UNIVERSITY OF THE WESTERN CAPE

Faculty of Community and Health Sciences

RESEARCH REPORT

Title: The effect of a proprioceptive training programme on ankle injury rates in soccer players in Rwanda.

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ABSTRACT

Background: Soccer is one of the most popular sports throughout the world, with more than 270 million players estimated to be participating in 2000. Soccer results in many injuries, with the lower extremities most commonly affected, and the knee and ankle joints are the most commonly affected sites. **Aims:** The study aimed to investigate the factors associated with ankle injuries in soccer players and to test the effect of a proprioceptive training programme on the incidence rates of these acute injuries among healthy players. **Methods:** The overarching design for the study was an quasi-experimental quantitative research design which included a survey, systematic review, Delphi study. Written permission and ethical approval was sought from the Higher Degrees Committee of the University of the Western Cape, as well as from the Rwanda football federation, before starting this research. **Baseline data**: 639 players in the 1st and 2nd division teams were approached and selected for participation in the study. Data were collected with instruments developed by the Federation International de Football Association Medical Assessment and research Centre (F-MARC). Data was analyzed using descriptive statistics with SPSS data analysis program. A systematic literature review on injury prevention strategies to reduce ankle sprains in soccer was conducted. **Intervention study**: Four of the teams that participated in the first phase were randomly selected and randomly allocated to either intervention or control groups. Two facilitators worked with approximately 40-60 players to deliver the proprioceptive training program for a period of 6-7 months during 2014-2015 competitive season. The primary outcome to be assessed in the study included ankle injury rates (and its 95% confidence interval) calculated as the incidence of ankle injury per 1000 playing hours. Secondary outcomes included ankle proprioception and balance. Data was analyzed using descriptive statistics with SPSS data analysis program.

Results:

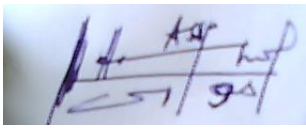
Baseline data: The incidence rate was **3.6 injuries per 1000** hours of exposure. Ankle was the body part which sustained more injuries with 92 (41.6%) injuries; the knee was the second body part with 41 (18.5%), followed by the thigh with 19 (8.5%) injuries. Proprioception and abnormal balance were significantly associated with the risk to sustain ankle sprains in this study with diminished proprioception (95% CI 0.24-0.089, p=0.000); standing balance (95% CI 0.46-1.216, p=0.020). **Intervention study**: The incidence rate was **5.5 injuries per 1000** hours of exposure in intervention group and **19.4 injuries per 1000** hours of exposure in control group. The relative risk reduction of ankle injury was **3.5.** The Multivariate analysis between ankle injuries, secondary outcomes and both groups showed that in intervention group, the ankle injuries were reduced by 0.205 (95% CI [0.056-0.747], p=0.016) compared to control group. The players with balance score equal to 3, were at 4.4 times risk to sustain ankle injury (95% CI [1.185-16.416], p=0.027). The players with diminished proprioception were at 3.792 times risk to sustain ankle injury (95% CI [1.246-11.537], p=0.019) compared to players who had maximum proprioception.

Conclusion: The ankle injury incidence rate in Rwanda football players was high. The diminished proprioception was the potential risk factor to sustain ankle injuries. The implemented proprioception training programme appears to be more effective to reduce the incidence of ankle sprains rate in healthy subjects.

DECLARATION

I hereby declare that **"THE EFFECT OF A PROPRIOCEPTIVE TRAINING PROGRAMME ON ANKLE INJURY RATES IN SOCCER PLAYERS IN RWANDA"** is my own work, that it has not been submitted, or part of it, for any degree of examination at any other university, and that all sources I have used or quoted have been indicated and acknowledged by means of complete references.

Student: Moussa HAKIZIMANA



Signature……..

August 2017

Supervisor: Prof JS Phillips

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Signature

August 2017

DEDICATION

To my beloved family (wife and children). You have been there for me with an immeasurable support. Thank you and I love you. You will stay in the deepest bottom of my heart.

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Above all, I am deeply grateful to God who blessed me with the opportunity and strength to further my studies.

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION TO CHAPTER

In this chapter, the background of the study highlights the prevalence of soccer injuries in general and the prevalence of ankle injuries among soccer players in particular. The chapter also highlights the different studies done with regards to ankle injury prevention. The problem statement of the study is explained and the specific aim and objectives are outlined. Finally, the significance of the study demonstrates the need to develop and implement effective proprioceptive training programs to reduce the incidence of ankle sprain which is the most prevalent injury sustained by soccer players. The chapter ends with the definition of terms used as well as a summary of the chapters that will compose the present study.

1.2 Background

Soccer is one of the most popular sports throughout the world, with more than 270 million players estimated to have participated in 2000 (Heidt et al., 2000; Junge et al., 2002; Woods et al., 2002; Andersen et al., 2003; Woung & Hong, 2005; Giza et al., 2005; Aoki et al., 2012; van Beijsterveldt et al., 2014; Stubbe et al., 2015; Mufty et al., 2015). This number has been reported to grow continually (Soligard et al., 2009; Mufty et al., 2015). The International Federation of Football Associations (FIFA) estimates that there are approximately 46 million players in Africa alone. In addition, FIFA (2010) estimated that more than 26 billion viewers watched the 2010 soccer world cup held in South Africa on television.

Participation in sports and physical activity is associated with numerous benefits such as the reduced risk of diabetes mellitus, hypertension and obesity amongst others, but it is also accompanied by the risk of injury at both recreational and elite levels (Olsen, Mykleburst, Engebretsen & Bahr, 2005; Krustrup et al., 2010). Fortunately, most are not life-threatening and the health benefits of sports and physical activity are generally greater than the risks involved (Aaltonen et al., 2007; Verhagen et al., 2005). Numerous researchers have reported on the substantial risk of injury associated with playing soccer (Olsen et al., 2005; Hagglund, Walden & Atroshi, 2009; Robertson et al., 2012; Zeck and Wellmann, 2017).

Studies have shown that the prevalence of injuries in soccer is high when compared to other sporting disciplines (Schmikli, de Vries, Inklaar & Backx, 2010; Stubbe et al., 2015). Soccer results in many injuries, with the lower extremities most commonly affected, and the knee and ankle joints are the most commonly affected sites (Olmsted et al., 2004; Verhagen, van Turder, van Der Beek, Bouter, van Mechelen, & Bahr, 2004; Woung & Hong, 2005; Olsen et al., 2005; Giza et al., 2005; Mickel et al., 2006; Sekir, Yildiz, Hazneci, Ors, & Aydin, 2007; Pasanen et al, 2008; Hupperets, Verhagen, & van Mechelen, 2009; Ben Moussa Zouita et al., 2013; Salces et al., 2013; Nilstad et al., 2014; Stubbe et al., 2015). In general, studies reported that the ankle is one of the most traumatized body sites in sports injuries and accounts for 10-30% of all sports injuries (Olmsted et al., 2004; Verhagen, van Turder, van Der Beek, Bouter, van Mechelen, Bahr, 2004; Woung and Hong, 2005; Olsen et al., 2005; Giza et al., 2005; Mickel et al., 2006; Sekir, Yildiz, Hazneci, Ors, Aydin, 2007; Hupperets, Verhagen, & van Mechelen, 2009; Schiftan, Ross, Hahne, 2014; Rivera et al., 2017). Research has further indicated that of these two sites (ankle and knee), ankle injuries are the most common in sports in general

and in soccer in particular, with the incidence ranging from 1.7 to 4.5 injuries per 1000 playing hours, resulting in 11-25% of all acute injuries (Anderson, Floerence, Arnason, & Bahr, 2004; Junge, Dvorak, Graf-Bauman & Peterson, 2004; Engebretsen, Myklebust, Engebretsen & Bahr, 2010; Dauty and Collon, 2011; Salces et al., 2013).

As indicated above, a large body of research has been conducted abroad regarding the prevalence and factors associated with soccer injuries. Very few studies have been done in Africa. These studies however highlighted the high number of injuries in soccer players in Africa (Azubuike & Okojie, 2008; Twizere, 2004). Azubuike & Okojie (2008) reported an injury prevalence of 81.6% in Nigeria and Twizere (2004) an injury prevalence of 68.1% in Rwanda. It is thus clear that a need exists to reduce short and long term social and economic consequences of soccer injuries, highlighting a need for effective injury prevention programmes. The high incidence of ankle injuries in cutting and jumping sports such as soccer means that much time and expenses are spent on treatment and rehabilitation (Kaminski et al., 2003). Researchers have alerted that being the most common sports related injury, ankle injuries should be a major focus of sports injury prevention (Verhagen et al., 2005).

There is surprisingly little evidence on the effectiveness of preventive measures for ankle injuries from controlled trials. Some evidence exists on the benefits of the preventive measures for ankle injuries in soccer, such as orthoses, bracing, taping and neuromuscular training in intervention studies (Engebretsen et al., 2010; Hubscher et al., 2010; Verhagen and Bay, 2010). There are some studies that investigated whether certain intrinsic risk factors (previous injury, increased range of motion, strength, proprioception, postural control, contact with another player and fatigue) could predict

ankle sprain (Pope et al., 1998; Willems et al., 2005a; de Noronha et al., 2006; Kofotolis et al., 2007; Hiller et al., 2008; Frisch et al., 2011; Witchalls et al., 2012; Kerkhoffs et al., 2012; de Noronha et al., 2013; Zech and Wellmann, 2017; Rivera et al., 2017). The results from these different studies however are inconclusive, and it remains unclear which intrinsic factors can be considered good predictors of ankle sprain. Nevertheless, the literature has consistently indicated the history of previous sprain as a predictor (Tyler et al., 2006; McHugh et al., 2006; Kofotolis et al., 2007; Hiller et al., 2008; de Noronha et al., 2013). Other variables were systematically investigated in a review on predictive factors for ankle sprain (de Noronha et al., 2006). The authors included 21 studies in their review, and the study with the best methodological quality, performed on army recruits, found that the participants with reduced dorsiflexion range of motion were almost five times more likely to suffer an ankle sprain (Pope et al., 1998). Other studies with lower methodological quality also presented some evidence that postural control (Watson, 1999; McGuine et al., 2000; Norohna et al., 2013) and proprioception (Willems et al., 2005b; Witchalls et al., 2012) could be used as predictive factors for ankle sprains. However, there are few prospective studies of good methodological quality, which reinforce the uncertainty regarding what factors can predict ankle sprains (de Norohna et al., 2013).

In a systematic review done by Fong et al. (2007), it was evident that all the data is from European and American studies with a lack of African data in terms of ankle injuries prevention in soccer. The importance of preventive programs for ankle injuries is clear; however, the development of effective prevention programs is strongly related to the capacity of identifying those with a higher risk of suffering a sprain. Therefore, the present study will aim to investigate the factors associated with ankle injuries in soccer

players and to test the effect of a proprioceptive training programme on the incidence rates of these acute injuries among healthy players.

1.3 Problem statement

Several studies reported that the ankle is one of the most common sites in sports injuries and accounts for 10-30% of all sports injuries. Ankle sprains are the most common injury that occurs in athletes and account 73% of all ankle injuries (Fong et al., 2007; McGuine and Keene, 2006; Bahr, 2002; Verhagen et al., 2000; Thacker et al., 1999; Powell and Barber-Foss, 1999; Garrick, 1977). In a study done more than a decade ago in Rwanda, the ankle was also found to be the most common site of injuries with38.5% (Twizere, 2004). Surprisingly there is a little evidence of the effectiveness of preventive measures against ankle sprains from controlled trials (Verhagen et al., 2005). Many studies in the literature showed the effect of proprioception training programme on subjects with previous ankle sprain, but its effect in prevention of ankle sprain among healthy subjects were inconclusive.

1.4 Aim of the study

The overall aim of the study is to investigate the effect of a structured proprioceptive training programme used to prevent acute ankle injuries among soccer players in Rwanda.

1.5 Objectives of the study

The specific objectives of the study are:

(a) To collect base-line data regarding ankle injuries among soccer players in Rwanda

i. To examine the potential intrinsic risk factors for injuries to the ankle among soccer players in Rwanda over one competitive season.

ii. To determine the incidence of ankle injuries among soccer players in Rwanda in one competitive season.

(b) To develop a proprioceptive training programme to reduce ankle injuries among soccer players in Rwanda by:

- Conducting a systematic review of the literature around proprioceptive training interventions that has demonstrated the best evidence in reducing ankle injuries among soccer players.
- Reaching consensus on the content of a proprioceptive training programme for the reduction of ankle injuries among soccer players.

(c) To implement and determine the effect of the developed proprioceptive training programme on the prevalence of ankle injuries and the potential intrinsic factors among soccer players in Rwanda.

1.6 Significance of the study

As an outcome of the study, a proprioceptive training program for the prevention and or reduction of ankle injuries will be developed and the program may be used in training sessions for soccer players in Rwanda. Baseline data regarding intrinsic factors associated with soccer injuries in Rwanda will also be collected. The use of the program in training

sessions may be seen as cost-effective compared to the social and economic consequences caused by ankle sprains.

1.7. Definitions of the key terms

Ankle injury: Ankle injuries are most frequently diagnosed as ligament sprains, fractures and contusions (Nelson et al., 2007).

Injury: Injury is defined as any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities (Fuller et al., 2006).

Proprioception: Proprioception is defined as the awareness of posture, movement, and change in equilibrium as well as the knowledge of position, weight, and resistance to objects in relation to the body (Hoffman & Payne, 1995; Ben Moussa Zouita et al., 2013; Schiftan, Ross, Hahne, 2014; Han et al., 2015; Han et al., 2016; Lee and Kuang, 2016; Rivera et al., 2017).

Proprioception is the sense of the relative position of neighbouring parts of the body and strength of effort being employed in movement or the unconscious perception of movement and spatial orientation arising from stimuli within the body itself (Mosby's Medical, Nursing and Allied Health Dictionary, 1994).

Training: The action of teaching a person or animal a particular skill or type of behaviour or the process by which an athlete prepares for competition by exercising, practicing, etc (Oxford dictionary.com).

Soccer: is a sport played between two teams of eleven players with a spherical ball

(www.wikipedia.org).

Rate: A specific kind of ratio, in which two measurements are related to each other.

Or is a ratio that compares two different kinds of numbers (www.math.com).

Programme: A planned series of future events or performance.

Programme is a leaflet listing information about a play, game or other activity (www.thefreedictionary.com, Dictionary of the English language, 2000).

Severity: Severity is defined as the number of days that have elapsed from the date of injury to the date of the player's return to full participation in team training and availability for match selection (Fuller et al., 2006).

Prevalence: Prevalence is a statistical concept referring to the number of cases of disease that are present at a particular point in time (Armstrong and Reilly, 2002).

Incidence: Incidence is the number of new cases of the condition/disease over a specified period of time (Rothman, 2002).

1.8 SUMMARY OF CHAPTERS

Chapter One provides a background of the study and highlights the growing participation in soccer as a sport worldwide. It further shows the prevalence of ankle injuries globally and in Rwanda specifically. The risk factors that contribute to sustain an ankle injury are mentioned in this chapter. The problem statement, aim, specific objectives and significance of the study are outlined. The chapter ends with the definition of terms and abbreviations used in this study.

Chapter Two presents a review of relevant literature around proprioceptive training interventions that have demonstrated the best evidence in reducing recurrent and acute ankle injuries in general and ankle sprains in particular. Furthermore, the intrinsic and extrinsic risk factors contributing to ankle injuries and the prevalence of ankle injuries are discussed. The theoretical framework underpinning sports preventive measure steps are outlined. In addition, a detailed anatomy of ankle ligaments is provided.

Chapter Three considers the methodological issues relevant to the study. It explains the research setting in which the study was based, as well as the study design used in this study. It further includes details regarding the study population and sampling methods for both quantitative and qualitative data. A description of the data collection methods is presented. This includes the instrument used in data collection, data collection procedures and issues of reliability, validity, credibility and trustworthiness. The chapter ends by giving the method of data analysis and showing how ethical issues were addressed.

Chapter Four outlines the results of the baseline quantitative data analysis. Data regarding the prevalence of injuries in general and ankle injuries in particular are presented. The severity of ankle injuries and the body parts injured are also presented. The relationship between ankle injuries and potential risk factors are presented. Results are summarized and presented in tables and figures.

Chapter Five presents the results of the Delphi study used to reach consensus on the content of the proprioceptive training programme for soccer players. The results of the rounds of Delphi study are outlined in this chapter.

Chapter six shows the results of the implementation of the proprioceptive training programme and the effectiveness thereof.

Chapter seven presents the discussions based on the results of baseline data and the intervention study.

Chapter eight provides a summary of the study and draws conclusions based on the findings. Limitations to the study are also outlined. In addition, recommendations based on the main findings of the study are made.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a systematic review of the literature around proprioceptive training interventions that demonstrated the best evidence in preventing ankle injuries in soccer or other sports. It further reviews studies regarding epidemiological data related to soccer ankle injuries. Literature regarding the prevalence of soccer injuries in general and ankle injuries in particular are reviewed. Lastly reviews of the literature regarding the prevention programmes of ankle injuries are also presented.

2.2 Efficacy of proprioception training interventions for ankle injuries: a systematic review

2.2.1 Review aim

To search the proprioceptive training interventions with best evidence in preventing ankle injuries in soccer to form a research tool using a Delphi study and to do a meta-analysis if an adequate number of RTCs is retrieved.

2.2.2 Sources of evidence Searched

A comprehensive systematic search of all studies and reviews measuring the efficacy of proprioceptive training program in prevention of ankle injuries in soccer and other sports was conducted in specific electronic databases such as PUBMED, ERIC, MEDLINE, EMBASE, PsycInfo, CINAHL, COCHRANE Database, SPORT DISCUS, PEDro

database, ScienceDirect, rehabilitation and Sports Medicine Source and additional resources obtained via review of reference lists and hand search.

2.2.3 Search Strategy

Keywords used for the search included:

- Proprioception training/ankle sprain/ankle instability
- Balance board exercises/ankle injuries
- Balance training/ ankle sprains
- Proprioception training/ankle muscle strength
- Risk factors/ankle injuries
- Efficacy of ankle proprioception training/ankle balance training

2.2.4 Inclusion Criteria

To be eligible for inclusion in the review, articles must have an online version of the article published in English language, studies must have the reporting standards for randomized controlled trials following CONSORT statement or other types of design with methodological rigour based on study; studies must be published between the years 1980 and 2012.

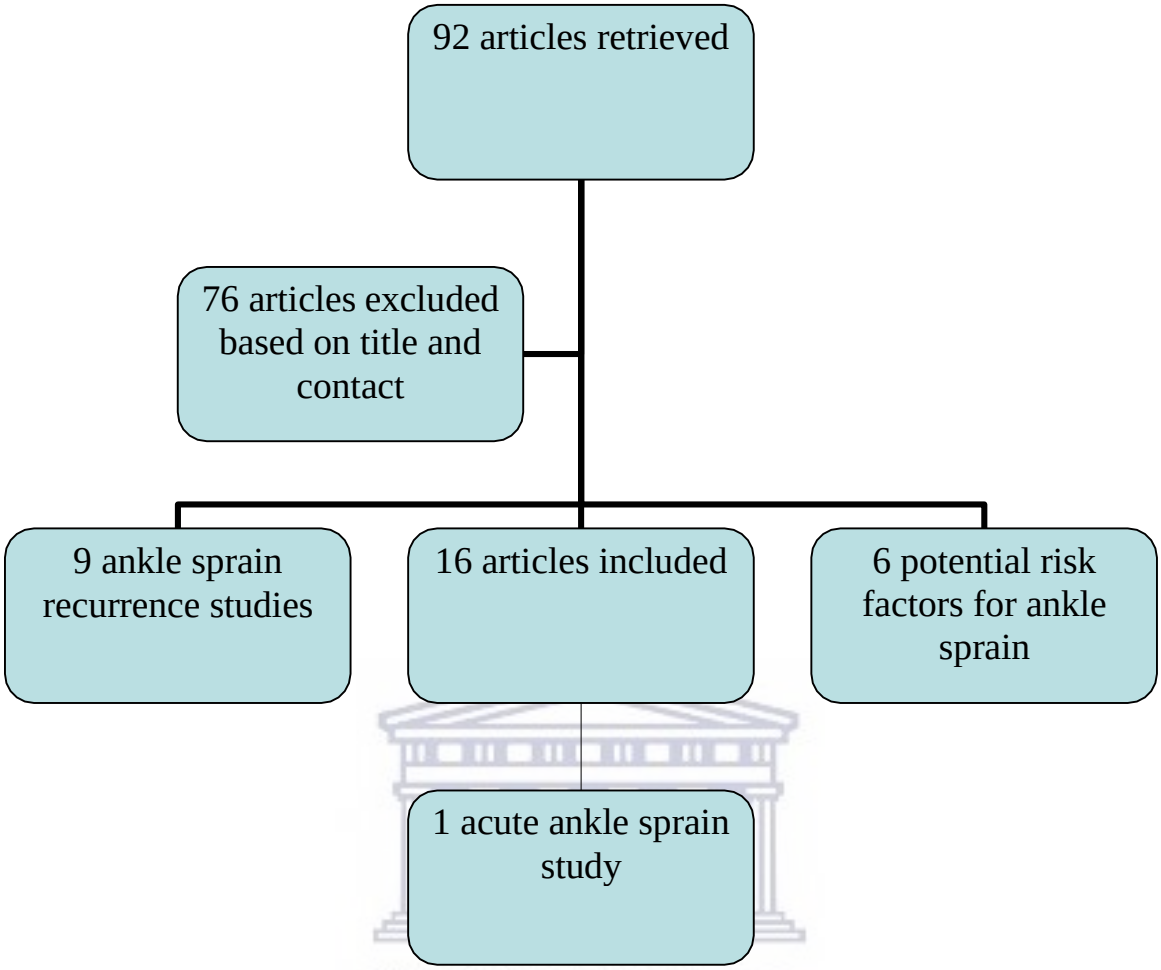

Figure 2.1. Flow chart for selecting articles to be included in the systematic review.

