors also had no significant association with injury. Factors that did have an influence on the injury occurrence were muscle strength of the right knee extensors and the right ankle dorsiflexors, and hamstring muscle length.

Right knee extensors and right ankle dorsiflexors were associated with the occurrence of injury. From the results it is difficult to say whether inadequate or excessive muscle strength is a predictor of injury. It is interesting to note that in this study all players were injured on their right side which was also their dominant side. The dominant side is usually the stronger and more developed side. This may indicate that the results of this study suggest that excessive muscle strength of the knee extensors and ankle dorsiflexors may lead to injury. Although previous literature suggested that decrease muscle strength can be associated with lower limb injuries (Tyler et al., 2002; Tyler et al., 2001; Orchard et al., 1997), an explanation for this study's results could be that increased muscle strength to the quadriceps and tibialis anterior muscle will cause an imbalance between the anterior and posterior muscle groups as well as between the left and the right sides. In the game of rugby the players are submitted to high intensity situations where they sprint and rapidly change direction (Devlin, 2000). Muscle strength imbalances are exposed in these conditions and could lead to injury either in the weaker muscles where the muscle cannot resist the stronger muscle or to the stronger muscles

where these muscles over work because they compensate for the weaker muscles (Croisier et al., 2008).

The semitendinosus and semimembranosus hamstring muscles, flexes and internally rotate the knee, where the biceps femoris is responsible for flexion and external rotation of the knee joint (Devlin, 2000). The hamstrings muscle also plays an important role in gait where it has to resist the quadriceps and decelerate the movement of knee extension. If the hamstring muscle cannot resist the force of the quadriceps muscle the hamstring muscle or the knee joint could be at risk of injury. If the quadriceps muscle is stronger and more developed in relation to the same side's hamstring muscle the knee ligaments and tendons could get injured due to the excessive pulling action the quadriceps will have on the patella and the weaker hamstring muscles not able to resist this force (Gabbe et al., 2005).

During walking the tibialis anterior muscle contracts concentrically to lift the foot during the swing phase of gait and acts eccentrically to control the plantar flexion of the ankle during the stance phase of gait (Holmback et al., 2003). The tibialis anterior muscle also functions as a stabilizer of the ankle joint and is needed for balance control in standing (Holmback et al., 2003). When the anterior leg muscles are stronger than the posterior muscles it causes an imbalance between the different muscle groups. If the ankle dorsiflexor muscles are stronger than the ankle plantarflexors it could lead to injuries to the weaker calf muscles because the calf muscles will not be able to resist the pulling force of the tibialis anterior muscle. It could also predispose the player to anterior leg pain or injury due to over working of the ankle dorsiflexors. Holmback et al (2003) stated that an impairment of dorsiflexor muscle function could have a negative influence on functional performance. This occurrence will be worse in a rugby situation where an increased tibialis anterior muscle function is needed when the activity and intensity increases (Holmback et al., 2003). School boys that do gym work might not be doing a correct and supervised exercise programme and this may result in certain muscle groups being developed more than others leading to muscle imbalances. This could predispose the rugby boys to muscle and ligament injuries.

Harvey (1998) stated that sufficient flexibility is needed to perform in sports. Previous research also showed conflicting results of whether inadequate flexibility or excessive flexibility was the cause of injuries (Hrysomallis, 2009; Jones et al., 1993; Taimela et al., 1990). Seventy one percent of the players, assessed in this study, failed the quadriceps length test and no association with lower limb injuries was shown. This result may suggest that poor quadriceps flexibility is not associated with lower limb injuries. Logistic regression analysis showed an association between injury and hamstring muscle length on the right ($p=0.04$) and to a lesser extent hamstring muscle length on the left ($p=0.05$). All injuries sustained in this study by the participants were on their right sides and five out of the six injured participants' scores were above the mean for the group's hamstring length. These results may indicate that above average hamstring length may lead to lower limb injuries. This was also demonstrated by other researchers where an increase in anterior pelvic rotation, due to tight hip flexors, could increase the length of the activated hamstring muscles and thus increase the risk of acute injury (Gabbe et al., 2006; Schache et al., 1999).

Different playing positions have different roles that they play in a rugby match, and these position specific actions are continuously repeated in training and matches. The same muscles are used over and over again and if not stretched regularly, are likely to develop muscle tightness. Tight muscles could cause a change in the biomechanics with either decrease movement or a change in the rotation of the hip, knee or ankle joint. This change in the biomechanics will alter the normal gait pattern and could place high stresses on the muscle tendons and the joints. These stresses could lead to injuries, especially when the lower limbs are challenged in situations of high speed or change of direction as in the game of rugby. The backline players need to have good muscle length to produce speed while running without straining a muscle and the forwards need good muscle strength for the physical contact situations. Coaches and rehabilitation personnel should make sure that players have the necessary muscle length and strength for their specific position to optimally perform and to avoid lower limb injuries (Harvey, 1998).