2.2.5 Data extraction

A standardized data abstraction form was used and the following variables were abstracted by three reviewers: authors, setting of data collection, locations, study period, sample characteristics, sample size, study design, types of comparison, data collection tools, method of data collection, withdrawal and findings. The reviewers were trained and the selected articles were included in the review once consensus was reached by the reviewers.

Efficacy criteria for best evidence: Efficacy criteria for best evidence were focused on several aspects of a study: quality of study design, quality of implementation and analysis, and strength of evidence. The criteria of quality of study design included prospective randomized controlled trials or a method with minimal bias. For quality of study implementation, the criteria included the assessment of the outcome after the intervention. For quality analysis, the performance of appropriate cluster-level analyses was included when assignment was done at the cluster level. To meet the strength of evidence criteria a study must demonstrate significant positive evidence and no significant negative evidence. The statistically significant ($P<0.05$) and positive intervention effect had to be evident for at least 1 relevant outcome measure. In the case of an adequate number of randomized controlled trials a meta-analysis will be done.

2.3 Prevalence of soccer injuries

In general, studies reported that the ankle is one of the most traumatized body sites in sports injuries and accounts for 10-30% of all sports injuries. Ankle sprains are the most common injury that occurs in athletes, and several studies have noted that sports that require sudden stops and cutting movements, such as soccer and basketball, cause the highest percentage of these injuries (Garrick, 1977; Thacker et al., 1999; Powell & Barber-Foss, 1999; Verhagen et al., 2000; Bahr, 2002; McGuine & Keene, 2006; Fong et al., 2007;). A study done by Fong et al. (2007) found that the ankle sprains accounted for 73% of ankle injuries and the incidence of ankle injuries per 1000 playing hours was 6.52 in soccer.

2.4 Ankle injuries

Literature has shown that the ankle joint is the most common site of injury in sports overall, particularly in soccer (Woods et al., 2003; Engebretsen et al., 2007; Fong et al., 2007). Several researchers highlighted the high incidence of ankle injuries among soccer players (Woods et al., 2003; Fong et al. 2007). Engebretsen et al. (2010) alerted to the fact that an ankle injury may render a player unable to play for several weeks and full recovery may take even longer. This is one of the reasons for the enormous concern regarding ankle injuries in sports and especially in soccer.

Research has indicated that ankle sprains were the most common ankle injury (Ekstrand & Tropp, 1990; Hawkins et al., 2000). Given the high incidence of ankle sprains, many authors suggested that prevention and rehabilitation of ankle sprains need further investigation (Woods et al., 2003). In a systematic review done by Fong et al. (2007) it was evident that all the data is from European and American studies with a lack of African data in terms of ankle injuries prevention in soccer. This supports the importance of the present study which aims to investigate the effect of a proprioceptive training programme on ankle injury rates in soccer players.

2.5 Prevention programmes for ankle injuries

Some types of preventive strategies have been used to reduce or prevent ankle injuries in different sports. Most of preventive strategies found in literature are balance training programmes, proprioceptive training programmes, and the use of ankle braces and ankle tapping. Pragmatists argue that the potential benefits of taping and bracing are related to enhancing sensorimotor control rather than providing mechanical constraint, but the evidence to support this remains contradictory (Abernethy & Bleakley, 2007). The

evidence for protective equipment (e.g. a brace) in injury prevention is inconclusive and requires more assessment.

Most of the studies investigated the effect of proprioceptive training programme on knee injuries. There were few studies in the literature that stated the effect of proprioceptive training in prevention of ankle sprains. Pasanen et al. (2008) concluded that a neuromuscular training program was effective in preventing acute non-contact injuries of the legs in female football players. Emery (2010) found that a neuromuscular training programme is protective of all injuries and acute onset injury in youth soccer players. Soderman et al. (2000) showed no significant change in the incidence of ACL injury following proprioceptive training in female soccer players. A systematic review done by Junge and Dvorak (2004), encouraged other interventions aimed specifically at the prevention of ankle sprains with proprioceptive training using ankle disks because it seemed to be the most promising.

2.5.1 Prevention of recurrent ankle injuries

Several studies in the literature showed that the proprioceptive training programme was more effective in subjects who had a history of a previous ankle injury. Hupperets et al. (2009) found that the use of a proprioceptive training program after usual care of an ankle sprain is effective for the prevention of self-reported recurrences. Verhagen et al., (2004) found that the use of a proprioceptive balance board programme is effective for the prevention of ankle sprain recurrence. Stasinopoulos (2004) found that technical training and proprioceptive training were equally effective at preventing further sprains.

In another study, Wedderkopp et al. (2003) again provided evidence that the combination of ankle disc training and functional strengthening is more effective at reducing injury incidence than functional strengthening alone.

Table 2.1: The proprioceptive training program to prevent recurrent ankle injuries

Author(s)	Year of Publication	Study design	Study aim	Intervention/ Assessment tool	Outcomes	Main result
Hupperets et al	2008	RCT	To evaluate the effect of proprioceptive balance board training programme on ankle sprain recurrences	Proprioceptive balance board training program	-incidence of recurrent ankle injuries -severity of re-injury	There were significant fewer recurrent ankle sprains in the intervention group than in the control group
Verhagen et al.	2004	RCT	To study the effect of a proprioceptive balance board training programme on the incidence of ankle sprains in volleyball players	Balance board training programme	Incidence of ankle sprains	The proprioceptive balance board training was effective in preventing recurrence of ankle sprain
Mohammadi et al	2007	RCT	To investigate which of these interventions are the most effective in preventing ankle sprains in athletes with previous ankle sprain	-Proprioception training programme -Strength training -Orthotic group	Incidence of ankle injuries	Proprioceptive training was an effective strategy to reduce the rate of ankle sprains among male soccer players wo suffered ankle sprain
Rozzi et al	1999	Pre-test Post-test	To determine the effects of a 4-week balance	Unilateral static and dynamic	-Increase joint proprioception	Balance training is an effective

.		design	training programme during stance on a single leg	balance training programme		means of improving joint proprioception and single leg standing ability in subjects with unstable and non-impaired ankles.
McHugh et al.	2007	Cohort study	To study whether the stability pad balance training reduces the incidence of non-contact inversion ankle sprain in football players with increased risk	Balance training programme	Incidence of ankle sprain	There is a reduction in injury prevalence in players with increased risks (high body mass and previous ankle sprain)
Stasinopoulos	2004	Cohort study	To investigate which of these three interventions is the most effective in preventing ankle sprain in female volleyball players	-Proprioceptive training -External support -Technical training	Incidence of ankle inversion sprains	Technical training and proprioceptive training were equally effective in preventing further sprains

Table 2.2: Characteristics of the sample

Author(s)	Year of publication	Sample age	Sample size	Sample description	Research setting
Hupperets et al.	2008	12-70 yrs	32	Male and female	Sports persons
Verhagen et al.	2004	----------	116 teams	Male and female	Volleyball teams
Mohammadi et al.	2007	21-28 yrs	80 players	Male	Teams/ soccer player
Rozzi et al.	1999	19-25 yrs	26 subjects	Male and female	----------
McHugh et al.	2007	----------	175 players	Male	Football teams
Stasinopoulos	2004	----------	52 players	Female	Volley ball teams

2.5.2 Prevention of acute ankle injuries

A proprioceptive exercise program led to a significant reduction in the incidence of ankle sprains; however, the effect on players without previous ankle remains unclear. There is limited information available concerning the effects of proprioceptive training for the primary prevention of ankle sprains in athletes (Eils, 2003). The proprioceptive training program may reduce the incidence of ankle sprains to the same level as for subjects without any history of ankle sprains (Tropp et al., 1985). Ekstrand et al (1983) concluded that there was no specific proprioceptive training programme performed and no distinction made between subjects with healthy and unstable ankle. Bahr et al (1997) concluded that the ankle disk training that was part of the intervention programme was recommended for players with previous injuries. However, it is not known whether healthy players used the ankle disk and what the effect may have been on the injury incidence in a healthy population. Therefore, the reduction of ankle sprains is as a result of the complex prevention programme, but the influence of the ankle disk training remains unclear, especially with respect to healthy subjects. Wedderkopp et al (1999) reported that the role of proprioception on the primary prevention of ankle sprains remains unclear because no distinction was made between subjects with normal and unstable ankles, as well as between the influence of ankle disk training and functional activities.

Table 2.3 Proprioceptive training studies in preventing acute ankle injuries

Author(s)	Year of publication	Study design	Study aim	Intervention/ Assessment tool	Outcomes	Main result
Tropp et al.	1985	Cohort study	To investigate the efficiency of a semi-rigid ankle orthosis and ankle disc training in reducin incidence of ankle sprains in soccer players	Orthosis and ankle disc	Incidence of ankle sprains	Ankle disc trainin reduced the Incidence Of ankle sprains among players with a history of related problems to the same level as men without any history and to the same level as when the orthosis was used

Table 2.4. Characteristics of the sample

Author(s)	Year of publication	Sample age	Sample size	Sample description	Research setting
Tropp et al.	1985	----------	450 players	Male	Soccer teams

2.5 Types of Proprioceptive exercises found in the literature

In the literature, there are many studies that used proprioception or balance programmes to treat or to reduce the incidence of different sports injuries or/and neuromuscular problems. Table 2.5 shows some of those studies.

Table 2.5: Proprioceptive or balance training programs used in different studies in the Literature

Author(s)	Year of publication	Exercises (proprioception, balance or neuromuscular)
Hupperets et al. Janssen et al.	2008 2011	A: one-legged knee flexion – on even surface - on even surface; eyes shut - on balance board B: toe-stand: - high surface with hand hold -high surface without hand hold C: one-legged stance (same 3 levels as exercise A) D: runner's pose (same 3 levels as exercise A) E: crossed-leg sway: -even surface with hand hold -even surface; without hand hold -even surface; eyes shut and without hand hold -on balance board F: toe-walk: - on even surface; walking -on even surface; jumping
McKeon et al.	2008	- Hop to stabilization - Hop to stabilization and reach - Hop to stabilization box drill - Single-limb stance with eyes open - Single-limb stance with eyes closed
Engebretsen et al.	2008	Weeks 1-2: - balance board: - both legs on board, arms crossed. Attempt to stand still and maintain balance. - Similar exercises, but now performed on one leg. - Both legs on the board, bouncing a Ball alternatively with both hands, standing as still as possible during the exercise. - Both legs on the board, throwing the ball and catching it. -balance pad: - one leg on the pad, maintaining balance for 30 seconds on alternating legs.

		Jumping exercises from outside the pad, landing on alternating legs Weeks 3-5: - balance board: - ball juggling performed while standing on one leg. -balance pad: bouncing ball around the pad while standing on one leg Calf raise while standing on both legs on the pad. Weeks 6-10: - balance board: - soccer-specific exercises, juggling the ball while standing on one leg, also combining both the balance board and the balance pad placing the pad on top of the board. balance pad: - closing eyes while standing on one leg, other exercises including jumping and landing on one or two legs from box/stairs.
Mohammadi et al	2007	- Stand on ankle disc on the injured leg, shift his/her weight (A/P, M/L, Circles) - Move with eyes open/eyes closed - From firm surfaces/soft and moving surfaces
McGuine & Keene	2006	

PHASE	SURFACE	EYES	EXERCISES
I (Week 1)	Floor	Open	Single-leg stance
		Open	Single-leg stance while swinging the raised leg
		Open	Single-leg squat (30°-45°)
		Open	Single-leg stance while performing functional activities (dribbling, catching, and kicking)
II (Week 2)	Floor	Closed	Single-leg stance
		Closed	Swinging the raised leg
		Closed	Single-leg squat (30°-45°)
III (Week 3)	Board	Open	Single-leg stance
		Open	Swinging the raised leg
		Open	Single-leg squat (30°-45°)
		Open	
IV (Week 4)	Board	Closed	Double-leg stance while rotating the board
		Open	Single-leg stance
		Open	Swinging the raised leg
		Open	Single-leg squat (30°-45°)
V (Week 5+)	Board	Closed	
		Open	Single-leg stance while rotating the board
		Open	Single-leg stance

				Open	Single-leg stance while performing functional activities (dribbling, catching, kicking) N.B, Phase I to V is 5 days per week; 30 seconds per leg and 30 seconds between repetitions.
Verhagen et al.	2004	- one-legged stance on the balance board with knee flexed, maintain balance and change stance leg (2 repetitions/both legs). - one-legged stance on balance board with hip and knee flexed.			
Blackburn et al	2000	- 4 square hops - Single-leg stance (foam surface) + ball used as visual or concentration deterrent; 3 repetitions, 20 seconds. - BAPS (maintain balance in single-leg stance), 3 repetitions, 20seconds.			
Rozzi et al.	1999	Static: single-leg stand (3 sets/30 seconds) Dynamic: A/P tilting, 3 sets; 6 repetitions M/L tilting, 3 sets; 6 repetitions CW circles, 1 set; 10 repetitions CCW circles, 1 set; 10 repetitions			

2.6 Risk factors of ankle injuries

Ankle sprains are extremely common, but very little is known about the variables that predispose individuals to these injuries (Willems et al., 2005). Several studies propose potential extrinsic and intrinsic factors of ankle sprain susceptibility. Direct contact with an opponent, inadequate warm-up, shoes, and playing on artificial turf are the primary extrinsic risk factors of ankle sprain. Whereas intrinsic risk factors include anatomic characteristics (e.g. increased foot width), functional deficits in isokinetic strength, flexibility, joint position sense, balance-postural sway and gait mechanics, limb dominance, previous ankle sprains, increased weight and body mass index. (Fousekis et al., 2012).

Table 2.6: The intrinsic risk factors for ankle sprain studies

Author (s)	Year of Publication	Study design	Study aim	Intrinsic risk factors studied	Main result
Fousekis et al	2012	Cohort Study	To identify intrinsic risk factors for Noncontact ankle Sprains in soccer.	Muscle strength, flexibility, proprioception, somatometric asymmetries, previous injury, Lateral dominance traits	Functional strength asymmetries of the ankle flexors, increased body mass index and body weight raise the propensity for ankle sprains. Age and asymmetries in ankle laxity are potential factors worth revisiting.
Arnason et al	2004	Cohort Study	To identify risk factors for football injuries.	Height, weight, body composition flexibility, leg extension power, jump height, peak O2 uptake, joint stability, and h previous injury	Age and previous injury were identified as the main risk factors for injury among elite football players.
Engebretsen et al	2010	Cohort Study	To identify risk factors for acute ankle injuries among male soccer players.	Previous injury, function score (FAOS), functional tests and clinical	Previous ankle injury and the FAOS score were candidate

				examination of the ankle	risk factors. Function scores, functional tests and clinical examination could not identify players at an increased risk.
Willems et al.	2005	Cohort Study	To examine intrinsic risk factors for inversion sprains in a young female population	anthropometrical characteristic ankle joint position sense, ankle muscle strength, lower leg alignment, postural control and muscle reaction time during inversion	Joint position sense, less coordination of postural control are at greater risk of an ankle sprain.
Hadzic et al	2009	Cohort Study	To investigate the influence of muscle strength, postural balance and active ROM on the ankle sprain occurrence in Volleyball players.	strength of plantar and dorsal flexors, postural balance and active ROM	Higher strength of plantar flexors and decreased ROM in dorsiflexion are risk factors for the ankle sprain.
de Noronha et al	2013	Prospective	To investigate whether certain intrinsic factors could predict ankle sprains in healthy active people.	postural control, ankle ROM, motor imagery, functional instability, history of previous injury, body mass index.	History of previous sprain was the strongest predictive factor and a weak performance on SEBT was considered a
					predictive factor for ankle sprains.

Conclusion:

Many studies found in the literature showed the effect of proprioception training programmes on recurrent ankle injuries. One study found in the literature on the effect of proprioception training programme on healthy subjects with ankle injuries and the results were not clear. It was not possible to do a meta-analysis because of the inadequate number of randomized controlled trials retrieved in the literature.

Many proprioceptive training interventions with best efficacy were found in the literature and these training programmes were used to inform the prevention programme designed for this study. However, consensus about the inclusion of these strategies was further investigated and is described in chapter 5.

2.7 Conceptual framework of the study

The study will be based on the conceptual framework proposed by Finch (2006). This strategy, proposed by Finch (2006) is known as: Translating Research into Injury Prevention Practice (TRIPP), and has 6 stages (Figure 2). These stages include injury surveillance, establishing the aetiology and mechanism of injury; the development of preventive measures; "ideal conditions"/scientific evaluations; the description of the intervention context and implementation strategies; and the evaluation of the effectiveness of prevention measures. Some of the principles outlined by the TRIPP model are similar to the model proposed by van Mechelen, Hlobil, and Kemper (1992) which has guided sports injury prevention research for years (Figure 3).

There are a number of limitations associated with this four-stage approach and the extent to which it has been implemented in practice. Firstly, the general sports injury research field still needs to move beyond stage 2. The model fails to adequately describe the directions required for research that leads to direct injury prevention. The most serious limitation of the van Mechelen Model is that it does not consider the need for research into implementation issues, once prevention measures have been proven effective (van Tiggelen, 2008; Finch, 2006).

The researcher chose the Finch Model as research framework to overcome this shortcoming of the van Mechelen Model.

Model stage	TRIPP	van Mechelen et al 4 stage approach [1]
1	Injury surveillance	Establish extent of the problem
2	Establish aetiology and mechanisms of injury	Establish aetiology and mechanisms of injury
3	Develop preventive measures	Introduce preventive measures
4	"Ideal conditions"/scientific evaluation	Assess their effectiveness by repeating stage 1
5	Describe intervention context to inform implementation strategies	
6	Evaluate effectiveness of preventive measures in implementation context	

Figure 2.2. The Translating Research into Injury Prevention Practice (TRIPP) framework for research leading to real-world sports injury prevention

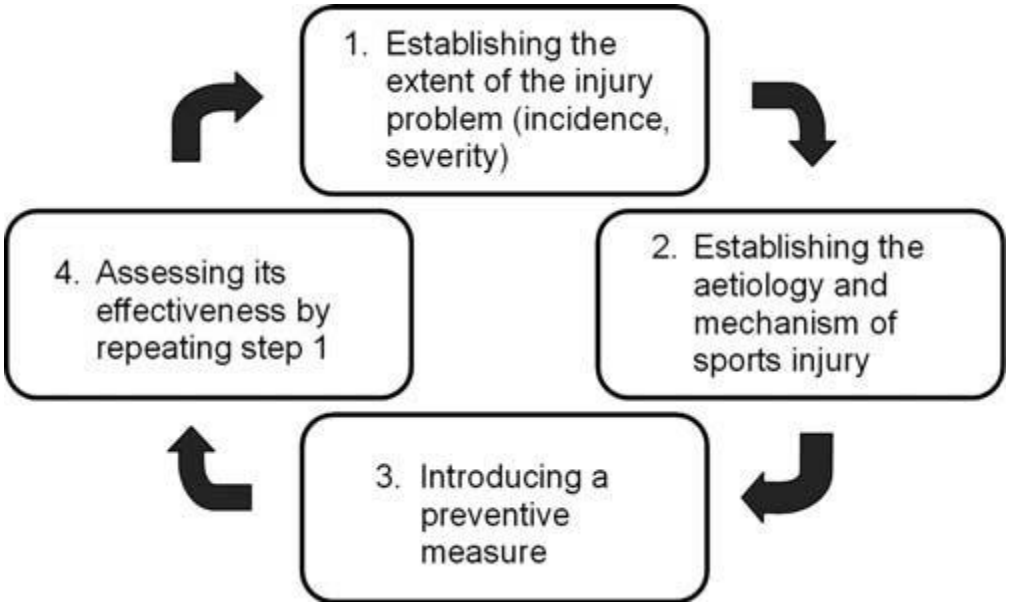

Figure 2.3. Sequence of prevention in four steps, adapted from van Mechelen et al. (1992)

2.8 ANATOMY OF THE ANKLE LIGAMENTS

Despite the fact that the ankle ligaments are prone to injury during different sports, literature focusing on the ankle ligaments is rare. Proper anatomical knowledge of the different ligaments is important for a correct diagnosis and subsequent treatment.

The ligaments around the ankle can be divided depending on their anatomical position into three groups: the lateral ligaments, the deltoid ligament on the medial side and the ligaments of the tibiofibular syndesmosis that join the distal epiphyses of the bone of the leg (tibia and fibula) (Golano P. et al., 2010). A brief description of these ligaments follows below.

2.8.1 Lateral collateral ligaments

The lateral collateral ligament complex (LCL) consists of the anterior talofibular (ATFL), the calcaneofibular (CFL) and the posterior talofibular (PTFL) ligaments (Yildiz S & Yalcin B, 2013; Raheem OA & O'Brien M, 2011; Golano et al., 2010).

2.8.2 Anterior talofibular ligament (ATFL)

The ATFL is the most frequently injured ligament of the ankle and it plays an important role in limiting anterior displacement of the talus and plantar flexion of the ankle. This ligament is closely related to the ankle joint capsule and is typically composed of two separate bands. The ATFL originates at the anterior margin of the lateral malleolus. The centre is on average 10 mm proximal to the tip of fibula as measured along the axis of fibula and its width is 6-10 mm. From its origin, it runs anteromedially to the insertion on the talar body immediately anterior to the joint surface occupied by the lateral malleolus. The ligament is virtually horizontal to the ankle in the neutral position but inclines upward in dorsiflexion and downward in plantar flexion. In plantar flexion, the ligament comes under strain and is vulnerable to injury, particularly, when the foot is inverted (Golano et al., 2010).

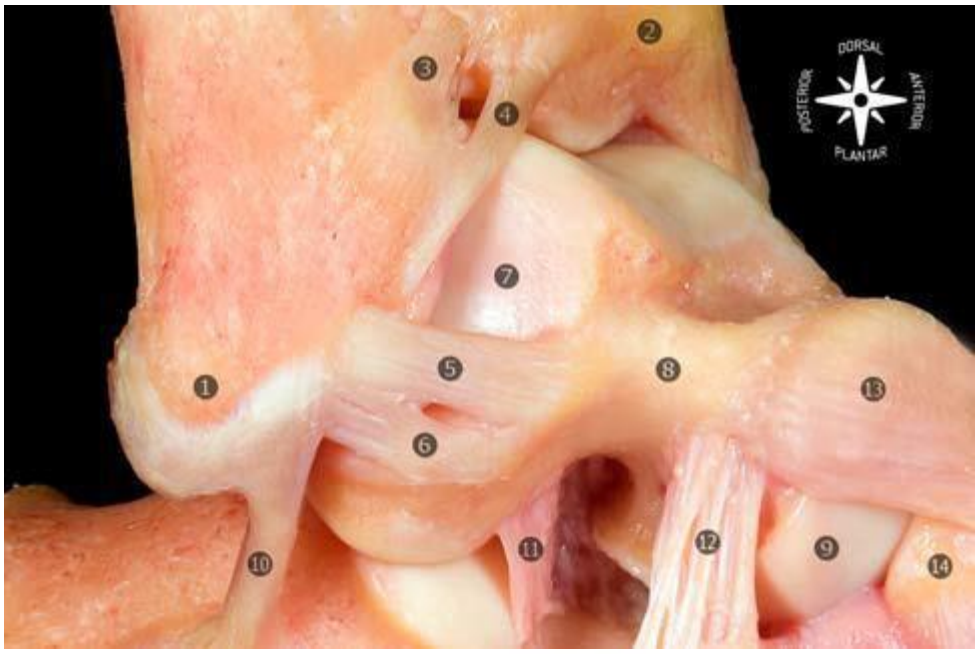

Fig. 2.4 Osteoarticular anatomic dissection of the lateral ligaments of the foot and ankle joint. The anterior talofibular ligament is typically composed of two separate bands. **1** tip of the lateral malleolus; **2** tibia; **3** anterior tibiofibular ligament; **4** distal fascicle of the anterior tibiofibular ligament; **5** superior band of the anterior talofibular ligament; **6** inferior band of the anterior talofibular ligament; **7** lateral articular surface of the talus; **8** neck of the talus; **9** head of the talus; **10** calcaneofibular ligament; **11** talocalcaneal interosseous ligament; **12** cervical ligament; **13** talonavicular ligament; **14** navicular (Golano et al., 2010).

2.8.3 Calcaneofibular ligament

The calcaneofibular ligament originates from the anterior part of the lateral malleolus. It is anatomically positioned just below the lower band of the anterior talofibular ligament. In the neutral ankle position, the ligament runs obliquely downwards and backwards to attach to the posterior region of the lateral calcaneal surface. This ligament is superficially crossed by the peroneal tendons and sheaths, which can leave a concavity over the ligament. In cross-section, the ligament is rounded and has a diameter of 6-8

mm, and its length is about 20 mm. The ligament is relaxed in the valgus position of the talus and tense in the varus position of the talus (Golano et al., 2010).

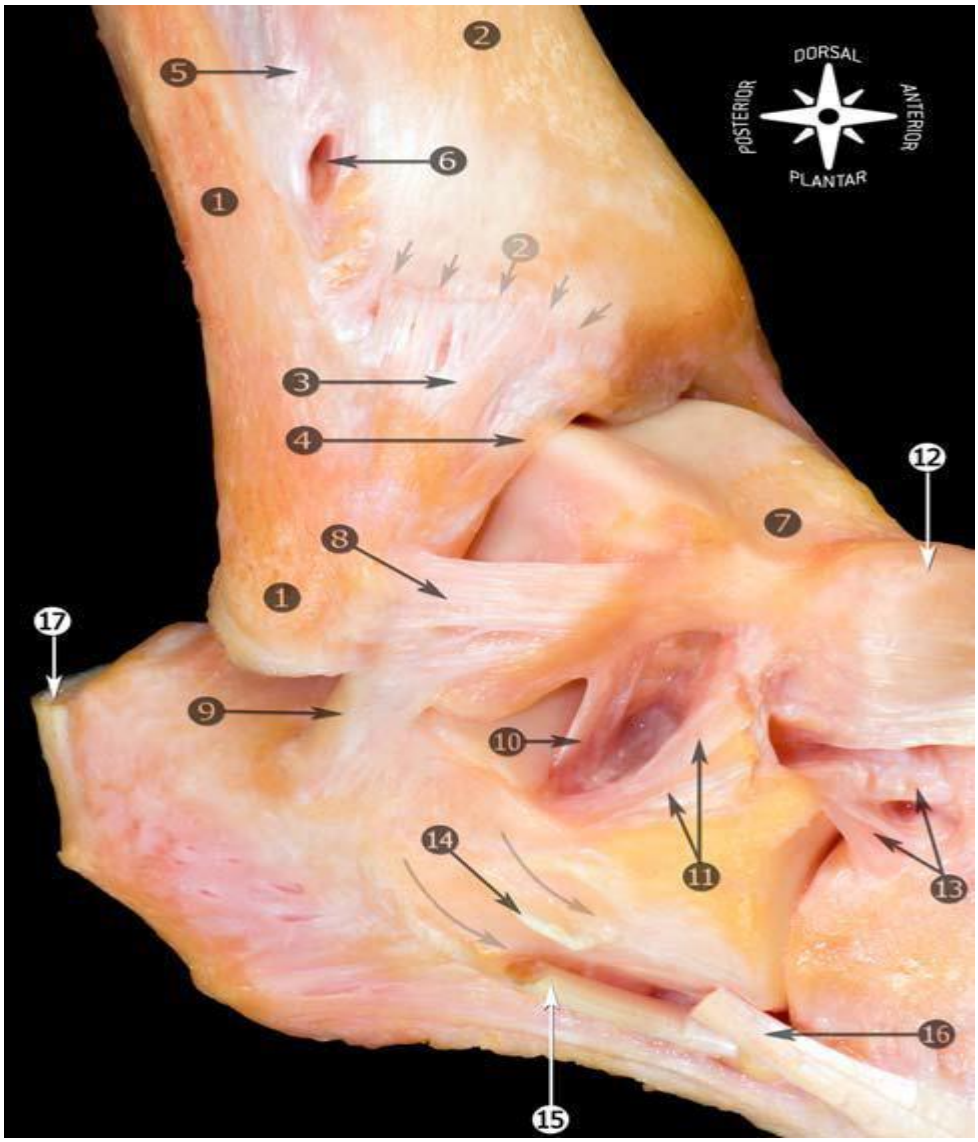

Fig. 2.5 Anatomic dissection of the lateral region of the foot and ankle showing the morphology and relationship of the anterior talofibular with the calcaneofibular ligaments. **1** fibula and tip of the fibula; **2** tibia (anterior tubercle with arrows); **3** anterior tibiofibular ligament; **4** distal fascicle of the tibiofibular ligament; **5** interosseous membrane; **6** foramen for the perforating branch of the peroneal artery; **7** talus; **8** anterior talofibular ligament; **9** calcaneofibular ligament; **10** talocalcaneal interosseous ligament; **11** inferior extensor retinaculum (cut); **12** talonavicular ligament; **13** bifurcate ligament; **14** peroneal tubercle (arrows showing the peroneal tendons sulcus); **15** peroneus longus tendon; **16** peroneus brevis tendon; **17** calcaneal tendon (Golano et al., 2010).

2.8.4 Posterior talofibular ligament

The posterior talofibular ligament originates from the malleolar fossa, located on the medial surface of the lateral malleolus, coursing almost horizontally to insert in the posterolateral talus. In plantar flexion and in neutral ankle position, the ligament is relaxed, while in dorsiflexion, the ligament is tensed (Golano et al., 2010).

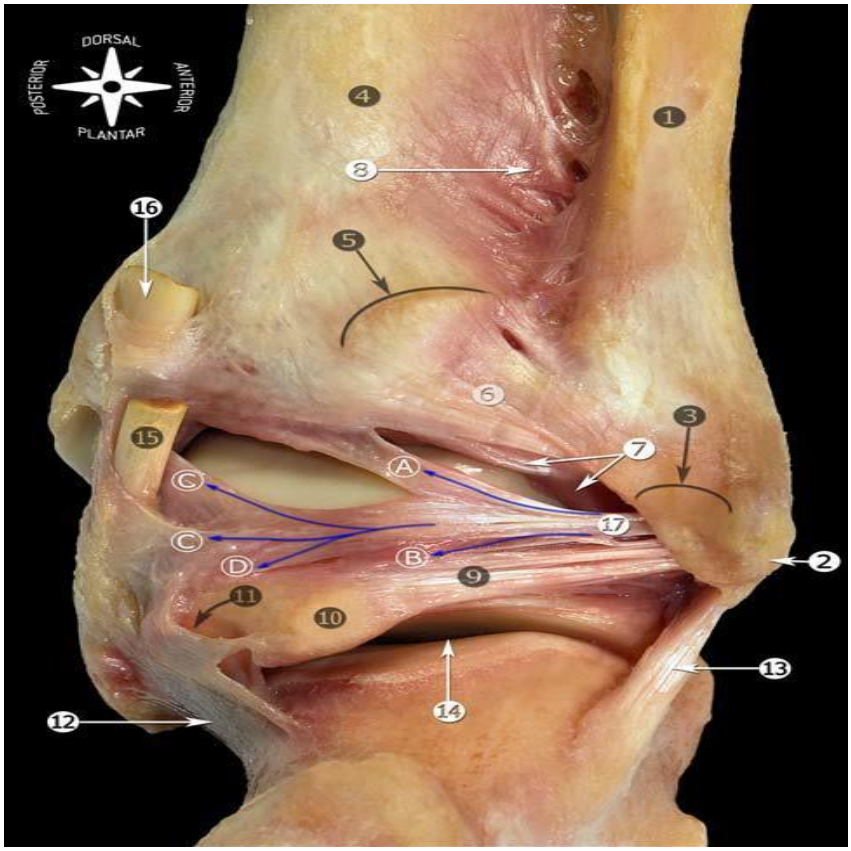

Fig. 2.6 Posterior view of the anatomic dissection of the ankle ligaments showing the posterior intermalleolar ligament with its relation to the surrounding anatomy. **1** Fibula; **2** tip of the fibula; **3** peroneal groove of the fibula; **4** tibia; **5** posterior tubercle of the tibia; **6** superficial component of the posterior tibiofibular ligament; **7** deep component of the posterior tibiofibular ligament or transverse ligament; **8** interosseous membrane; **9** posterior talofibular ligament; **10** lateral talar process; **11** tunnel for flexor hallucis longus tendon; **12** flexor hallucis longus retinaculum; **13** calcaneofibular ligament; **14** subtalar joint; **15** flexor digitorum longus tendon (cut); **16** tibialis posterior tendon (cut); **17** posterior intermalleolar ligament: **A** Tibial insertion (tibial slip in arthroscopic view). **B** Talar insertion (lateral talar process). **C** Tibial malleolar insertion through the septum

between the flexor digitorum longus and posterior tibial tendons. **D** Talar insertion (medial talar process) through the joint capsule (Golano et al., 2010).**2.8.5 Medial collateral ligament**

The MCL is called also "deltoid ligament". The anatomical descriptions of the MCL vary widely in the literature; however, in general most agree that it is composed of two layers; the **superficial and deep**.

The MCL is the multi-fascicular ligament, originating from the medial malleolus to insert in the talus, calcaneus, and navicular bone. The tendon sheath of the posterior tibial muscle covers the posterior and middle part of the deltoid ligament in much the same way as the peroneal tendon sheath is associated with the calcaneofibular ligament on the lateral side. Most of the MCL is covered by tendons as it extends down the leg to the bony insertions in the foot. Six bands or components have been described for the MCL, but the anatomy of this ligament and its components is still confusing (Golano et al., 2010; Savage-Elliott I. et al., 2013).

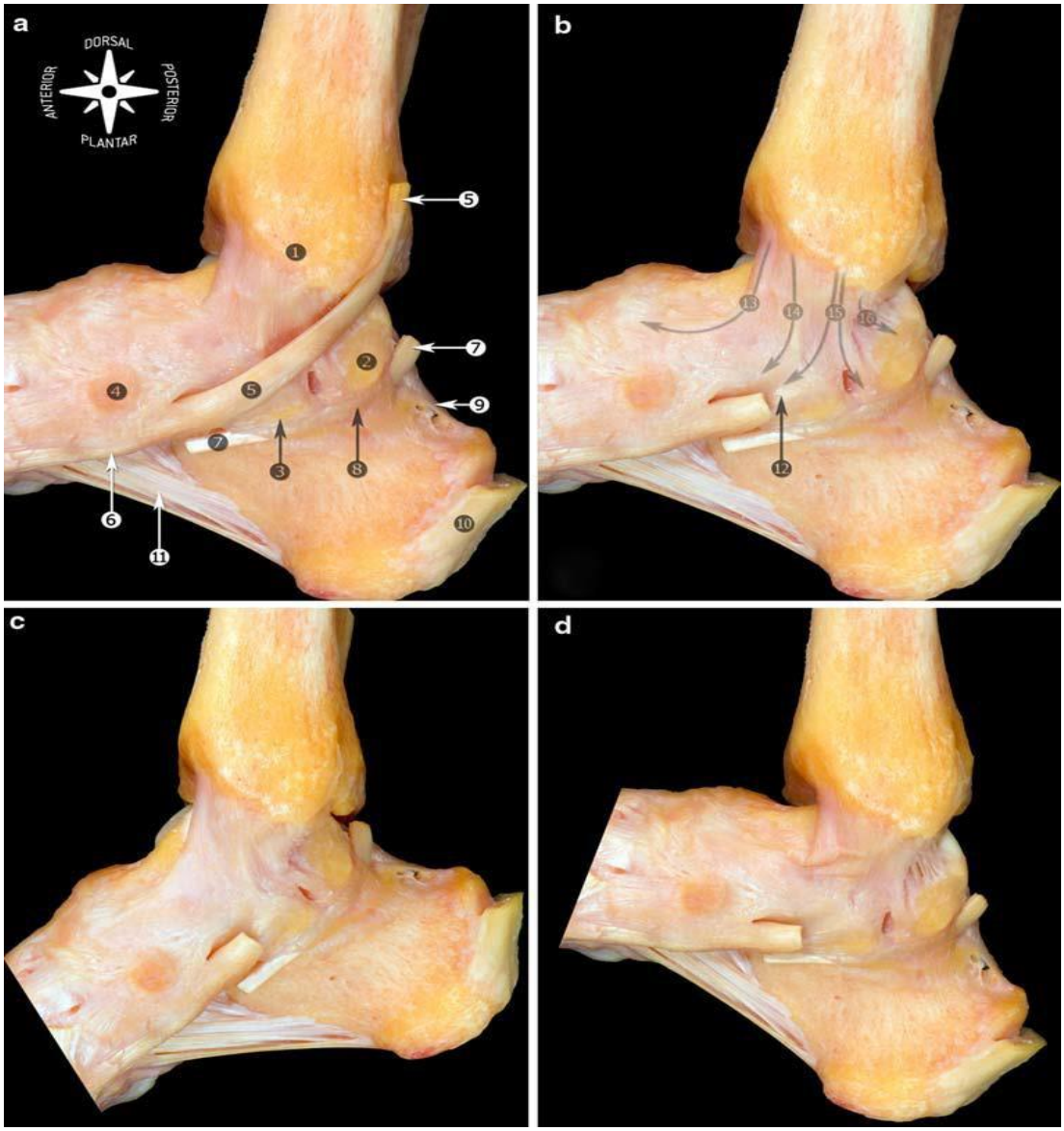

Fig. 2.7 Medial view of the anatomic dissection of the medial collateral ligament. Most of the medial collateral ligament is covered by tendons (tibialis posterior and flexor digitorum longus tendons). In order to see the ligament, the tendon of flexor digitorum longus was removed. **a** Neutral position showing the relationship with the tibialis posterior tendon. **b** The posterior tibialis tendon was removed.
c Plantar flexion. The components located anteriorly to the bimalleolar axis are tensed. **d** Dorsiflexion. The components located anteriorly to the bimalleolar axis are relaxed. **1** Medial malleolus; **2** lateral talar process; **3** sustentaculum tali; **4** navicular; **5** tibialis posterior tendon; **6** navicular tuberosity; **7** flexor hallucis longus (cut); **8** flexor hallucis longus retinaculum; **9** posterior talocalcaneal ligament; **10** calcaneal tendon (cut at the level of the insertion); **11** long plantar ligament; **12** spring ligament complex (superomedial calcaneonavicular ligament); **13** tibionavicular ligament; **14** tibiospring ligament; **15** tibiocalcaneal ligament; **16** deep posterior tibiotalar ligament (Golano et al., 2010).