Coaches and rehabilitation personnel also need to make sure that players have good balance. Although the study did not show balance to be a predictor of injury, other

studies have shown results that indicate that poor balance can cause lower limb injuries in athletes (Wang et al., 2006; McGuine et al., 2000). Caraffa et al (1996) highlighted the importance of balance training to prevent lower limb injuries. The results of this study found significant differences in reach distance between the left and the right limb for the backline players for the star excursion balance test (SEBT). This was in relation to posterior lateral reach and posterior medial reach. In the case of the forward players posterior medial reach was shown to have resulted in significant variations in reach distance. These results appear to indicate that players may have better balance on one leg than on the other. In situations where a players attempts to side-step another player good balance comes into play. If a player has poor balance he can easily twist his ankle when side-stepping as movements such as these usually occur at a relatively high running speed. Twisting of the ankle as a result of a player losing his balance, when attempting to transfer all their body weight to one leg and quickly shift over to the other leg, could lead to ligament, muscle and even joint injuries (Krivickas and Feinberg, 1996). This study showed that the SLB test and the SEBT can give valuable information that coaches and rehabilitation personal can use to improve a player's physical ability and condition.

5.4 CONCLUSION

The research study was done to document the number of rugby injuries sustained in the league and to explore the risk factors that caused these lower limb injuries in high school boys. Previous literature shows different risk factors for school boy rugby players but because not much research has been done specifically in an adolescent population the literature is sometimes contradicting with regards to identifying these risk factors. This study documented 29 injuries in the 2009 season and six injuries during the 2010 rugby league. Knee and ankle injuries accounted for more than 70% of the injuries sustained over these two seasons. Dynamic balance testing through the star excursion balance test (SEBT) showed differences between right and left legs' reach distances. Although this study did not find dynamic balance to be a risk factor for injury, previous literature did show decreased balance to be a predictor of injury. The results do show differences between left and right which could mean that there is an imbalance somewhere in the kinetic chain of the lower limbs that could lead to injury at a later stage. Muscle strength and muscle length showed to be risk

factors for lower limb injuries. This correlates with previous literature and coaches or rehabilitation personal need to pay attention to these two factors. Different players in different playing positions have different needs to fulfill their specific position. They need to have the correct strengthening and stretching programme to be able to perform at their best without sustaining injuries during the rugby season.

CHAPTER 6

LIMITATIONS AND RECOMMENDATIONS

6.1 LIMITATIONS AND STRENGTHS OF THE STUDY

Limitations of this study included the observation of injuries that were sustained during the six week season. The researcher could not be at every practice or match because of time constrains and matches being played on the same day and time but at different venues. Injuries might have been missed due to this reason. Although each coach was phoned within two days after a game the coach might have forgotten about the minor injuries and only focused on the injuries that can have an influence on the team selection for the following game. Injuries might also have been missed due to an under reporting of injuries from the players. A player might not report a minor injury due to the risk of losing his place in the team.

There are only a few research studies done in South Africa on school boy rugby players and most of the studies only explore a few risk factors. To the researcher's knowledge this is the first study to look at a wider list of potential risk factors and their relationship and the influence these factors had on lower limb injuries. This study shows important risk factors that need to be considered for prevention of injuries and preseason programmes.

6.2 RECOMMENDATIONS

To establish injury prevention programmes in adolescents, injury risk factors need to be identified. More prospective school rugby union studies are needed to determine these risk factors especially in South-Africa where rugby is increasing in popularity and few studies have been done on this population group.

Future studies should perhaps look at prospective designs to avoid recollection problems. Future studies should also look to use uniform methodologies, study designs, injury definitions, calculations and incidence rates that has already been

used to make comparison between studies easier and to determine these injury risk factors.