2.8.6 Ligaments that join the distal epiphyses of the tibia and fibula.

The talocrural joint consists of a fork-shaped dome formed by the distal tibia and fibula and the talar trochlea enclosed by this mortise. Cartilaginous areas of the ankle joint are not congruent in their surface outlines. In the frontal plane, the talar dome has a slightly concave profile. The planes of the tibial and fibular facets are not parallel. The trochlea is wider anteriorly than posteriorly, and the cartilage covered surfaces have slightly curved sides. The fibular facet has a convex contour, whereas the tibial facet is concave (Golano et al., 2010; Ebraheim et al., 2006).

It is a syndesmotic articulation that allows the tibiafibula as a whole to adapt to the varying width of the upper articular surface of the talus by slight ascending and medial rotation movements of the fibula during extreme dorsiflexion (maximum width) and by inverse movements during plantar flexion (minimum width).

The syndesmotic ligament complex ensures the stability between the distal tibia and the fibula and resists the axial, rotational, and translational forces that attempt to separate the tibia and fibula. The three ligaments responsible are the anterior or anteroinferior tibiofibular ligament, the posterior or posteroinferior tibiofibular ligament, and the interosseous tibiofibular ligament (Golano et al., 2010; Ebraheim et al., 2006).

2.8.6.1 Anterior or anteroinferior tibiofibular ligament

The ligament originates in the anterior tubercle of the tibia (5 mm in average above the articular surface (Golano et al., 2010; van den Bekerom et al., 2007), and its fibres extend in a distal and lateral direction to the insertion site in the anterior margin of the lateral

malleolus, with increased length of the fibres distally. Upon examination, the ligament is seen to be divided into several fascicles, allowing the perforation branches from the peroneal artery. The most distal fibres of the ligament at its origin may be confused with those of the anterior talofibular ligament (Golano et al., 2010; Akseki et al., 1999; Bassett et al., 1990).

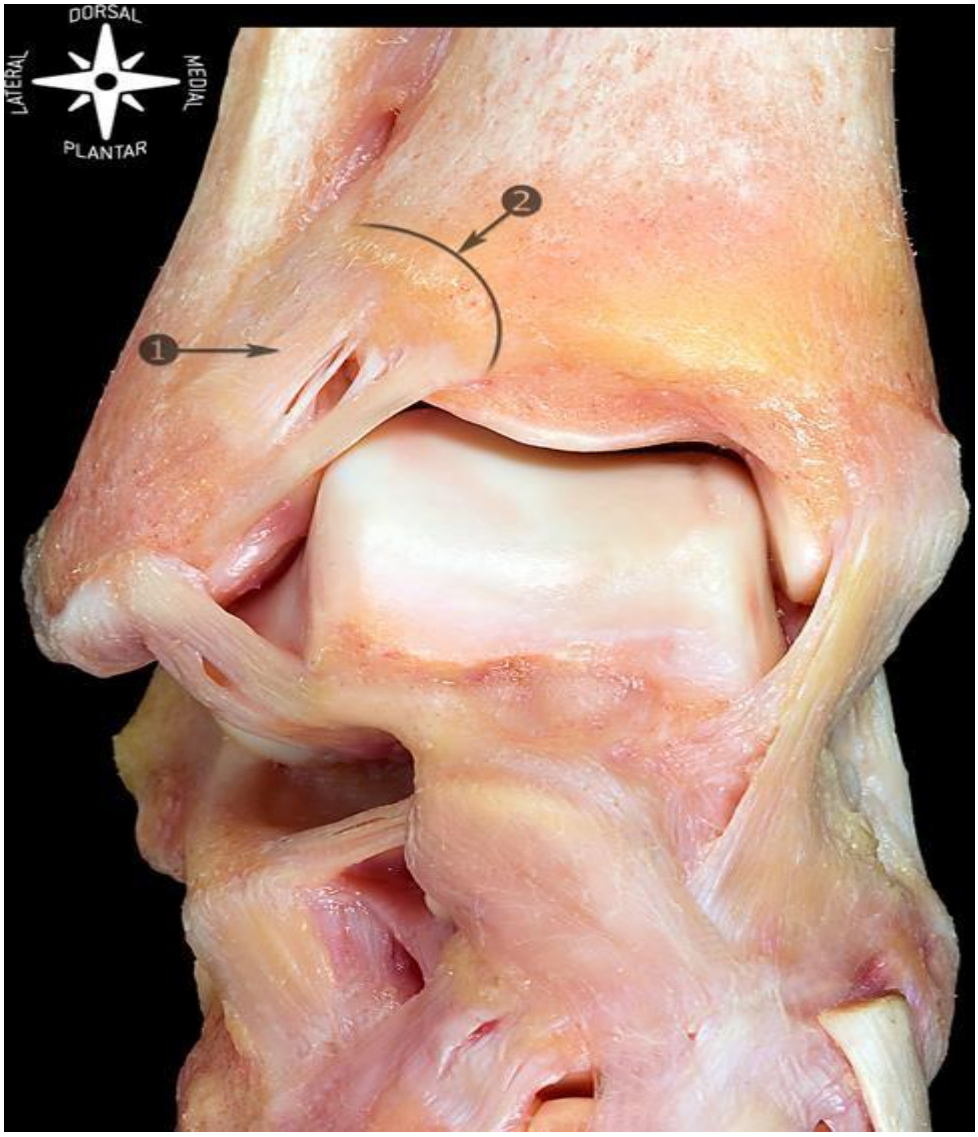

Fig. 2.8 Anterosuperior view of talocrural joint and dorsum of the foot. 1 Anterior tibiofibular ligament; 2 anterior tubercle of the tibia (Golano et al., 2010).

2.8.6.2 Posterior or posteroinferior tibiofibular ligament

This ligament is basically formed by two independent components, the superficial and deep component The superficial component originates at the posterior edge of the lateral malleolus and directs proximally and medially to insert in the posterior tibial tubercle. This component would be homologous to the anterior tibiofibular ligament. The term posterior or posteroinferior tibiofibular ligament is usually used to refer to the superficial component. The deep component is cone shaped and originates in the proximal area of the malleolar fossa to insert in the posterior edge of the tibia. Its insertion is immediately posterior to the cartilaginous covering of the inferior tibial articular surface; the fibres may reach the medial malleolus. This component is also known as the transverse ligament, forming a true labrum to provide talocrural joint stability and to prevent posterior talar translation (Golano et al., 2010; Taylor et al., 1992).

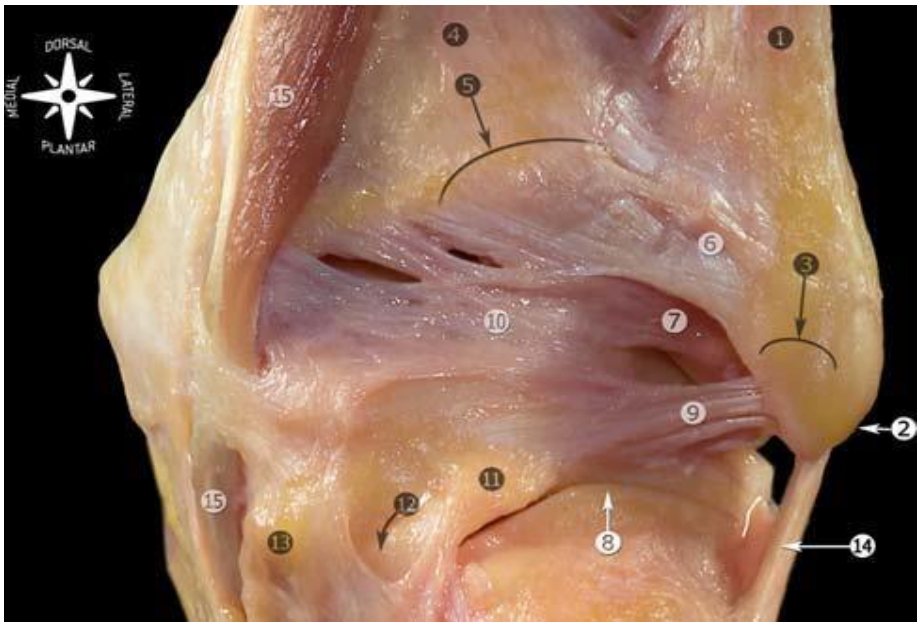

Fig. 2.9 Anatomic dissection of the posterior ligaments of the ankle. **1** Lateral malleolus; **2** tip of the lateral malleolus; **3** peroneal groove; **4** tibia; **5** posterior tubercle of the tibia; **6**

posterior tibiofibular ligament, superficial component; **7** posterior tibiofibular ligament, deep component or transverse ligament; **8** subtalar joint; **9** posterior talofibular ligament; **10** posterior intermalleolar ligament; **11** lateral talar process; **12** tunnel for flexor hallucis longus tendon (tendon was removed); **13** medial talar process; **14** calcaneofibular ligament; **15** flexor digitorum longus (Golano et al., 2010).

2.8.6.3 Interosseous tibiofibular ligament

The interosseous tibiofibular ligament is a dense mass of short fibres, which, together with adipose tissue and small branching vessels from the peroneal artery, span the tibia to the fibula. It can be considered a distal continuation of the interosseous membrane at the level of the tibiofibular syndesmosis. The interosseous ligament plays an important role in the stability of the ankle (Golano et al., 2010; Hoefnagels et al., 2007).

2.9 Summary of the chapter

This chapter reviewed the relevant literature regarding ankle injuries among football players. It further presents the procedures used and the results of a systematic literature review regarding injury prevention strategies in different sports. The finding of this systematic review was that very few studies (RCTs) were conducted on primary prevention of ankle injuries and none conducted in developing countries. The theoretical framework used for the study is outlined in the chapter. An overview of the anatomy of the ankle is also presented in this chapter. The methodology used to collect baseline data and intervention data is discussed in the following chapter (Chapter 3).

CHAPTER THREE

METHODOLOGY

3.1 Introduction of the chapter

This chapter presents the description of the research setting and study population. This is followed by the sampling method and instruments used to collect data. Furthermore, the chapter describes the study design, statistical data analysis and the ethical issues of the study are explained.

3.2 Research setting

Rwanda is an African country in the Great Lakes Region with a surface area of 26,338 Km2 (UNICEF, 1998). Rwanda is a member of African Confederation of Football (CAF) and has been affiliated to the International Federation of Football Associations (FIFA) since 1976 (CAF, 2004; FIFA, 2003). Soccer in Rwanda is predominantly for males and is ranked 107th in the world. Football in Rwanda is governed by FERWAFA (Federation Rwandaise de Football Association) and supervised by the Ministry of Sports and Culture. FERWAFA is organized in two male competitive divisions (1st and 2nd) and one female competitive 1st Division. FERWAFA has also a third male division which is at recreational level and supervises different youth soccer academies located in different provinces of the country. In Rwanda, the 1st division is considered as a semi-professional level and the 2nd division as an amateur level. The 3rd division is a recreational level as mentioned above. FERWAFA also governs all soccer national teams (Senior, under-23,

under-20 and under-17 teams), although all the national teams are fully sponsored by the Rwanda government through the Ministry of Sports and Culture.

3.3 Study Design

The overarching design for the study was an quasi-experimental design with a quantitative approach, which included a survey, systematic review, Delphi study and pre-test and post-test designs.

3.4 Study population and sample

3.5 Data collection methods

The data collection methods for each one of the phases of the study is described separately below.

Phase 1: To collect baseline data regarding ankle injuries among soccer players in Rwanda.

Study population and sample: The population for this study comprised the male soccer players of the 1st and 2nd division teams in the Rwandan National League. The Rwandan 1st and 2nd Divisions had twelve teams each, thus the total number was 24 teams. Each team had a maximum of 30 players on the league list. The total population was approached for participation in the study. Therefore, at the beginning of the season 639 players were registered in the federation (FERWAFA). All 639 players were approached and were conveniently selected to participate in the study.

Data collection instrument and procedures

The instrument used to collect baseline information regarding the prevalence and factors associated with soccer injuries was the one developed by the Federation International de Football Association Medical Assessment and Research Centre (F-MARC) (Fuller et al.; 2006). F-MARC forms can be used freely by different researchers. The two forms used included baseline information regarding player information and the injury registration form.

The **player's baseline information** form (Appendix H) includes general player information (age, height, weight, body mass index); playing position; number of years playing soccer; level of play for current and previous season; history of previous injuries (number, severity, nature, number of months since most recent ankle injury, use of protective gear, and whether the most recent injury caused the player to miss matches.

The **injury registration form** (Appendix I) completed by medical personnel includes date of injury, date of return to full participation, injured body part, type of injury, nature of injury and if the injury was due to the violation of the laws governing the game. The form used was the one developed by the Federation International de Football Association Medical Assessment and Research Centre (F-MARC) (Fuller et al.; 2006). In addition, coaches were requested to complete exposure report forms for each player/team. The form includes date, period (training/match), player's code number, duration of training session (minutes), and duration of match. The form used was the one developed by the Federation International de Football Association Medical Assessment and Research centre (F-MARC) (Fuller et al.; 2006). An ankle injury was defined as damage to the

ankle structures. The majority of ankle injuries are sprains and the spectrum encompasses soft tissue injury through isolated fracture to joint disruption (Cloke DJ et al., 2009). All diagnosis in this study was performed by teams' medical staff.

In addition, the following measurements were taken:

Balance was tested as follows: The player was asked to stand barefoot on one straight leg, keeping his arms crossed across the chest and his other leg bent to 90^0 at the knee, only using the ankle joint to correct his balance. The balance test was scored into five categories (Appendix J):

- 5 points (maximum score): The player could maintain his balance for 60 seconds with eyes open and for an additional 15 seconds with eyes closed, always using an ankle strategy only to maintain his balance.
- 4 points: The player could maintain his balance for 60 seconds with eyes open, using an ankle strategy only for at least 45 seconds of this period.
- 3 points: The player was able to maintain his balance for 60 seconds with eyes open, but needed to use body parts other than the ankle joint (knee, hip, torso, and arms) to correct his balance for more than 15 seconds of this period.
- 2 points: The player could balance for 60 seconds but needed to use the upper body and touch the floor with his other foot at times to correct imbalance.
- 1 point: The player could not manage to balance on one leg for more than short periods of time.

Validity and reliability of standing balance: Standing balance test has been confirmed to be valid and reliable in many studies found in the literature (Kejonen & Kauranen, 2001; Kluding P et al., 2010). In this study, the assistant-researcher gave a practice of standing balance and explained what the researchers expected from them. After the practice, the researchers performed the test and recorded the results.

Inter-rater reliability of standing balance: Many studies have shown high inter-rater reliability in standing balance test with intra-class correlation coefficients (ICC) ranging from 0.70 (moderate) to 0.97 (strong) (Kejonen & Kauranen, 2001; Tyson & Connell, 2009; Kluding et al., 2010).

The **clinical testing** of players' feet was performed and both legs were examined for foot type (normal, pes planus, pes cavus, splayed forefoot); standing rearfoot alignment (Normal, valgus); hallux position (normal, valgus); anterior drawer (normal, pathologic); range of motion for inversion, eversion (measured in degrees with the ankle at 10^0 of plantar flexion) and dorsiflexion. All tests were performed by two different physiotherapists to check the accuracy of the measurements (Appendix K).

The **function score for the ankle** was done using the Foot and Ankle Outcome Score (FAOS) (Roos et al., 2001) (Appendix L). The form consisted of five major parts (symptoms, pain, activities of daily living, function in sport and recreation, quality of life) and is scored by calculating the mean value of the five parts in percent of total possible score, where 100% was the maximal and 0% the lowest score.

Validity and reliability of the FAOS

The FAOS validity and reliability have been confirmed by several studies on lateral ankle instability, Achilles' tendinosis and plantar fasciitis (Roos et al, 2001; Eechaute et al., 2007; Carcia et al., 2008; Negahban et al., 2010; Mazaheri et al., 2010).

Inter-rater reliability of the FAOS: Inter-rater reliability of the FAOS has been reported to be high and strong with ICC ranging from 0.90 to 0.96 (Roos et al, 2001; Eechaute et al., 2007; Carcia et al., 2008; Negahban et al., 2010; Mazaheri et al., 2010).

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Validity and reliability of one-leg hop test

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Inter-rater reliability of One-leg hop test: For the one-leg hop test the level of agreement between raters ranges from moderate to high with intra-class correlation

coefficients ranging from 0.70 to 0.90 (Booher et al., 1993; Bolgla & Keskula, 1997; Ageberg et al., 1998; Warren et al., 2006; Bremander et al., 2007; Sekir U et al., 2008).

Statistical analysis:

Double data entry was done using Microsoft EXCEL and data was analysed using descriptive statistics with SPSS data analysis program (version 23). The analysed data was presented using percentages, frequency, mean, standard deviation, tables and figures. Exposure to matches and training was calculated by adding individual duration of all training and match play during the season. Logistic regression analysis was used to analyse the relationship between injury occurrence and their risk factors. All risk factors were examined in univariate analysis and those found statistically significant were further investigated in a multivariate model.

Phase 2: To develop a proprioceptive training programme to reduce ankle injuries among soccer players in Rwanda.

(i) **A systematic review** of the literature around proprioceptive training interventions that demonstrated the best evidence in preventing ankle injuries in soccer or other sports was conducted. A comprehensive systematic search of all studies and reviews measuring the efficacy of proprioceptive training program in prevention of ankle injuries in soccer and other sports was conducted in specific electronic databases (PUBMED, ERIC, MEDLINE, EMBASE, PsycInfo and COCHRANE Database).

To be eligible for inclusion in the review, articles should have an online version of the article published in English language, studies should have the reporting standards for

randomized controlled trials following CONSORT statement or other types of design with methodological rigour based on study; studies must be published between the years 1990 to 2011. Keywords to be used for the search include:

- Proprioception training/ankle sprain/ankle instability
- Balance board exercises/ankle injuries
- Balance training/ ankle sprains
- Proprioception training/ankle muscle strength
- Risk factors/ankle injuries
- Efficacy of ankle proprioception training/ankle balance training

Data extraction: A standardized data abstraction form was used and the following variables were abstracted by three reviewers: authors, setting of data collection, locations, study period, sample characteristics, sample size, study design, types of comparison, data collection tools, method of data collection, withdrawal and findings. The reviewers were trained and the selected articles were included in the review once the consensus had been reached by the reviewers.

Efficacy criteria for best evidence: Efficacy criteria for best evidence focused on several aspects of a study: quality of study design, quality of implementation and analysis, and strength of evidence. The criteria of quality of study design included prospective randomized controlled trials or a method with minimal bias. For quality of study implementation, the criteria included the assessment of the outcome after the intervention. For quality analysis, the performance of appropriate cluster-level analyses was included when the assignment was done at the cluster level. To meet the strength of

evidence criteria a study must demonstrate significant positive evidence and no significant negative evidence. The statistically significant ($P<0.05$) and positive intervention effect had to be evident for at least 1 relevant outcome measure. There were an inadequate number of randomized controlled trials to do a meta-analysis.

The results of the systematic review are described in Chapter 2 of the thesis.

(ii) **A Delphi-study** was used to reach consensus on the content of the intervention that was drawn up based on the best evidence gathered in the systematic review described above and outlined in chapter 2. In addition, the results of the baseline study regarding the risk factors associated with ankle injuries were also used to inform the intervention. The Delphi study was originally designed to "obtain the most reliable consensus of opinion from a group of experts by a series of intensive questionnaires interspersed with a controlled feedback" (Ludwig & Starr, 2005). The panel of the Delphi technique most often consists of five to 25 members, as the validity of the technique does not depend on the number of participants but rather on the expertise of the panel. Experts were selected by nominations of people or organizations. Nominators were identified from organizations such as the FIFA Medical Assessment and Research Centre, South African Institute of Sports Science, and researchers at Universities. These nominators were asked to provide a list of names of people with expertise in the prevention of ankle injuries in soccer who may be willing to participate in the study. Identified experts were contacted to determine their willingness to participate in the study. When a group of at least 15 experts involved in the prevention of ankle injuries in soccer were obtained, round one begun. Each member was asked to comment on each item/statement and rate it on a 1-5

Likert-type scale (strongly disagree to strongly agree). This process was repeated until consensus was reached regarding the relevance of the information to be included in the proprioceptive training program.

Consensus in this study was defined as agreement by 65% or more of the participants (Ludwig & Starr, 2005). After consensus had been reached about the relevance of the information included in the programme, the proposed programme was finalized and implemented in the teams randomized into the intervention group. The results of the Delphi study are presented in chapter 5.

Phase 3: To implement and determine the effect of the developed proprioceptive training programme on the prevalence of ankle injuries, and the potential intrinsic factors among soccer players in Rwanda.