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APPENDIX A: Injury questionnaire

QUESTIONNAIRE No:	**date: / / 2010**
SCHOOL:	
DATE OF BIRTH (Date/Month/Year):	___/___/_____

Do you currently suffer from headaches, a cold or dizziness? Yes ☐ No ☐

Have you had a lower limb injury in the previous month? Yes ☐ No ☐

Have you had a concussion within the past 3 months? Yes ☐ No ☐

RUGBY:

WHAT POSITION(S) DO YOU PLAY? Nr. 1 being the position you play the most

Position Played 1:	
Position Played 2:	

PARTICIPATION LEVEL (Tick the level(s) you play)

School level	**Provincial level**

With which leg (right or left) do you prefer to kick a ball with? R ☐ L ☐

PREVIOUS INJURIES (injuries sustained to the legs in the last year)

Tick if you sustained an injury to the following body parts in 2009 up to now.
Indicate if the injury was on your right or left limb.
Also state whether the injury was minor, mild, moderate or severe according to the injury classification:

Minor: You returned to the game/ training in which the injury occurred;
Mild: You missed one week of training due to the injury;
Moderate: You missed two weeks of training due to the injury;
Severe: You missed more than two weeks of training due to the injury

Area	**Injury classification**	**Side of injury**

	Tick body part	Minor	Mild	Moderate	Severe	Right	Left
Hip							
Knee							
Ankle							
Quadriceps (Front of the thigh)							
Hamstrings (Back of the thigh)							
Calf							
Other (specify injury)							

HOW DID YOU TREAT YOUR INJURY/ INJURIES ?

Specify the injury and tick what treatment you had received for that specific injury. You can tick more than one.

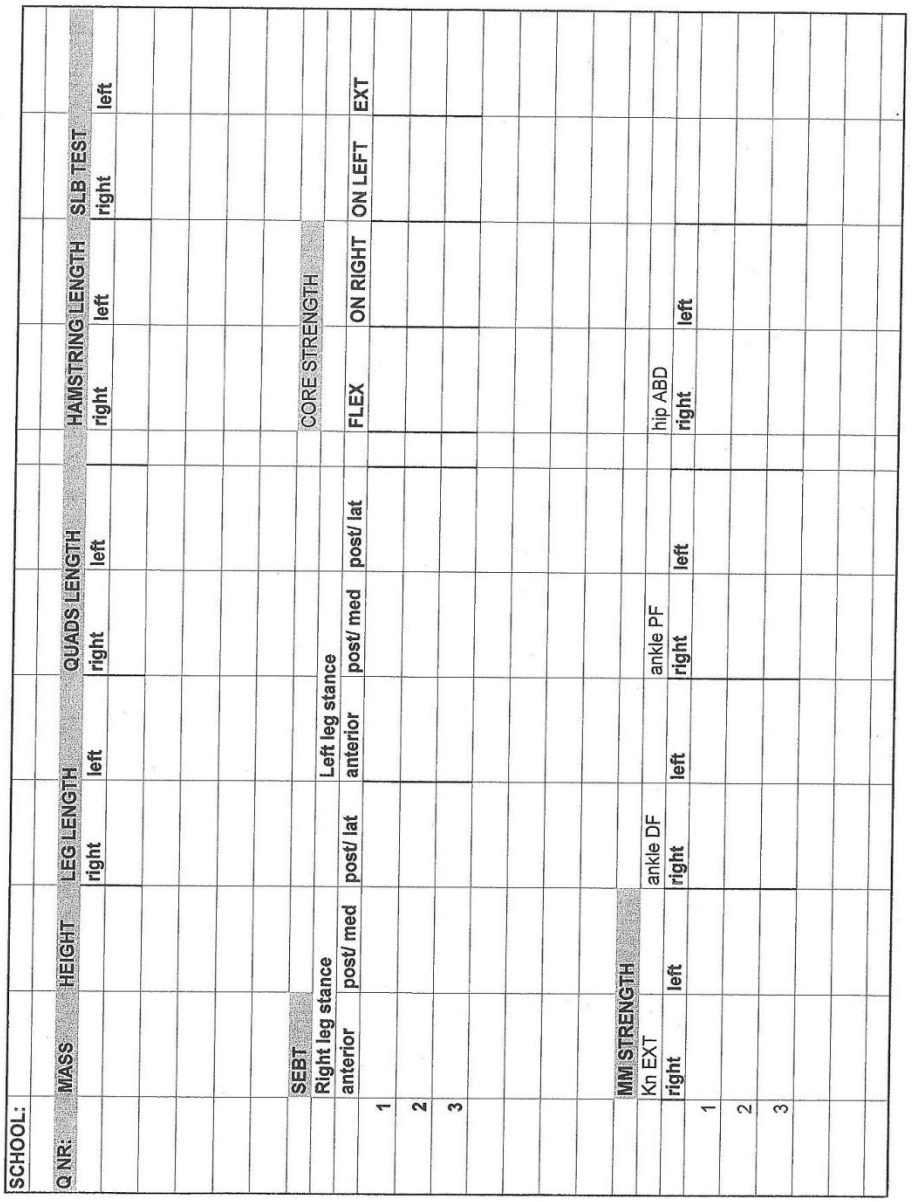
Specify injury	No Rx	Physiotherapy	Doctor	Surgery	Podiatrist	Other (specify)
1.						
2.						
3.						
4.						
5.						

OTHER SPORTS PLAYED (e.g. Tennis, karate, cross country, golf etc)							
SPORT	PARTICIPATION LEVEL Tick your highest level of participation			How many times/week do you participate in this sport			
	School	club	provincial	< once a week	Once a week	2-5 times	>5 times a week

APPENDIX B: Rugby training exposure form

TRAINING FORM **TRAINING: Rugby specific**		
(What type of training does the team do, how many times and for how long do they train?)		
Type:	**How many times/ week**	**Duration of session in minutes**
Rugby fitness training		
Rugby skill training		
Stretching before training		
Stretching after training		
Gymnasium work		
Balance training		
Other training		
Specify 'other' training done:		
Training surfaces: specify		

APPENDIX C: Data collection form



SCHOOL:

Q NR: MASS HEIGHT LEG LENGTH QUADS LENGTH HAMSTRING LENGTH SLB TEST

	right	left	right	left	right	left	right	left

SEBT

CORE STRENGTH

	Right leg stance			Left leg stance							
	anterior	post/ med	post/ lat	anterior	post/ med	post/ lat	FLEX	ON RIGHT	ON LEFT	EXT	
1											
2											
3											

MM STRENGTH

	Kn EXT		ankle DF		ankle PF		hip ABD			
	right	left	right	left	right	left	right	left		
1										
2										
3										

APPENDIX D: Injury data collection form

McManus

A

ID# □□□□□1–5

Name _____ 1. Grade _____ (Office use only) □□6–7

2. Date □□dd□□mm□□yy 8–13 3. Age (in years) ____ □□14–15

4. Site of injury (circle) Head, Face, Neck, Shoulder, UArm, LArm, Wrist, Hand, Fingers, Thumb, Chest, Abdomen, Spine, Back, Pelvis, ULeg, LLeg, Knee, Ankle, Foot, Toes, Other _____ (Office use only) □□ 16–17

5. Severity of injury (circle) minor / mild / moderate / severe □□ 18–19

6. Mechanism of injury (circle) extrinsic / intrinsic □□ 20–21

7. Where (circle) game / training □□ 22–23

8. Phase of play or aspect of training (circle) Scrum, Lineout, Ruck, Maul, Tackle, Kicking, Pileup, Collision, Other _____ □□ 24–25

9. If terrain a factor of injury (circle) hard / soft / muddy / other _____ □□ 26–27

10. If weather a factor of injury (circle) hot / cold / wet / other _____ □□ 28–29

If injured in game continue. If at training, go to Question 16. *on the reverse.*

11. Time of game (circle) 1st half / 2nd half / time on (Office use only) □□ 30–31

12. Relationship of ball and injured player (circle) near ball / behind play □□ 32–33

13. Play (circle) legal / illegal □□ 34–35

14. Position played (circle) LHP H THP LL RL LF RF 8 HB 5/8 LW IC OC RW FB □□ 36–37

15. Back or forward (circle) B / F □□ 38–39

NOTE: SEVERITY OF INJURY - required treatment but:
MINOR - if able to return to game/training in which injury occurred MILD - if missed one week
MODERATE - if missed two weeks SEVERE - if missed more than two weeks

POSITION PLAYED - 1. LHP - Loosehead prop, 2. H - Hooker, 3. THP - Tighthead prop, 4. LL - Left lock, 5. RL - Right lock, 6. LF - Left flanker, 7. RF - Right flanker, 8. No 8, 9. HB - Half back, 10. 5/8 - Five eight, 11. LW - Left wing, 12. IC - Inside centre, 13. OC - Outside centre, 14. RW - Right wing, 15. FB - Full back.