Design: The design adopted for this phase of the study was quasi-experimental.

Population and Sampling: All the teams who participated in the first phase of the study were asked to indicate their willingness to participate in the implementation of the proprioceptive training programme. All teams indicated their willingness to be part of the intervention study and four (4) teams were randomly selected to participate in the intervention study. Teams were randomly allocated to either the intervention or control groups. One physiotherapist in the Physiotherapy department (University of Rwanda) conducted randomization of teams to be part of intervention group or control group. The physiotherapist responsible for the randomization given codes that represented each team and was asked to choose two codes for intervention group and two other codes for control group. This physiotherapist did not participate in the intervention study.

Two facilitators worked with approximately 40-60 players to deliver the proprioceptive

training program. This programme started during the preseason period of one month before the league and the programme was given three times a week in training sessions. During the league, the programme was given twice a week in training sessions.

To reduce potential confounding, the teams were matched by region, playing level and number of players. The person to conduct the randomization was not involved in the intervention. To counter contamination bias, province and or district was also considered in the allocation of teams.

Inclusion criteria

Players who had no ankle injuries at the time of the intervention and who did not sustain ankle injuries in previous season were included in the study.

Exclusion criteria

Players who had ankle injuries at the time of the intervention and who sustained ankle injuries in previous season were excluded in the study. Players who played in other divisions than 1st and 2nd divisions were also excluded in the study.

Data collection instrument and Procedures

The injury registration form includes date of injury, date of return to full participation, injured body part, type of injury, nature of injury and if injury due to the violation of the laws governing the game. In addition, coaches were requested to complete exposure report forms for each player/team (Appendix M). The form includes date, period (training/match), player's code number, duration of training session (minutes), and duration of match. The two forms used were the ones developed by the Federation

International de Football Association Medical Assessment and Research Centre (F-MARC) (Fuller et al.; 2006).

The following outcome measures were used and were described in detail under phase 1 of this chapter.

To examine for potential intrinsic risk factors for injuries to the ankle among players, the screening of all players in the intervention teams was done by **physiotherapists**. This screening included balance testing, testing of ankle proprioception, foot and ankle outcome score and clinical testing for foot type, standing rear foot alignment, hallux position, anterior drawer and range of motion for inversion/eversion and dorsiflexion.

Balance was tested as follows: The player was asked to stand barefoot on one straight leg, keeping his arms crossed across the chest and his other leg bent to 90^0 at the knee, only using the ankle joint to correct his balance. The balance test was scored into five categories:

- 5 points (maximum score): The player could maintain his balance for 60 seconds with eyes open and for an additional 15 seconds with eyes closed, always using an ankle strategy only to maintain his balance.
- 4 points: The player could maintain his balance for 60 seconds with eyes open, using an ankle strategy only for at least 45 seconds of this period.
- 3 points: The player was able to maintain his balance for 60 seconds with eyes open, but needed to use body parts other than the ankle joint (knee, hip, torso, and arms) to correct his balance for more than 15 seconds of this period.
- 2 points: The player could balance for 60 seconds but needed to use the upper body and touch the floor with his other foot at times to correct imbalance.

- 1 point: The player could not manage to balance on one leg for more than short periods of time.

Validity and reliability of standing balance: Standing balance test has been confirmed to be valid and reliable in many studies found in the literature (Kejonen & Kauranen, 2001; Kluding et al., 2010). In this intervention study, the assistant-researcher demonstrated the standing balance and explained what the researchers expected from them. After the practice, the researchers performed the test and recorded the results.

Inter-rater reliability of standing balance: Many studies have shown high inter-rater reliability in standing balance test with intra-class correlation coefficients (ICC) ranging from 0.70 (moderate) to 0.97 (strong) (Kejonen & Kauranen, 2001; Tyson & Connell, 2009; Kluding et al., 2010).

The **clinical testing** of players' feet was performed and both legs were examined for foot type (Normal, pes planus, pes cavus, splayed forefoot); standing rearfoot alignment (Normal, valgus); hallux position (normal, valgus); anterior drawer (normal, pathologic); range of motion for inversion, eversion (measured in degrees with the ankle at 10^0 of plantar flexion) and dorsiflexion. All tests were performed by two different physiotherapists to check the accuracy of the measurements.

The **function score for the ankle** was done using the Foot and Ankle Outcome Score (FAOS) (Roos et al., 2001). The form consisted of five major parts (symptoms, pain, activities of daily living, function in sport and recreation, quality of life) and is scored by calculating the mean value of the five parts in percent of total possible score, where 100% was the maximum and 0% the lowest score.

Validity and reliability of the FAOS

The FAOS validity and reliability have been confirmed by several studies on lateral ankle instability, Achilles' tendinosis and plantar fasciitis (Roos et al, 2001; Eechaute et al., 2007; Carcia et al., 2008; Negahban et al., 2010; Mazaheri et al., 2010).

Inter-rater reliability of the FAOS: Inter-rater reliability of the FAOS has been reported to be high and strong with ICC ranging from 0.90 to 0.96 (Roos et al, 2001; Eechaute et al., 2007; Carcia et al., 2008; Negahban et al., 2010; Mazaheri et al., 2010).

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Inter-rater reliability of One-leg hop test: For one-leg hop test the level of agreement between raters range from moderate to high with intra-class correlation coefficients ranging from 0.70 to 0.90 (Booher et al., 1993; Bolgla & Keskula, 1997; Ageberg et al.,

1998; Warren et al., 2006; Bremander et al., 2007; Sekir U et al., 2008).

The intervention programme was implemented in 2014-2015, during preseason period and during competitive season of Rwandan national football league. The teams in the control group were asked to continue with their usual programmes used to prevent injuries. Furthermore, they were informed that if the intervention programme prevented injuries in the intervention teams, they will receive the proprioceptive training programme in the subsequent season.

Two facilitators worked with approximately 40-60 players to deliver the proprioceptive training program for a period of 6-7 months during 2014-2015 competitive season. Before the intervention programme workshops were conducted to train the facilitators (physiotherapists) on how to deliver the proprioceptive training program to the participants.

The primary outcome to be assessed in the study included ankle injury rates (and its 95% confidence interval) calculated as the incidence of ankle injury per 1000 playing hours. Secondary outcomes included ankle proprioception and balance. Outcome measures were collected in both intervention and control groups by independent therapists who were blinded to whether teams belong to intervention or control groups.

Statistical analysis:

Double data entry was done using Microsoft EXCEL and data was analysed using descriptive statistics with SPSS data analysis program (Version 23). The analysed data were presented using percentages, frequency, mean, standard deviation, tables and figures. All the analyses were performed according to the intention-to-treat principle to

compare the risk of an injury in the two groups. The relative risk reduction was calculated using the rate in the control group divided by the rate in the intervention group and will be reported as a ration with 95% confidence intervals. The study will use a significance level of P value <0.05.

3.6 Ethics

Permission and ethics clearance to conduct the study was obtained from the Senate Higher Degrees Committee and Senate Research committee at the University of the Western Cape (UWC) (Appendix A). Further permissions were requested (Appendix B) and obtained (Appendix C) from the Rwandan Federation of Football Associations. The study was conducted according to ethical practices pertaining to the study of human subjects as specified by the Faculty of Community and Health Sciences Research Ethics Committee of the UWC and the Rwandan Ethical Committee. The following guidelines were observed:

- Risk: No perceived risks were expected in the study.
- Benefits of the study to participants: Through the intervention the participants benefited with the decrease of ankle injuries occurrence and the teams reduced the expenditures of ankle injuries treatments.
- Informed Consent: Written and signed informed consent was obtained from each participating team and player. The study was explained to all the participating players (Appendix D) and participating experts (Appendix E) in the form of an information sheet. Furthermore, consent forms were provided and signed by all the participants (Appendix F and G).
- Anonymity: The confidentiality and anonymity were ensured. Identification

codes using numbers was used on data to ensure anonymity.

- Voluntary participation: Participation into the study was voluntary. Withdrawal from the study at any stage of the study was guaranteed. Participants were treated with respect and dignity.
- Distribution of findings: The study findings will be made available to the public through public lecture, workshops for all concerned parties.

3.7 Summary of the chapter

This chapter outlined the methods used to collect baseline data regarding injuries among Rwandan football players and intervention data. The next chapter presents the results of the data analysis for the first objective (i.e. baseline data)

CHAPTER 4

QUANTITATIVE BASELINE DATA

PREVALENCE AND POTENTIAL RISK FACTORS FOR ANKLE INJURIES

4.1 INTRODUCTION

This chapter contains the results of the statistical analysis that attempted to answer the objectives set out as the first phase of the study, i.e. to examine the potential intrinsic risk factors for injuries to the ankle among soccer players, and to determine the prevalence of ankle injuries among soccer players in Rwanda in one competitive season. The following will be outlined in the chapter: an overview of the description of study sample, the prevalence of injuries, injury characteristics and the potential intrinsic risk factors for ankle injuries. The results are summarized in tables and presented in graphs where needed.

4.2 DESCRIPTION OF STUDY SAMPLE

All teams returned the forms used to collect baseline data in the period of 2012 to 2013 football season in Rwanda. The response rate was 100%. Therefore, the total sample was 639 soccer players. The sample was composed of 24 soccer teams, where 12 teams were in first Division (n= 321 i.e. 50.2%) and 12 teams in second Division (n=318 i.e. 49.8%). The mean age of the players was 20.7 years (SD = ± 3.1) the minimum age was 16 years; the maximum age was 32 years old and the standard deviation of. The characteristics of the study sample are summarized in table 4.1.

Table 4.1: Characteristics of the study sample (n=639)

CHARACTERISTICS	FREQUENCY (n=639)	PERCENTAGE
League Division:		
First Division	321	50.2
Second Division	318	49.8
Player Position:		
Goalkeeper	51	8.0
Defender	187	29.3
Midfielder	216	33.8
Forwarder	185	29.0

The mean height and weight of players was 176.1 cm and 67.3 kg respectively. The minimum and maximum values for these variables are summarized in table 4.2.

Table 4.2: The mean age, weight and height of soccer players (n=639)

Variables	Mean	Minimum	Maximum	Standard Deviation
Age (Years)	20.7	16	32	±3.1
Height (Cm)	176.1	158	190	±4.6
Weight (Kgs)	67.3	55	79	±5.07

4.3 INJURY PREVALENCE

In the study sample of 639 players, 221 injuries occurred during the period of one football season, therefore a prevalence of 34.6%. Of these injuries, 149 (67.4%) occurred during training and 72(32.6%) during matches as illustrated in figure 4.1.

Of the 221 injuries sustained by players, 92 (41.6%) injuries were to the ankle. Ankle was the prevalent body part, followed by the knee with 18.5% of all injuries as illustrated in table 4.3.

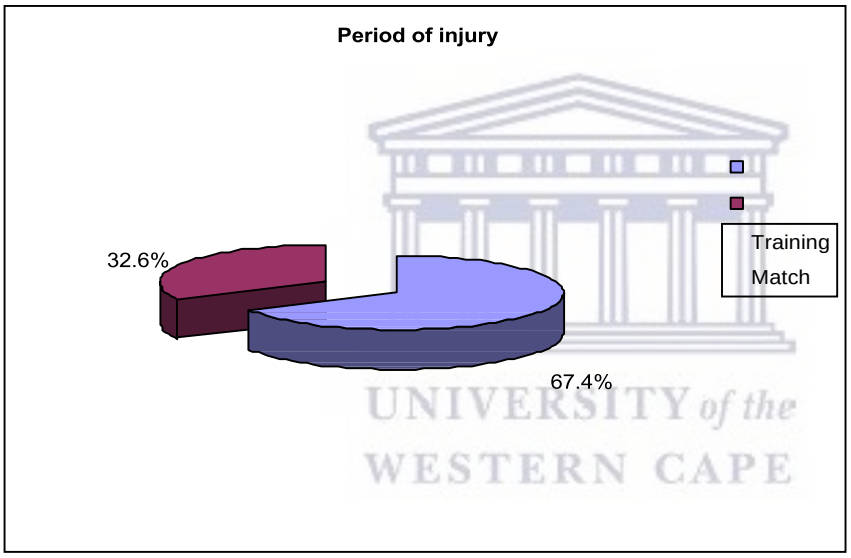

Figure 4.1 Period of injury (Training vs Match) (n=221)

Table 4.3 summarizes the frequency and percentage of injuries sustained to the different body parts.

Table 4.3: Prevalence of injuries for different body parts (n=221)

Body parts	**Frequency**	**Percentage**
No injury	418	65.4
Ankle	92	41.62
Knee	41	18.55
Thigh	19	8.59
Lower limb	17	7.7
Head	11	4.97
Fingers	10	4.52
Groin	9	4.07
Upper limb	8	3.61
Trunk	8	3.61
Face	5	2.26
Cardiac problem	1	0.45

4.3.1 Incidence of ankle injuries

The incidence rate was **3.6 injuries per 1000** hours of exposure. The incidence rate in relation to exposure hours was calculated by taking the total number of injuries recorded in one season divided by the total exposure for that season, and the result multiplied by 1000 hours (Knowles et al., 2006).

4.4 INJURY CHARACTERISTICS

This part will present the location of injuries, types of injuries, severity of injuries and finally contact and non-contact injuries sustained by soccer players.

4.4.1 Location of injury

The results of this study revealed that the ankle was body part which sustained more injuries with 92 (41.6%) injuries; the knee was the second body part with 41 (18.5%), followed by the thigh with 19 (8.5%) injuries. The head was the next body part to sustain injuries with 11 (4.9%) injuries and fingers with 10 (4.5%) injuries. The groin and the foot sustained 9 (4%) and 8 (3.6%) injuries, respectively. The face, Achille's tendon and lumbar spine sustained 5 (2.3%) injuries for each body part. Many other body parts had below 1% of injuries. Figure 4.2 shows the injured body parts.

Table 4.4: Location of injuries on different body parts (n=221)

Body parts	Frequency	Percentage
No injury	418	65.4
Ankle	92	41.62
Knee	41	18.55
Thigh	19	8.59
Head	11	4.97
Fingers	10	4.52
Groin	9	4.07
Foot	8	3.61
Face	5	2.26
Achille's Tendon	5	2.26
Lumbar spine	5	2.26
Forearm	3	1.35
Shoulder	2	0.9
Wrist	2	0.9
Clavicle	2	0.9
Hip	2	0.9
Tibia	1	0.45
Ribs	1	0.45
Lower leg	1	0.45
Elbow	1	0.45
Cardiac problem	1	0.45

4.4.2 Types of injuries

The present study show that the most common injury type was ligament sprain (50.7%), followed by contusion (12.2%); muscle strain (8.11%), tendinitis (5.9%) and dislocation (5%). Fracture and ligament rupture without instability presented (4.07%) each. Other types of injuries were skin laceration with 3.2%, meniscus lesion and concussion presented both with 1.8%. Many other types of injuries had below 1%. Figure 4.3 below shows the different types of injuries sustained by soccer players.

Table 4.4. Different types of injuries (n=221)

Types of injuries	Frequency	Percentage
Sprain	112	50.7
Contusion	27	12.2
Strain	18	8.11
Tendinitis	13	5.9
Dislocation	11	5
Fracture	9	4.07
Ligament rupture w/t instability	9	4.07
Laceration	7	3.2
Meniscus lesion	4	1.8
Concussion	4	1.8
Bursitis	2	0.9
Dental injury	2	0.9
Ligament rupture w/ instability	1	0.45
Semi-coma	1	0.45
Wound	1	0.45

4.4.3 Severity of ankle injuries

The results of this study show that most of the injuries sustained were transient with 39.8%, followed by mild (26.7%) and moderate injuries with (21.3 %). In all injuries, 12.7% of injuries were severe. Figure 4.4 shows the severity of injuries sustained by soccer players.

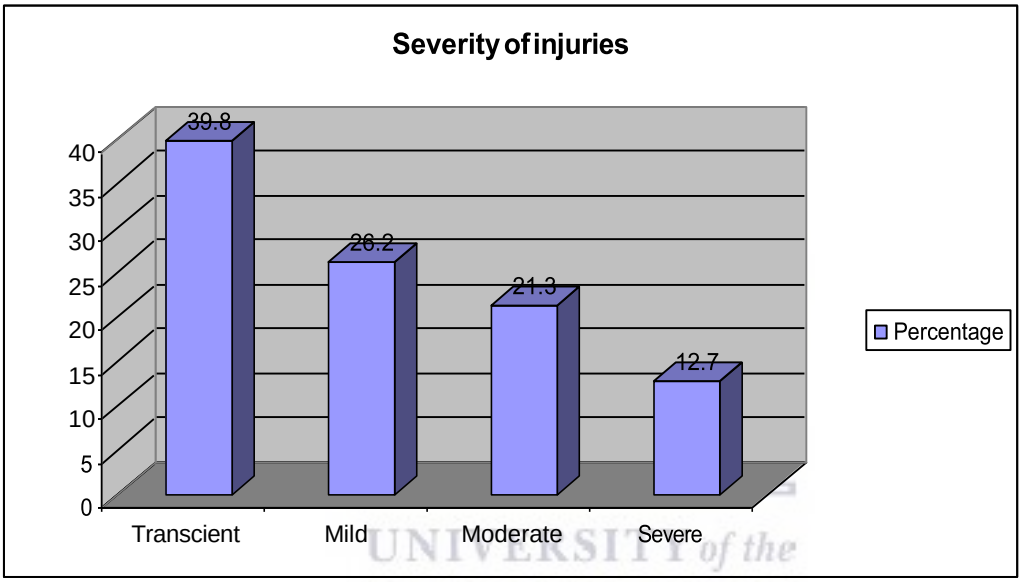

Figure 4.4 Severity of injuries (n=221)

4.4.4 Contact vs non-contact injuries

The present study results revealed that in the total of 221 of injuries sustained by soccer players, 115 (52%) injuries occurred during contact and 106 (48%) injuries occurred without contact with other players. Figure 4.5 shows the contact and non-contact injuries.

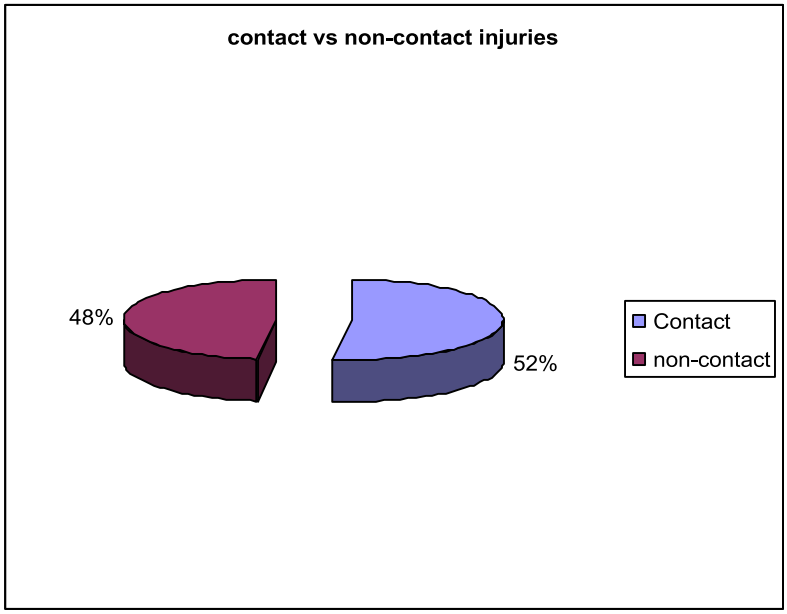

Figure 4.5 Contact and non-contact injuries (n=221)

4.5 POTENTIAL INTRINSIC RISK FACTORS FOR ANKLE INJURIES

The results of this study show that the strongest potential risk factors for ankle sprains were diminished proprioception, abnormal standing balance and abnormal rearfoot alignment. Inferential statistics (Chi-square analysis) and logistic regression were used to determine if relationships exist between the occurrence of ankle sprains and different risk factors. Relative risk was calculated with a 95% confidence interval (C.I) and significance set at $p<0.05$. A chi-square test and logistic regression indicated that the players who had diminished proprioception, and abnormal balance presented a high risk to sustain an ankle sprain. These two variables were significantly associated with the risk to sustain ankle sprains in this study with diminished proprioception **(95% CI 0.24-0.089, p=0.000)**; standing balance **(95% CI 0.46-1.216, p=0.020)**. Table 4.4 shows the potential risk factors for the present study.