B

16. Classification of injury □□□ 40–42

Assessment

Treatment

Instruction to player/carer

Referred to

Other information

Medic/Sports Trainer's Name _____ Signature _____

APPENDIX E: Approval from the Educational Department of Gauteng

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries: Nomvula Ubisi (011)3550488

Date:	04 March 2010
Name of Researcher:	Griffiths Noelle
Address of Researcher:	207 Bell Street
	Noordheuwel
	Krugersdorp 1739
Telephone Number:	0116652106/0834545109
Fax Number:	0116653344
Research Topic:	Factors Associated with Lower Limb Injuries in High School Rugby Players
Number and type of schools:	4 Secondary Schools
District/s/HO	Gauteng West

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. ***The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.***
2. ***The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.***
3. ***A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.***

Office of the Chief Director: Information and Knowledge Management
Room 501, 111 Commissioner Street, Johannesburg, 2000 P.O.Box 7710, Johannesburg, 2000

4. ***A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.***
5. ***The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.***
6. ***Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.***
7. ***Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.***
8. ***Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.***
9. ***It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.***
10. ***The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.***
11. ***The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.***
12. ***On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.***
13. ***The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.***
14. ***Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.***

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Pp Nomvula Ubisi
Martha Mashego
ACTING DIRECTOR: KNOWLEDGE MANAGEMENT & RESEARCH

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	

APPENDIX F: CONSENT FOR THE HEADMASTER

CONSENT FOR THE SCHOOL's HEADMASTER

I……
principal of ……
give my permission to Noelle Griffiths, a student at the University of the Witwatersrand to conduct a study to determine if certain factors hold a risk for injuries in rugby players in my school.

I am aware that the pupils' participation is voluntary and that there are no risks involved for them or for the school participating in the study.

Signed at……..…….this…… day of……2010
Signature: ……

APPENDIX G: INFORMATION SHEET FOR PARTICIPANTS

Hello, my name is Noelle Griffiths. I am doing my Masters degree in Physiotherapy at the University of the Witwatersrand. I am doing a research study to see which factors will lead to rugby injuries among high school rugby players.

You are invited to participate in this study. Please take some time to read the information below, which will explain the details of this study. If you have any questions, feel free to ask me. My telephone number is provided below. Participation is voluntary and refusing to participate in the study will not affect your school activities or your participation in rugby.

If you agree to participate in the study you will receive a questionnaire. After completion of the questionnaire, a few tests will be conducted. These tests will include muscle strength tests, muscle length tests and balance tests. Before each test you will be given an explanation of what to do and you will be showed exactly how to do each test. The questionnaire and the tests will take approximately 30 minutes.

Efforts will be made to keep personal information confidential. You can withdraw from the study at any time without any consequences or effect on your school work or sport. There are no costs involved in participating in the study, nor are there any risks.

If this study shows that certain factors can lead to injuries it might be helpful in the future in pre season rugby training.

Thank you for your help.

_____

Noelle Griffiths
Tel: 011 665 2106 (work); Mobile: 083 454 5109; Email: noelletjie@yahoo.com

APPENDIX H: INFORMATION SHEET FOR PARENTS

Hello, my name is Noelle Griffiths. I am doing my Masters degree in Physiotherapy at the University of the Witwatersrand. I am doing a research study to see if certain factors will lead to rugby injuries among high school rugby players.

Your child is invited to participate in this study. Please take some time to read the information below, which will explain the details of this study. If you have any questions, feel free to ask me. My telephone number is provided below. Participation is voluntary and refusing to participate in the study will not affect your child's school activities or his participation in rugby. As parent/ guardian you must consent to letting your child participate in this study.

Your child will receive a questionnaire to complete that consists of questions about his rugby participation and previous injuries he had had. After completion of the questionnaire a few tests that include muscle strength, muscle length and balance tests will be done. This will take approximately 30 minutes.

Efforts will be made to keep personal information confidential. Your child can withdraw from the study at any time without any consequences or effect on his school work or sport. There are no costs involved in participating in the study, nor are there any risks.

If this study shows that injuries can be predicted, this information might be helpful in the future in pre season rugby training.

Thank you for your help.

_____

Noelle Griffiths
Tel: 011 665 2106 (work); Mobile: 083 454 5109; Email: noelletjie@yahoo.com

APPENDIX I: CONSENT FORM FOR THE PARENT/GAURDIAN

I……. ……. parent/guardian grant consent for my child……(name and surname) to participate in the research study conducted by Noelle Griffiths. I have read the information sheet and understand that there are no risks involved in participating in the study. My child has been assured that the study is voluntary and that he can withdraw participation at any time. I also understand that withdrawal from the study will not affect his school activities or his sport participation in any way.

Signed at……..……..….this…… day of……2010
Signature: …….

APPENDIX J: ASSENT FORM FOR PARTICIPANTS

I ……, a scholar at ……..... (school), have read the information sheet and understand what is expected of me during the research study. All my questions have been satisfactory answered. I understand that my participation is voluntary and that I can withdraw participating from the study at any time. I understand that withdrawal from the study will not affect my school activities or my participation in sport in any way.

I hereby agree to take part in the study conducted by Noelle Griffiths.

Signed at……..…….this…… day of……2010
Signature: ……