Table 4.4: Potential risk factors for ankle sprains

Variables	Injured		Non- injured		95% C.I	P-value
	Fequency	%	Fequency	%		
Proprioception:						
Maximum	23	3.6	477	74.6	[0.24-0.089]	0.000
Diminished	101	15.80	38	5.9		
Balance:						
3	11	1.7	14	2.19	[0.46-1.216]	0.020
4	41	6.4	49	7.7		
5	46	7.19	478	74.80		

None of the dorsiflexion (95% CI 0.578- 1.456, p=0.713), eversion (95% CI 0.731-1.233, p=0.698), inversion (95% CI 0.615-1.064, p=0.129), hallux position 95% CI 0.333- 1.677, p=0.480), anterior drawer (95% CI 0.465- 3.512, p=0.635) and rearfoot standing (95% CI 0.595- 2.305, p=0.647) were the risk factor for ankle sprains. Additionally, the height, weight, age, and FAOS records were not the risk factor for ankle sprains in the present study (p>0.05). Table 4.5 shows the variables that have no statistical significance to be a risk factor for ankle sprain.

Table 4.5: Variables with no statistical significance for ankle sprain risk factors

Variables	Injured		Non-injured		95% C.I	P-value
	Frequency	%	Frequency	%		
Foot type						
Normal	66	10.3	444	69.5	[0.578-1.456]	0.713
Pes cavus	3	0.5	21	3.3		
Pes planus	24	3.8	81	12.7		
Rearfoot alignment						
Normal	68	10.6	447	70	[0.595-2.305]	0.647
Valgus	22	3.4	102	16		
Hallux position						
Normal	80	12.5	482	75.4	[0.333-1.677]	0.480
Valgus	14	2.2	63	9.9		
Anterior drawer						
Normal	84	13.1	514	80.4	[0.456-3.512]	0.635
Pathological	8	1.3	33	5.2		

4.6 SUMMARY OF THE CHAPTER

In this chapter, the results of the baseline data were presented. A total of 221 injuries were recorded over the study period. The total prevalence of all injuries is 34.6 %. Totals of 72 (67.4%) match injuries (injuries occurring during a match) and 149 (32.6%) training injuries (injuries occurring during training) were recorded in 24 teams during the study period. The ankle injury prevalence was 41.6% (n=92). The injury incidence rate of ankle injuries was 3.6 injuries per 1000 hours exposure per player. The strongest potential risk factors for ankle sprains were diminished proprioception, abnormal standing balance and abnormal rearfoot alignment. The next chapter outlines the procedure used in designing a proprioceptive training programme to reduce ankle injury rate in footballers. This programme was designed based on the systematic literature review (chapter 2) and the results discussed in chapter 4.

CHAPTER 5

THE DELPHI STUDY

5.1 INTRODUCTION TO THE CHAPTER

This chapter describes the second phase of the procedure used in designing and reaching consensus on a proprioceptive training programme to reduce the incidence of ankle sprains in football players. Results of each phase of the Delphi study will be presented separately.

5.2 BACKGROUND

Literature has shown that the ankle joint is the most common site of injury in sports overall and in soccer in particular (Woods et al., 2003; Engebretsen et al., 2007; Fong et al., 2007; Zouita et al., 2013; Salces et al., 2013; Schiftan, Ross, Hahne, 2014; Nilstad et al., 2014; Stubbe et al., 2015; Rivera et al., 2017). Several researchers highlighted the high prevalence of ankle injuries among soccer players (Fong et al. 2007; Woods et al., 2003; Salces et al., 2013; Dauty and Collon, 2011). Due to the high prevalence of ankle injuries some types of preventive strategies have been used to reduce or prevent ankle injuries in different sporting codes. Most of preventive strategies found in literature include balance training programmes, proprioceptive training programmes, and the use of ankle braces and ankle tapping (Abernethy & Bleakley, 2007).

- According to Frisch et al (2009), injury prevention strategies may be divided into two types i.e. passive and active models of injury prevention. Passive models of injury

- prevention are those strategies that do not require the athlete to adapt any conditions of training/matches, once the strategy has been applied. An example of such a strategy would be the use of ankle bracing/taping, as the reduction in injury risk occurs as soon as the strategy is applied without necessitating any further changes from the athlete. In contrast, active injury prevention strategies require the athlete to consistently modify training /behaviour to ensure the efficacy of the intervention e.g. a structured warm-up programme. The efficacy of an active injury prevention strategy is dependent on acceptance and compliance by all the relevant stakeholders, i.e. players, rehabilitative and conditioning staff and coaches. And active prevention strategy can be facilitated by: integrating the intervention into the participants' usual training regime
- making audio-visual reference material readily available and accessible to participants to encourage correct technique and consistent performance
- interventions should aim to be easily comprehensible and transferrable across varying age groups
- interventions should be time-efficient, to prevent distraction of participants or disruption of the regular training regime

Most of the studies found in literature, investigated the effect of a proprioceptive training programme on knee injuries. There are few studies in the literature that stated the effect of proprioceptive training in the prevention of ankle sprains. Emery (2010) found that a neuromuscular training programme is protective of all injuries and acute onset injury in youth soccer players.

This proprioceptive training programme was based on a compilation of the rehabilitation and balance training protocols validated and published in prior studies (Hoffman et al., 1995; Bernier et al., 1998; Holme et al., 1999; Verhagen et al., 2004; McGuine et al., 2006; Kidgell et al., 2007; Hupperets et al., 2009).

5.3 PARTICIPANTS

Participants in the Delphi study were professionals (physiotherapists, exercise physiologists, athletic trainers and sports science researchers) working in the field of sports and football in particular. These professionals were selected based on their relevant work experience and/ or contributions to research in the field. Written, informed consent was obtained from each of the participants. A panel of twenty-five professionals was contacted via e-mail by the researcher, informing them about the purpose and content of the study as well as requesting their participation in the Delphi study. Two declined and excused themselves by not interested by the field of research, 18 did not answer the e-mail and five professionals agreed to participate. The participants were informed that anonymity and confidentiality would be strictly maintained.

5.4 METHOD

An epidemiological study on injuries in Rwanda football teams of 1st and 2nd Divisions conducted by the researcher, reported the following results:

The results of this study revealed that the ankle was body part which sustained more injuries with 92 (41.6%) injuries; the knee was the second body part with 41 (18.5%),

followed by the thigh with 19 (8.5%) injuries. The incidence rate was **3.6 injuries per 1000** hours of exposure.

A proprioceptive training programme was designed to be included as part of training routine and to be applied for the duration of one football season. The underlying principle of this intervention was to facilitate and reinforce the proprioception, balance and biomechanical alignment of the ankle. The Delphi method was used in this study to gain consensus on the efficacy of the proposed proprioceptive training programme and was conducted over two rounds.

5.5 INSTRUMENT

Participating professionals were requested to agree or disagree on the type of exercise given in each phase, time spent on each exercise, type of surface where the exercise should be performed and with eyes opened or closed. They were requested also to give their comments and /or suggestions where applicable.

The introductory note of the programme states clearly the time, repetition and the frequency of the exercise training. The first column shows the number of phases of the programme, the second shows the types of exercise to be performed, the third contains the surface where the exercise will be performed, the fourth indicates whether the eyes are opened or closed, the fifth shows time for each exercise and the sixth is the commentary or suggestions area.

Answers from different experts on each exercise in different phases, time, surface using agree or disagree were collected after each round. This data was then expressed as

percentages in order to calculate level of consensus. Consensus was defined as ≥ 65 % agreement amongst participants on all items in the proposed proprioceptive training programme.

The second round of the survey evolved from consensus and/or suggestions from the first round of the Delphi study.

5.6 DATA COLLECTION

The study was conducted via e-mail. The proposed proprioceptive training programme was mailed to the consenting participants. The participants were then requested to give their views and suggestions using agree or disagree and mail it to the researcher. This process of discussion and feedback was repeated for a total of two rounds until consensus was reached.

5.7 RESULTS

The characteristics of the participants as well as the results of each round of the Delphi study are described in detail below

5.7.1 Characteristics of the Participants

The group of 5 experts consisted of 1 physiotherapist, 1 exercise physiologist, 2 athletic trainers and 1 sport exercise expert. Four participants were male and one female. Two of the participants were working on the African continent, while two participants were working in Europe and one participant practicing in America. The lack of published scientific studies on prevention strategies of acute ankle injuries in Africa, as opposed to

those in Europe, Asia and the Americas was previously discussed by the researcher. The geographic context was considered to be important by the researcher in order to compare the opinions of the “African” professionals with their “European” and “American” counterparts. Table 5.1 describes the characteristics of the participants.

Table 5.1 Characteristics of the participants

No	GENDER	NATIONALITY	OCCUPATION	SPECIALITY	CONTINENT
1	Male	Netherlands	Sport exercise expert Exercise	Academician and researcher	EUROPE
2	Female	South Africa	Physiologist	Academician and researcher	AFRICA
3	Male	USA	Athletic Trainer and Physiotherapist	Sport injury Rehabilitation	AMERICA
4	Male	UK	Athletic Trainer	Strength and conditioning training	EUROPE
5	Male	ALGERIA	Physiotherapist	Sport injury Rehabilitation	AFRICA

5.7.2 Round One of the Study

During round one, 100% (5) of the participants responded. The proposed proprioceptive training programme is presented in Figure 5.1. The opinions and recommendations of the participants are discussed below.

Consensus was reached on the type of exercise of four of the six phases included in the protocol. 100% of the participants (5) agreed that exercises in phase 2; 3; 5 and 6 in the protocol were well designed to reduce incidence of ankle injuries in football players. One participant (20%) required more clarity on one exercise in phase 1 and other four (80%) agreed on the exercise. In phase 4, one participant (20%) suggested that the introduction of a new instrument would decrease the adherence of the programme but other four (80%) agreed on the exercise. 100% of the participants (5) agreed on the timing, surface where the exercise will be performed and with eyes opened or closed. The exercises in phases 1 and 4 were then amended and discussed further in round 2 of the study.

One participant required more clarity on the frequency (how often per week), progression and repetition of the programme.

These recommendations were then considered by the researcher and used to amend the protocol. The amended protocol, including the requested information, was then sent to all the participants.

The results of the first round are described in Table 5.2 below.

This program was based on a compilation of the rehabilitation and balance training protocols validated and published in prior studies (Bernier et al., 1998; Hoffman et al., 1995; Holme et al., 1999; McGuine et al., 2006; Kidgell et al., 2007). Each exercise will be performed for 30 seconds and the legs will be alternated during a 30 seconds rest interval between each exercise. For repetitions, we will consider the number of phases. As can be seen in these phases, there are repetitions and progression from the easiest to hardest exercise. The program will be performed in form of "circuit". The number of sets will be two sets. The total time of the training program will be 35 minutes.

Table 5.2: Results of the first round

Phase	Exercises	Surface	Eyes	Time	Agree/Yes	Disagree/No	Suggestions/comments
I	Single-leg stance	Field/floor	Open	1.5 min	100%		
	Single-leg stance while swinging the raised leg	Field/floor	Open	1.5 min	100%		
	Single-leg squat (30-45)	Field/floor	Open	1.5 min	100%		
	Single-leg stance while catching and kicking a ball	Field/floor	Open	1.5 min	80%	20%	What is it?
II	Single-leg stance	Field/floor	Closed	1.5 min	100%		
	Single-leg stance while swinging the raised leg	Field/floor	Closed	1.5 min	100%		Frequency: How often/week?
	Single-leg squat (30-45)	Field/floor	Closed	1.5 min	100%		
III	Single-leg stance	balance board	Open	1.5 min	100%		
	Single-leg stance while swinging the raised leg	balance board	Open	1.5 min	100%		Progression: How will progression be done week by week?
	Single-leg squat (30-45)	balance board	Open	1.5 min	100%		
	Double-leg stance while rotating on the board	balance board	Open	1.5 min	100%		
IV	Single-leg stance	balance board	Closed	1.5 min	100%		
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min	100%		
	Single-leg squat (30-45)	balance board	Closed	1.5 min	100%		

	Double-leg stance while rotating on the board	balance board	Closed	1.5 min	100%		
	Simple jump and land on trampoline	Trampoline	Open	1.5 min	80%	20%	Introducing an additional instrument will make programme adherence less
V	Single-leg stance	balance board	Closed	1.5 min	100%		
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min	100%		
	Single-leg squat (30-45)	balance board	Closed	1.5 min	100%		
	Single-leg stance while rotating on the board	balance board	Closed	1.5 min	100%		
VI	Single-leg stance while catching and kicking a ball	balance board	Open	1.5 min	100%		
	Jumping higher and landing on forefoot	Trampoline	Open	1.5 min	100%		
	Single-leg jump	Trampoline	Open	1.5 min	100%		

This programme was based on a compilation of the rehabilitation and balance training protocols validated and published in prior studies (Hoffman et al., 1995; Bernier et al., 1998; Holme et al., 1999; McGuine et al., 2006; Kidgell et al., 2007). Each exercise will be performed for 30 seconds and the legs will be alternated during a 30 seconds rest interval between each exercise. For repetitions, we will consider the number of phases. As shown in these phases, there are repetitions and progression from the easiest to hardest exercise. The programme will be performed in form of a "circuit". The number of sets will be two sets. The total time of the training programme will be 35 minutes.

Table 5.3 Proposed Proprioceptive Training Programme Protocol

Phase	Exercises	Surface	Eyes	Time
I	Single-leg stance	Field/floor	Open	1.5 min
	Single-leg stance while swinging the raised leg	Field/floor	Open	1.5 min
	Single-leg squat (30-45)	Field/floor	Open	1.5 min
	Single-leg stance while catching and kicking a ball	Field/floor	Open	1.5 min
II	Single-leg stance	Field/floor	Closed	1.5 min
	Single-leg stance while swinging the raised leg	Field/floor	Closed	1.5 min
	Single-leg squat (30-45)	Field/floor	Closed	1.5 min
III	Single-leg stance	balance board	Open	1.5 min
	Single-leg stance while swinging the raised leg	balance board	Open	1.5 min
	Single-leg squat (30-45)	balance board	Open	1.5 min
	Double-leg stance while rotating on the board	balance board	Open	1.5 min
IV	Single-leg stance	balance board	Closed	1.5 min
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min

	Single-leg squat (30-45)	balance board	Closed	1.5 min
	Double-leg stance while rotating on the board	balance board	Closed	1.5 min
	Simple jump and land on trampoline	Trampoline	Open	1.5 min
V	Single-leg stance	balance board	Closed	1.5 min
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min
	Single-leg squat (30-45)	balance board	Closed	1.5 min
	Single-leg stance while rotating on the board	balance board	Closed	1.5 min
VI	Single-leg stance while catching and kicking a ball	balance board	Open	1.5 min
	Jumping higher and landing on forefoot	Trampoline	Open	1.5 min
	Single-leg jump	Trampoline	Open	1.5 min

5.7.3 Round Two of the Study

During the 2nd round of the study consensus was reached on all the items of the proprioceptive training programme by all participants (100%). The purpose of the 2nd round of the study was to seek consensus on the items where consensus was not reached in round 1, namely, the type of exercise in phase 1 and 4, frequency, progression of the programme. All participants responded during the 2nd round of the study.

The results of the second round of the study as well as the final proprioceptive training programme are presented in Table 5.4

This program was based on a compilation of the rehabilitation and balance training protocols validated and published in prior studies (Hoffman et al., 1995; Bernier et al., 1998; Holme et al., 1999; Verhagen et al., 2004; McGuine et al., 2006; Kidgell et al., 2007; Hupperets et al., 2009). Each exercise will be performed for 30 seconds and the legs will be alternated during a 30 seconds rest interval between each exercise. For repetitions, we'll consider the number of phases. If you observe in these phases, there are repetitions and progression from the easiest to hardest exercise (exercises on floor/field to balance board, open to closed eyes, etc…). The program will be performed in form of "circuit". The number of sets will be two sets. Frequency: The programme will be performed 3 times a week during pre-season period and 2 times a week during the league. The total time of the training program will be 35 minutes.

Table 5.4: Results of the 2nd round

Phase	Exercises	Surface	Eyes	Time	Agree/Yes	Disagree/No	Suggestions/comments
I	Single-leg stance	Field/floor	Open	1.5 min	100%(n=5)		
	Single-leg stance while swinging the raised leg	Field/floor	Open	1.5 min	100% (n=5)		No other comments or suggestions from the participants.
	Single-leg squat (30-45)	Field/floor	Open	1.5 min	100%		
II	Single-leg stance	Field/floor	Closed	1.5 min	100%		
	Single-leg stance while swinging the raised leg	Field/floor	Closed	1.5 min	100%		
	Single-leg squat (30-45)	Field/floor	Closed	1.5 min	100%		
III	Single-leg stance	balance board	Open	1.5 min	100%		
	Single-leg stance while swinging the raised leg	balance board	Open	1.5 min	100%		
	Single-leg squat (30-45)	balance board	Open	1.5 min	100%		
	Double-leg stance while rotating on the board	balance board	Open	1.5 min	100%		
IV	Single-leg stance	balance board	Closed	1.5 min	100%		
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min	100%		
	Single-leg squat (30-45)	balance board	Closed	1.5 min	100%		
	Double-leg stance while rotating on the board	balance board	Closed	1.5 min	100%		

V	Single-leg stance	balance board	Closed	1.5 min	100%		
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min	100%		
	Single-leg squat (30-45)	balance board	Closed	1.5 min	100%		
	Single-leg stance while rotating on the board	balance board	Closed	1.5 min	100%		
VI	Single-leg stance while catching and kicking a ball	balance board	Open	1.5 min	100%		
	Simple jump and land on trampoline	Trampoline	Open	1.5 min	100%		
	Jumping higher and landing on forefoot	Trampoline	Open	1.5 min	100%		
	Single-leg jump	Trampoline	Open	1.5 min	100%		

5.7.4 FINALIZED PROPRIOCEPTIVE TRAINING PROGRAMME PROTOCOL

The finalized proprioceptive training programme (Table 5.5) was designed after the second round of the survey, once consensus was reached on all the items. This was then e- mailed to all the participants.

This program was based on a compilation of the rehabilitation and balance training protocols validated and published in prior studies (Hoffman et al., 1995; Bernier et al., 1998; Holme et al., 1999; Verhagen et al., 2004; McGuine et al., 2006; Kidgell et al., 2007; Hupperets et al., 2009).

TIME: Each exercise will be performed for 30 seconds and the legs will be alternated during a 30 seconds rest interval between each exercise. The total time of the training program will be 35 minutes.

REPETITIONS: For repetitions, we'll consider the number of phases. If you observe in these phases, there are repetitions and progression from the easiest to hardest exercise (exercises on floor/field to balance board, open to closed eyes, etc…). The programme will be performed in form of "circuit". The number of sets will be two sets.

FREQUENCY: The programme will be performed 3 times a week during pre-season period and 2 times a week during the league.

Table 5.5: Finalized proprioceptive training protocol (Also see Appendix N)

Phase	Exercises	Surface	Eyes	Time
I	Single-leg stance	Field/floor	Open	1.5 min
	Single-leg stance while swinging the raised leg	Field/floor	Open	1.5 min
	Single-leg squat (30-45)	Field/floor	Open	1.5 min
II	Single-leg stance	Field/floor	Closed	1.5 min
	Single-leg stance while swinging the raised leg	Field/floor	Closed	1.5 min
	Single-leg squat (30-45)	Field/floor	Closed	1.5 min
III	Single-leg stance	balance board	Open	1.5 min
	Single-leg stance while swinging the raised leg	balance board	Open	1.5 min
	Single-leg squat (30-45)	balance board	Open	1.5 min
	Double-leg stance while rotating on the board	balance board	Open	1.5 min
IV	Single-leg stance	balance board	Closed	1.5 min
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min
	Single-leg squat (30-45)	balance board	Closed	1.5 min
	Double-leg stance while rotating on the board	balance board	Closed	1.5 min
V	Single-leg stance	balance board	Closed	1.5 min
	Single-leg stance while swinging the raised leg	balance board	Closed	1.5 min
	Single-leg squat (30-45)	balance board	Closed	1.5 min
	Single-leg stance while rotating on the board	balance board	Closed	1.5 min
VI	Single-leg stance while catching and kicking a ball	balance board	Open	1.5 min
	Simple jump and land on trampoline	Trampoline	Open	1.5 min
	Jumping higher and landing on forefoot	Trampoline	Open	1.5 min
	Single-leg jump	Trampoline	Open	1.5 min

5.8 SUMMARY OF THE CHAPTER

This chapter outlined the method of the Delphi study used to design a Proprioceptive training programme to reduce the incidence of ankle injuries in football players. Furthermore, it described the results of the various rounds of the survey. Consensus was reached on all the items of the proprioceptive training programme.

CHAPTER SIX

INTERVENTION RESULTS

6.1. INTRODUCTION

This chapter contains the results of the statistical analysis that attempted to answer the third objective of the study, i.e. to implement and determine the effect of the developed proprioceptive training programme on the prevalence of ankle injuries and the potential intrinsic factors among soccer players in Rwanda. The following will be outlined in the chapter: an overview of the description of intervention sample, the prevalence of injuries, ankle injury rate, relative risk reduction of ankle injury and secondary outcomes in relation to ankle injuries in both groups. The results are summarized in tables.

6.2. DESCRIPTION OF INTERVENTION SAMPLE

The sample consisted of 4 soccer teams, selected randomly out of 24 soccer teams. 2 teams were randomly selected in intervention group (n=54) and other 2 teams in control group (n=55). The players who sustained ankle injuries in previous season or who had ankle injury at the time of intervention were removed from the sample. All 4 teams returned the forms used to collect intervention data in the period of 2014 to 2015 football season in Rwanda. The response rate was 100%. The total sample was 109 soccer players (table 2). The mean age of the players was 18.57 years old (SD= ± 1.6). The mean height of players was 173.18 cm (SD= ± 5.3). The mean weight of players was 61.6 kg (SD= ± 5.01). These characteristics are summarized in table 6.1 below.

Table 6.1: Description of the study sample (n=109)

Characteristic	Mean (SD)	
	Intervention (n=54)	**Control (n=55)**
Age	18.57 (±1.6)	19.76 (±1.68)
Height	173.18 (±5.3)	177.02 (±4.62)
Weight	61.6 (±5.01)	68.33 (±4.74)

6.3. DISTRIBUTION OF INJURIES IN INTERVENTION AND CONTROL GROUPS

The most prevalent injury in both the intervention and control group were ankle sprain (7.4% and 25.5% respectively). This was followed by the knee with 3.7% in the intervention group and 9.1% in the control group. The thigh had 5.5% in intervention group and 3.6% (n=2) in control group. Table 6.2 shows the occurrence of all injuries in both the intervention and control groups.

Table 6.2 Body parts injured by intervention and control groups (n=109)

Body part	**Intervention (n=54)**	**Control (n=55)**
No injury	59.3 (n=32)	47.3 (n=26)
Ankle	7.4 (n=4)	25.5 (n=14)
Knee	3.7 (n=2)	9.1 (n=5)
Thigh	5.55 (n=3)	3.6 (n=2)
Groin	0	5.50 (n=3)
Wrist	3.7 (n=2)	0
Shoulder	3.7 (n=2)	0
Hip	3.7 (n=2)	0
Finger	1.85 (n=1)	1.80 (n=1)
Face	1.85 (n=1)	1.80 (n=1)
Foot	1.85 (n=1)	1.80 (n=1)
Lower Leg	1.85 (n=1)	1.80 (n=1)
Head	1.85 (n=1)	0
Toe	1.85 (n=1)	0
Elbow	1.85 (n=1)	0
Forearm	0	1.80 (n=1)

6.4. ANKLE INJURY PREVALENCE

6.4.1. INTERVENTION GROUP

In the sample of 54 players, 4 (7.4%, 95% CI [2.8-18.4]; P=0.040) players sustain ankle injuries and 32 (59.3%) players did not sustain any injury and 18 (33.3%) players sustained different injuries on different body parts. Table 4 shows the players who did not sustain injuries and those who sustained injuries on different body parts.

6.4.2. CONTROL GROUP

In the sample of 55 players, 14 (25.5%, [15.6-38.7]; P=0.040) players sustain ankle injuries and 26 (47.3%) players did not sustain any injury and 15 (27.3%) players sustained different injuries on different body parts. Table 4 shows the players who did not sustain injuries and those who sustained injuries on different body parts.

Table 6.3:ANKLE INJURIES IN BOTH GROUPS

	GROUP									
	INTERVENTION (n=54)			CONTROL (n=55)			TOTAL (n=109)			P-VALUE
	Freq	Percent	95% CI	Freq	Percent	95% CI	Freq	Percent	95% CI	
Injury location										
No injury	32	59.3	[45.6-71.6]	26	47.3	[34.4-60.6]	58	53.2	[43.7-62.5]	
Ankle injury	4	7.4	[2.8-18.4]	14	25.5	[15.6-38.7]	18	16.5	[10.6-24.8]	0.040
Other injuries	18	33.3	[22.0-47.0]	15	27.3	[17.0-40.7]	33	30.3	[22.3-39.7]	

6.5. ANKLE INJURY INCIDENCE RATE

6.5.1. INTERVENTION GROUP

The ankle was the most prevalent body part that injured with 7.4% (n=4). The incidence rate was **5.5 injuries per 1000** hours of exposure. The incidence rate in relation to exposure hours was calculated by taking the total number of injuries recorded in one season divided by the total exposure for that season, and the result multiplied by 1000 hours (Knowles et al., 2006).

6.5.2. CONTROL GROUP

The ankle was the prevalent body part with 25.5% (n=14). The incidence rate was **19.4 injuries per 1000** hours of exposure.

6.6. RELATIVE RISK REDUCTION OF ANKLE INJURY

The relative risk reduction was calculated using rate in control group divided by the rate in the intervention group and is reported as a ratio. The results showed that the relative risk reduction of ankle injury in present study was **3.5**

6.7. SECONDARY OUTCOMES IN RELATION TO ANKLE INJURIES

The results of the present study showed that the players who sustained ankle injuries 7.4% (n=4), 3 of them (75%, 95% CI [23.1-96.8], p=0.000) had diminished proprioception and 1 (25%, 95% CI [3.2-76.9], p=0.000) had maximum proprioception in intervention group.

In control group, 25.5% (n=14) sustained ankle injuries where 8 (57.1%, 95% CI [31.3-79.6], p=0.007) of them had diminished proprioception and 6 (42.9%, 95% CI [20.4-68.7], p=0.007) had maximum proprioception.

The multivariate analysis between ankle injuries, secondary outcomes and both groups showed that in intervention group, the ankle injuries were reduced by 0.205 (95% CI [0.056-0.747], p=0.016) compared to control group. The players with balance score equal to 3, were at 4.4 times risk to sustain ankle injury (95% CI [1.185-16.416], p=0.027). The players with diminished proprioception were at 3.792 times risk to sustain ankle injury (95% CI [1.246-11.537], p=0.019) compared to players who had maximum proprioception.

Table 6.4: SECONDARY OUTCOMES IN RELATION TO ANKLE INJURIES IN BOTH GROUPS

PROPRIOCEPTION											
		Diminished			Maximum			TOTAL			P-Value
		Frequency	%	95% CI	Frequency	%	95% CI	Frequency	%		
INTERVENTION	Ankle injury	3	75	[23.1-96.8]	1	25	[3.2-76.9]	4	100		0.000
CONTROL		8	57.1	[31.3-79.6	6	42.9	[20.4-68.7]	14	100		0.007
BALANCE											
		3			4			5			
		Frequency	%	95% CI	Frequency	%	95% CI	Frequency	%	95% CI	P-Value
INTERVENTION	Ankle injury	1	25	[3.2-76.9]	2	50	[12.0-88.0]	1	25	[3.2-76.9]	0.115
CONTROL		2	14.3	[3.5-43.3]	4	28.6	[11.0-56.5]	8	57.1	[31.3-79.6]	0.252

Table 6. 5 MULTIVARIATE ANALYSIS BETWEEN ANKLE INJURY AND SECONDARY OUTCOMES IN BOTH GROUPS

VARIABLES		OR	95% CI	P-Value
Intervention vs Control group				
Control		1		
Intervention		0.205	[0.056-0.747]	0.016
BALANCE				
	5	1		
	4	12.212	[1.589-93.861]	0.016
	3	4.411	[1.185-16.416]	0.027
PROPRIOCEPTION				
Maximum		1		
Diminished		3.792	[1.246-11.537]	0.019

6.8 SUMMARY OF THE CHAPTER

In this chapter, the results of the intervention and control groups were presented. The ankle injury prevalence was 7.4% (n=4) in intervention group and 25.5% (n=14) in control group. The injury incidence rate of ankle injuries was 5.5 injuries per 1000 hours exposure per player in intervention group and 19.4 injuries per 1000 hours exposure per player in control group. In four players (7.4%) who sustained ankle injuries in intervention group, 3 of them had a diminished proprioception whereas 14 players (25.5%) who sustained ankle injuries in control group, 8 of them had a diminished proprioception. The ankle injuries were reduced by 0.205 in intervention group compared to control group. The players with diminished proprioception were 3.792 times at risk to sustain ankle injury compared to players who had maximum proprioception. These results are discussed in chapter seven.

CHAPTER 7

DISCUSSION

7.1 INTRODUCTION TO THE CHAPTER

This chapter will present the discussion of baseline data (first phase of the procedure) used in designing a proprioceptive training programme to reduce ankle injuries in soccer players. This programme was designed by compiling the information gathered from the systematic literature review (chapter 2) and the results discussed in the Delphi study (chapter 5). It will also outline the discussion of the intervention results obtained from intervention study done in soccer teams in Rwanda (Chapter 6)

7.1.1 BASELINE DATA DISCUSSION

7.1.2 DEFINITIONS

In the present study, an injury was defined as any physical complaint sustained by a player that result from a football match or football training, irrespective of the need for medical attention or time loss from football activities. An injury that results in a player receiving medical attention is referred to as a “medical attention” injury, and an injury that results in a player being unable to take a full part in future football training or match play as a “time loss” injury (Fuller et al.,2006). This was to avoid variations in definitions

and methodologies that created significant differences in the results and conclusions obtained from studies of sports.

7.1.3 INJURY INCIDENCE

The overall injury incidence rate found in the present study was **3.6 injuries per 1000** hours of exposure. Various injury incidence rates have been reported in literature, some similar to this study (Engebretsen, Myklebust, Holme, Engebretsen & Bahr (2008), others lower (Verhagen et al., 2004; Willems et al., 2005) or higher (Peterson et al., 2000; Dauty and Collon, 201; Salces et al., 2013). It is however noticeable that all these studies mentioned here, were conducted in the developing world with very little literature found to compare it with on the African continent. Most of the studies done on the African continent are retrospective in nature (Twizere, 2004) whereas those conducted in Europe are mostly prospective in nature.

The incidence, however if comparable to other studies, is a cause of concern as it is well established that soccer players in countries such as Norway, Sweden and Spain under investigation in the studies above, have greater access to resources such as physiotherapist, sports physicians, and other health care professionals, compared to players in less developed countries. One of the few studies done in Africa by Akodu et al. (2012) reported 289 injuries per 1000 player hours. These authors postulated that more studies to be done for the African region so as to establish appropriate intervention strategies that is suitable for the African players. Every effort should therefore be made to decrease the incidence rate of injuries among elite soccer players in Rwanda, and Africa in general.

It has been argued that higher injury incidence rates could be attributed to both lower skills and performance levels of players (Akodu et., 2012). The influence of skills levels on injury incidence has been a controversial issue. Despite this, when an investigation into the successes of international football matches is done, it seems that the skills level of African players is lower than those in Europe. And to this end Dvorak nd Junge (2000) reported a higher occurrence of injuries among players with lower skills levels.

7.1.4 PREVALENCE OF ANKLE INJURIES

The results of the study showed that ankle was the prevalent body part (41.6% of all injuries), followed by the knee (18.5%). This high percentage of ankle injuries differs from many epidemiological studies found in the literature where it is 10% to 30% of all injuries (Hawkins et al., 2001; Woods et al., 2003; Boyce et al., 2005; Fong et al., 2007; Tang et al., 2009; Fousekis, 2012; Dauty and Collon, 2011; Salces et al., 2013).

7.1.5 INJURY CHARACTERISTICS

7.1.5.1 Injury Location

The present study revealed that the most frequently injury body part was the ankle (41.6%), followed by the knee (18.5%) and the thigh (8.5%). This was similar to many studies found in the literature over a considerable time period. Studies as far back as approximately 3 to 4 decades ago reported similar findings (Garrick et al., 1973; Ekstrand & Gillquist, 1983; Wexler, 1988; Yde & Nielsen, 1990; Brynhildsen et al., 1990; Schmidt-Olsen et al., 1991). More recent literature (the last decade) however also

reported similar findings that the ankle was the most common site of injury in soccer players (Verhagen et al., 2005; Hinton et al., 2005; Sekir et al., 2006; McGuine & Keene, 2006al., 2006; Zetou et Fong et al., 2007; Hootman, 2007; Hupperets et al., 2008; Pasanen et al., 2008; Engebretsen et al., 2010; Dauty and Collon, 2011; Salces et al., 2013).

Although most studies, as indicated above found the ankle to be the most common site, other studies reported the knee or thigh as the most common body part (Hawkins et al., 2001).

7.1.5.2 Injury Mechanism

A high percentage of injuries sustained by soccer players occurred by contact (52%) and 48% of injuries occurred without contact with other players. There is a slight difference between both mechanisms and this may be explained by the mean age (20.7 years old) of players in Rwanda soccer league where the level of competition is very high in all aspects of play. In the literature, studies showed that direct contact with an opponent was an extrinsic risk factor of injury (Fousekis et al., 2012; Andersen et al., 2004; Woods et al., 2003); this may explain the high percentage of injury.

7.1.5.3 Types of injuries

The ligament sprain (50.7%) was the most common injury type in the present study followed with contusion (12.2%), muscle strain (8.1%), tendinitis (5.9%) and dislocation (5%). Many authors in the literature reported similar results in their respective studies (Mohammadi, 2007; Fong et al., 2007; Schneider et al., 2006; McGuine & Keene, 2006; Stasinopoulos, 2004; Zöch et al., 2003). Other studies in the literature found that strain was the most common type of injury (Hawkins et al., 2001; Mohib et al., 2014). The increase of ankle injury in the present study may be

explained by the increase of artificial turf as football infrastructures in Rwanda. Studies showed that artificial turf increased injury risk compared to grass football field (Engebretsen & Kase, 1987; Arnason et al., 1996, Ekstrand et al., 2006; Soligard et al., 2012).

7.1.5.4 Injury severity

The majority of injuries (39.8%) were considered as transient. Mild and moderate injuries accounted 26.7% and 21.3% respectively. In all injuries 12.7% of injuries were severe. The results and definition of severity of injury in this study concur with the study done by Hägglund et al. (2005) where the authors defined injury severity as transient or light (1-3 days), minor (4-7 days), moderate (8-28 days) and severe or major (>28 days). The variation in definitions of severity, as found in the literature, makes comparison between different studies difficult.

7.1.7 POTENTIAL INTRINSIC RISK FACTORS FOR ANKLE INJURIES

The strongest potential risk factors for ankle sprains in this study were diminished proprioception, abnormal standing balance and abnormal rearfoot alignment. A chi-square test and logistic regression indicated that the players who had diminished proprioception, and abnormal balance presented a high risk to sustain an ankle sprain. These two variables were significantly associated with the risk to sustain ankle sprains in this study with diminished proprioception **(95% CI 0.24-0.089, p=0.000)**; standing balance **(95% CI 0.46-1.216, p=0.020)**. Some studies in the literature support the findings of the present study (McGuine et al., 2000; Willems et al., 2005b; Trojian &

McKeag, 2006; Noronha et al., 2013). Other studies revealed different risk factors such as previous injury to the ankle (Beynnon et al., 2002; Arnason et al., 2004; McHugh et al., 2006; Hiller et al., 2008; Engebretsen et al., 2010; Brinkman & Evans, 2011; Noronha et al., 2013), sex (Nilsson & Roaas, 1978; Inklaar, 1994), age (Ekstrand et al., 1983; Nielsen & Yde, 1989; Inklaar, 1994; Schmidt- Olsen et al., 1991), level of play (Nielsen & Yde, 1989; Ekstrand & Tropp, 1990; Zech and Wellmann, 2017) and many others.

7.2 INTERVENTION DISCUSSION

7.2.1. DISTRIBUTION OF INJURIES IN INTERVENTION AND CONTROL GROUPS

In general, the prevalent injury was the ankle sprain 7.4% (n=4) in intervention group and 25.5% (n=14) in control group, followed by knee 3.7% (n=2) in intervention group and 9.1% (n=5) in control group. Thigh had 5.5% in intervention group and 3.6% (n=2) in control group. The results of the present study showed that the ankle sprain was the most prevalent injury in both groups. Many studies in the literature support the results of this study (Mohammadi, 2007; Fong et al., 2007; Schneider et al., 2006; McGuine & Keene, 2006; Stasinopoulos, 2004; Zöch et al., 2003)

There is a significant reduction of ankle injuries in intervention group compared to control group. Many studies concur with the findings of the present study (Wedderkopp et al., 1999; Bahr et al., 1997; Tropp et al., 1985)

7.2.2. ANKLE INJURY INCIDENCE RATE

The result of the present study revealed that the incidence rate was 5.5 injuries per 1000 hours of exposure in intervention group. In the control group, the incidence rate was 19.4 injuries per 1000 hours of exposure. The present study showed that the designed proprioceptive training programme implemented has reduced significantly the ankle injuries rate among health subjects in intervention group compared to control group.

Recent review articles showed that there is limited evidence on the role of proprioception in the prevention of ankle sprains in sports and even less on the primary prevention of ankle sprains in healthy athletes (Eils, 2003). In the study done by Bahr et al. (1997) investigated the influence of an injury prevention programme in volleyball. It consisted mainly of an injury awareness session, technical training and balance board training. At the end of the intervention, a 50% reduction in ankle sprains was reported and the ankle disk training that was part of the intervention programme was recommended for players with previous injuries. However, it is not reported whether healthy players used the ankle disk and what the effect may have been on the injury incidence in a healthy population. Therefore, the reduction of ankle sprains is as a result of the complex prevention

programme, but the influence of the ankle disk training remains unclear, especially with respect to healthy subjects.

Wedderkopp et al. (1999) investigated the effect of an intervention programme in team handball, with special emphasis on injuries of the lower extremities. The specific programme mainly consisted of ankle disk training in combination with functional activities for all major muscle groups. A significant reduction in the frequency of ankle sprains was found in the experimental group compared to the control group. However, the role of proprioception on the primary prevention of ankle sprains remains unclear because no distinction was made between subjects with normal and unstable ankles.

In the study done by Tropp et al. (1985) investigated the influence of ankle braces and ankle disk training on the frequency of ankle injuries in soccer. In this study, the proprioceptive exercise programme led to a significant reduction in the incidence of ankle sprains but the effect on players without previous ankle injuries was not reported and therefore remains unclear.

In the literature, many studies have been done on the effect of proprioception training for the prevention of ankle sprain in subjects with previous ankle injuries (Tropp et al., 1985; Bahr et al., 1997; Beynnon et al., 2002; Arnason et al., 2004; McHugh et al., 2006; Hiller et al., 2008; Engebretsen et al., 2010; Brinkman & Evans, 2011; Noronha et al., 2013)

There is limited or no information available concerning the effects of proprioceptive training for the primary prevention of ankle sprains in athletes (Eils, 2003).

The present study is among few studies that tried to reveal the effect of proprioceptive training for the prevention of ankle sprains in healthy athletes.

At the time of carrying out this study, most of teams played on second generation of artificial turf. In the literature, it stated that the first and second generations of artificial turfs were hard and shoe-surface traction was high, which made the playing characteristics different from natural grass and the injury risk higher (Arnason et al., 1996; Engebretsen & Kase, 1987). Ekstrand et al. (2006) found that elite male players had a higher risk of ankle injuries on artificial turf. The artificial turf may be the associated factor of the high incidence of ankle injuries in the present study.

In contrast, Soligard et al. (2012) found that playing on artificial turf was a lower risk of ankle injuries and a higher risk of back and spine injuries, but interpretations of these results should be made with caution because they showed many limitations.

The small sample size and lower exposure hours for each group (Intervention and control groups) made the calculation of injury incidence rate to be high in this study.

7.2.3. RELATIVE RISK REDUCTION OF ANKLE INJURY

The relative risk reduction will be calculated using rate in control group divided by the rate in the intervention group and will be reported as a ratio. The results showed that the relative risk reduction of ankle injury in present study was 3.5.

7.2.4. SECONDARY OUTCOMES IN RELATION TO ANKLE INJURIES

The results of the present study showed that most of players who sustained ankle injuries in both the intervention and control groups had diminished proprioception. The players with diminished proprioception were at 3.792 times risk to sustain ankle injury (95% CI [1.246-11.537], p=0.019) compared to players who had maximum proprioception.

This is similar to the finding of Verhagen et al. (2004) who reported significantly fewer ankle sprains among volleyball players who completed a proprioceptive balance board programme. Researchers have speculated that ankle sprains could possibly be as a result of incorrect positioning of the foot just before and as the foot make contact. This could be as a result of either poor or no proprioception in the ankle (Willems et al., 2002).

The present study and those of others (Willems, et al., 2002) therefore support the crucial element of proprioception training in the rehabilitation programme after an ankle injury. The improved proprioception will therefore not only improve the stability around the ankle, but will also assist in breaking the cycle of recurrent ankle injuries.

7.3. SUMMARY OF THE CHAPTER

This chapter outlined the discussions of the baseline data and intervention data results. This was achieved by comparing the results of the current study to that of the studies discussed in the systematic literature review. The next chapter will present the conclusion, recommendations and the limitations for the present study.

CHAPTER 8

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

8.1 INTRODUCTION TO THE CHAPTER

This chapter summarizes and presents the conclusions drawn from the study, along with the limitations of the study. Recommendations for future research regarding ankle injuries prevention in soccer are also outlined.

8.2 CONCLUSION

The first objective of this study was to collect base-line data regarding ankle injuries among soccer players in Rwanda by examining the potential intrinsic risk factors for injuries to the ankle and determining the incidence of ankle injuries among soccer players in one competitive season.

The second objective of this study was to develop a proprioceptive training programme to reduce ankle injuries among soccer players in Rwanda by conducting a systematic review of the literature around proprioceptive training interventions that have demonstrated the best evidence in reducing ankle injuries among soccer players and reaching a consensus on the content of a proprioceptive training programme for the reduction of ankle injuries among soccer players from different experts in the field. The searched information was then combined to design a proprioception training programme used in this study. The systematic literature review showed a small number of studies on injury prevention

regarding ankle injuries in healthy players and most of them remained inconclusive. In the literature, it was evident that all the data is from European and American studies with a lack of African data in terms of ankle injuries prevention in soccer; where the importance of the present study.

In this study, the prevalence and incidence of ankle injuries were high. The ankle continues to be the most prevalent body part and ankle sprain the prevalent injury type. Players who presented diminished proprioception and reduced balance were at high risk to sustain an ankle injury. After the intervention, a diminished proprioception was a high potential risk factor to sustain an ankle injury with a high statistical significance. The proprioception training programme implemented, significantly reduced the incidence rate of ankle injury in healthy soccer players in the intervention group compared to control group. In the current scientific literature, the information on the effect of proprioceptive training programme to reduce ankle injury rate in healthy soccer players was unclear and inconclusive. Players, coaches and soccer teams need to be informed and educated on the benefits of the present ankle injury prevention programme. The Rwandan football federation and its member clubs should be aware and advocate for the use of this programme to prevent ankle injuries in soccer. However, the researcher recommends the introduction of this proprioception training programme in a team's training routine as a prevention tool to sustain an ankle injury and this programme may help in rehabilitation ankle sprain. The study presented a limitation in terms of the small sample size in the intervention group therefore further research needs to be done with randomized controlled trials and a large sample size for the generalizability of the present study results.

8.3 RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

Government and football governing body:

- The governing bodies should be aware of high prevalence and incidence of ankle injuries among soccer players in Rwanda in order to handle this problem at its level of concern.
- Advocate at the ministerial level (Ministry of Health) for the introduction of this proprioception training programme in national policy of ankle injuries prevention.
- Introduce this proprioception training programme as a preventive measure of ankle sprain at CAF and FIFA levels.
- Advocate for the use of this proprioception training programme in teams' training programme for the safety and health of the players.
- Introduce this programme as part of football coaching course module/unit.

Teams and coaches:

- Encourage coaches and teams to use the prevention programme as part of their training regime in preseason and during the league to reduce the prevalence of ankle injuries.
- Educate players on the importance of using this proprioception training programme as a preventive measure of their ankle injuries.

Researchers:

- More studies on ankle injuries prevention programmes on healthy subjects need to be done worldwide in general and in Africa in particular, to ensure the appropriate prevention of ankle injuries in soccer players.

- In the future, more randomized controlled trials with large sample size should be done for the confirmation and generalizability of the present study's findings.

8.4 LIMITATIONS OF THE STUDY

The following limitations were identified for this study:

- The small sample size and small number of player/team exposure hours may have influenced the calculations of injury incidence and the significance of the results.
- The researcher also acknowledged that the lack of sufficient funds had a negative impact on the intervention study.

- The delay in receiving feedback from the experts in the Delphi study was a serious limitation as far as the PhD timeframe is concerned.

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APPENDIX A

OFFICE OF THE DEAN
DEPARTMENT OF RESEARCH DEVELOPMENT

UNIVERSITY of the
WESTERN CAPE

30 July 2012

To Whom It May Concern

I hereby certify that the Senate Research Committee of the University of the Western Cape has approved the methodology and ethics of the following research project by:
Mr M Hakizimana (Physiotherapy)

Research Project:	The effect of a proprioceptive training programme on ankle injury rates in soccer players in Rwanda.
Registration no:	12/4/8

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Private Bag X17, Bellville 7535, South Africa
T: +27 21 959 2988/2948 . F: +27 21 959 3170
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A place of quality,
a place to grow, from hope
to action through knowledge

APPENDIX B

UNIVERSITY of the
WESTERN CAPE

Private Bag X17, Bellville 7535, South Africa
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Website: www.uwc.ac.za

DEPARTMENT OF PHYSIOTHERAPY

FERWAFA
Réception
Le 06 JUIL. 2011
Signature

To the President of FERWAFA
P.O.Box 2000/ Kigali
Republic of Rwanda
RWANDA.

Dear Sir,

RE: Request to conduct a research study.

I am a PhD student in Physiotherapy at the University of the Western Cape, Cape Town in the Republic of South Africa. My research project will be done as a fulfillment of the requirements for PhD in Physiotherapy.

The title of my research is: **Proprioceptive training programme to prevent ankle injuries among soccer players in Rwanda.**

I hereby request your permission to carry out this research study in the Rwandan soccer teams. The results of this study will be discussed with the Rwandan football body, the management of all football teams and players. It is believed that it will help to reduce ankle injuries in soccer players. The study will be carried out during 2011-2012 season for baseline data and 2012-2013 season for the intervention.

Ethical issues will be taken into consideration. Participation in this research project will be voluntary. Confidentiality and anonymity will be assured. Codes will be used instead of names. Hoping your positive response to my request,

Yours faithfully,

.....

Mr Moussa Hakizimana

Student researcher

.....

Prof Julie Phillips

Research Supervisor.

APPENDIX C

FEDERATION RWANDAISE DE FOOTBALL ASSOCIATION

B.P. 2000 Kigali
Email : ferwafa@yahoo.fr
contact@ferwafa.rw
Web site: www.ferwafa.rw

Kigali, 15/01/2012
N°...012.../FERWAFA/2012

Mr MOUSSA HAKIZIMANA
UNIVERSITY OF THE WESTERN CAPE
DEPARTMENT OF PHYSIOTHERAPY
Private Bag X17 Bellville 7535
SOUTH AFRICA

Re: Allowing to conduct research study in Rwanda.

Sir,

This is to inform you that we received your letter of 06 July 2011 and wish to encourage you dealing with your research titled "**The effect of a proprioceptive training programme on ankle injury rates in soccer players in Rwanda.**

So, we hereby make you know that you are allowed to conduct your research from now until the end of your studies.

For more information according to your program, please contact the Rwandan Football Federation.

Yours sincerely,

GASINGWA MICHEL

General Secretary of FERWAFA

C.C to:

The Minister of Culture and sport.

APPENDIX E

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 2542, Fax: 27 21-959 1217
E-mail: hakizamoise@yahoo.fr

INFORMATION SHEET

Dear Player,

Project title: The effect of a Proprioceptive training programme on ankle injury rates in soccer players in Rwanda

What is this study about?

This is a research project being conducted by **Mr Moussa Hakizimana** from the University of the Western Cape. We are inviting you to participate in this research because soccer players have a high incidence of ankle sprains. When injury occurs at the ankle, its ability to sense its position in space is disturbed due to the involvement of injury to the ligaments surrounding the ankle. This ability of a joint to sense its position in space is called proprioception. This "disturbed sense" have been shown to increase players' risk to further ankle injuries. The aim of this project is thus to investigate the effect of a proprioceptive training programme (i.e. a programme that will improve the ability of the joint to sense its position in space) on ankle injury rates in soccer players in Rwanda.

What shall I be asked to do if I participate?

The study will be carried out in your teams during all the 2012/2013 season. Players who have sustained ankle injuries will be identified during this season. The project will involve performing a proprioceptive training programme during training sessions three times a week. The maximum duration of that programme will be 35 minutes.

Would my participation in this study be kept confidential?

We will do our best to keep your personal information confidential. Your confidentiality will be protected as your name will not appear on data capture sheet. If we write a report or article about this research project, your identity will be protected to the maximum extent possible.

What are the risks of this research?

There are no known risks associated with participating in this research project.

What are the benefits of this research?

The outcome of this research will prove valuable for the prevention and reduction of ankle injuries among soccer players such as you. In addition you will benefit from a prevention programme for ankle injuries throughout the season.

Do I have to be in this research and stop participating at any time?

Your participation in this study is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you qualify to obtain.

What if I have questions?

This research is being conducted by Moussa Hakizimana, Doctoral Physiotherapy Student, at the University of the Western Cape. If you have any questions about the research itself, please contact:

Mr. Moussa Hakizimana @ Department of Physiotherapy, UWC

Mobile: (+250)788468370

E-mail: 2465735@uwc.ac.za **or** hakizamoise@yahoo.fr
If you have any questions regarding this study and your rights as a research participant or you wish to report any problems that you have experienced related to the study, please contact:

Head of Physiotherapy Department: Prof A Rhoda
Faculty of Community and Health Sciences
University of the Western Cape
Private Bag X 17,
Belville 7535

This research has been approved by the University of the Western Cape's Senate Research Committee and Ethics Committee.

APPENDIX E

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
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DELPHI STUDY INFORMATION SHEET

Title of Research Project: A Delphi study to design a Proprioceptive training programme to be used in prevention of ankle injuries in soccer players in Rwanda.

Invitation

You are being invited to take part in a research study being conducted by **Moussa HAKIZIMANA** (PhD candidate) of the Department of Physiotherapy, University of the Western Cape, Republic of South Africa. More information regarding the study is outlined below. Please feel free to contact me if more information/clarification is needed.

What is the purpose of the study?

This is a part of the research project being conducted by **Mr Moussa Hakizimana** from the University of the Western Cape. We are inviting you to participate in this study because the researcher need to obtain the most reliable consensus from a group of experts in sports medicine on proprioceptive training programme to be implemented to reduce the rate of ankle injuries. The aim of the project is to investigate on the effect of proprioceptive training programme on ankle injury rates in soccer players in Rwanda.

Why have I been chosen?

You have been chosen to participate in this research project because you have been identified as an expert in the field of Sports Medicine and rehabilitation. The development of this proprioceptive training programme will be based on the results of baseline data from soccer teams in Rwanda and literature review.

Do I have to participate?

Participation is voluntary. If you decide to participate you will be asked to complete a consent form. You are free to withdraw at any time without giving a reason. A decision not to participate or to withdraw at any time, will not affect you in any way.

What will happen if I participate?

If you agree to participate in the study you will firstly be asked to complete a consent form and return it via email. This research will be carried out using the Delphi study technique consisting of two to three rounds aimed to achieve consensus on that proprioceptive training programme to be used. With your permission the programme will be emailed to you. Simple and specific instructions will be provided for the programme. The amount of time necessary to go through the programme will vary with each panelist, but

APPENDIX F

UNIVERSITY OF THE WESTERN CAPE

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CONSENT FORM

Dear player,

Title of the research Project: The effect of Proprioceptive training programme on ankle injury rates in soccer players in Rwanda.

The study has been described to me in language that I understand and I freely and voluntary give consent to participate in the research project. My questions about study have been answered. I understand that my identity will not be disclosed and that I have the right to withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.

Player's name: ……
Player's signature: …….
Date: ……..

If you have any questions regarding this study or wish to report any problems that you have experienced related to the study, please contact the study coordinator:

Study Coordinator's Name: Prof J. Phillips
University of the Western Cape
Private Bag X 17, Belville 7535
Telephone: (021)959-2542
E-mail: jphillips@uwc.ac.za
Principal Researcher: Mr. Moussa Hakizimana
E-mail: 2465735@uwc.ac.za or hakizamoise@yahoo.fr
Postgraduate student, Physiotherapy Department

APPENDIX G

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e-mail: hakizamoise@gmail.com

DELPHI STUDY CONSENT FORM

Title of Research Project

A Delphi study to design a Proprioceptive training programme to be used in prevention of ankle injuries in soccer players in Rwanda.

1	I confirm that I read and understood the information sheet dated for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily	
2	I am willing to participate in all the rounds of the Delphi study and the follow-up stage	
3	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. However, I understand that the success of this study depends on all participants completing all the Delphi rounds	
4	I understand that I will remain anonymous to the other participants (or experts) throughout this Delphi study and only the researcher will be able to identify my specific answers	
5	I understand that the researcher will hold all information and data collected in a secure and confidential manner	

....

Participant's name **Date** **Signature**

1	I am NOT willing to participate in this study.	

should range between 10-15 minutes per round. There is no right or wrong answers/suggestions to the programme. This study is seeking your opinion.

The following points are important for you to remember:

• Your participation is entirely voluntary.

• You may decline or withdraw from the study at any time.

• You will remain anonymous to the other participants (or experts) throughout this Delphi study and only the researcher will be able to identify your specific answers.

• All records are confidential. Your name will only be recorded on the consent form; it will not be recorded on any data sheet. All information will only be available to members of the research team. All information will be destroyed 5 years after the research is completed.

• Any information that you be provided will be confidential and when the results of the study are reported you will not be identifiable in the finding.

• Following the study, information gathered will be sent for publication in professional journals and will be presented at conferences. All details of people who participated in the study will be kept anonymous.

• You will only have to complete the consent form once; return of the completed Delphi rounds implies your consent to participate.

What if something goes wrong?

I am not aware of any complications or risks that could arise from participating in this study. However, if you decide to participate in the study, you will be given written information dealing with the names and telephone numbers to contact should you have any complaints or difficulties with any aspect of the study.

Will my participation in the study be kept confidential?

If you consent to participate in the study, your name will not be disclosed and would not be revealed in any reports or publications resulting from this study. Apart from your consent form, your name will not be recorded on Delphi rounds. Each participant will be allocated a unique code. You will remain anonymous to the other participants (experts) throughout this Delphi study and only the researcher will be able to identify your specific answers. All information will be destroyed after 5 years after the research is completed.

What happens when the research study stops?

The results of this study will be used to design a Proprioceptive training programme to be used in prevention of ankle injuries in soccer players in Rwanda.The findings will also be published in professional journals and/or presented at conferences.

This study has been approved by the University of the Western Cape's Senate Research Committee and Ethics Committee (2012/7/30) and Rwandan Ministry of Sports and Culture.

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact:

MOUSSA HAKIZIMANA

PhD student,

Physiotherapy Department,
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Private Bag X17, Belville 7535,
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E-mail: jphillips@myuwc.a.za

APPENDIX H

FIFA F-MARC
For the Good of the Game

Players' Baseline Information Form

Team-code No: _____

Logo

Player's code No.[1]	Playing position[2]	Age[3], years	Stature, cm	Body mass, kg	Dominant leg[4] (L/R/B)	Details of previous major injuries	Study specific variable	Study specific variable

Notes: [1] Use additional sheets if required [2] Goalkeeper, Defender, Midfielder, Forward [3] Age as at the start of season / year / tournament [4] Left, Right, Bilateral

FIFA F-MARC
For the Good of the Game

Injury Report Form

APPENDIX I

(Team) Player-code: _____ Date: _____

LOGO

1A Date of injury: _____

1B Date of return to full participation: _____

2A Injured body part

- ☐ head / face
- ☐ neck / cervical spine
- ☐ sternum / ribs / upper back
- ☐ abdomen
- ☐ low back / sacrum / pelvis
- ☐ shoulder / clavicula
- ☐ upper arm
- ☐ elbow
- ☐ forearm
- ☐ wrist
- ☐ hand / finger / thumb
- ☐ hip / groin
- ☐ thigh
- ☐ knee
- ☐ lower leg / Achilles tendon
- ☐ ankle
- ☐ foot / toe

2B Injured body part

- ☐ right
- ☐ left
- ☐ not applicable

3 Type of injury

- ☐ concussion with or without loss of consciousness
- ☐ fracture
- ☐ other bone injury
- ☐ dislocation / subluxation
- ☐ sprain / ligament injury
- ☐ lesion of meniscus or cartilage
- ☐ muscle rupture / strain / tear / cramps
- ☐ tendon injury / rupture / tendinosis / bursitis
- ☐ haematoma / contusion / bruise
- ☐ abrasion
- ☐ laceration
- ☐ nerve injury
- ☐ dental injury
- ☐ other injury (please specify): _____

4 Diagnosis (text or Orchard code): _____

5 Has the player had a **previous injury** of the same type at the same site (i.e. this injury is a recurrence)?

- ☐ no
- ■ yes

If **YES**, specify date of player's return to full participation from the previous injury: _____

6 Was the injury caused by **overuse** or **trauma**?

- ☐ overuse
- ☐ trauma

7 When did the injury occur?

- ☐ training
- ☐ match

8 Was the injury caused by **contact** or **collision?**

- ☐ no
- ☐ yes, with another player
- ☐ yes, with the ball
- ☐ yes, with other object (specify) _____

9 Did the referee indicate that the action leading to the injury was a **violation of the Laws?**

- ☐ no
- ☐ yes, free kick / penalty
- ☐ yes, yellow card
- ☐ yes, red card

If **YES**, was the referee's sanction against: ☐ injured player ☐ opponent

APPENDIX J

BALANCE AND PROPRIOCEPTION FORM

PLAYERS	BALANCE					PROPRIOCEPTION	
No	1	2	3	4	5	Maximum	Diminished
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
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30							

APPENDIX K

CLINICAL TESTING

	FOOT TYPE				STANDING REARFOOT ALIGNMENT		HALLUX POSITION		ANTERIOR DRAWER		ROM		
No	Normal	Pes planus	Pes cavus	Splayed forefoot	Normal	Valgus	Normal	Valgus	Normal	Patho	inversion	eversion	D-flexion
----	------	----------	----------	------	------	------	-------	-------	------	------	-------	------	---------
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	FOOT TYPE				STANDING REARFOOT ALIGNMENT		HALLUX POSITION		ANTERIOR DRAWER		ROM		
No	Normal	Pes planus	Pes cavus	Splayed forefoot	Normal	Valgus	Normal	Valgus	Normal	Patho	inversion	eversion	D-flexion
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APPENDIX L

FAOS FOOT & ANKLE SURVEY

Todays date: _____/_____/_____ Date of birth: _____/_____/_____

Name: _____

INSTRUCTIONS: This survey asks for your view about your foot/ankle. This information will help us keep track of how you feel about your foot/ankle and how well you are able to do your usual activities.
Answer every question by ticking the appropriate box, only one box for each question. If you are unsure about how to answer a question, please give the best answer you can.

Symptoms

These questions should be answered thinking of your foot/ankle symptoms during the **last week**.

S1. Do you have swelling in your foot/ankle?

Never	Rarely	Sometimes	Often	Always
☐	☐	☐	☐	☐

S2. Do you feel grinding, hear clicking or any other type of noise when your foot/ankle moves?

Never	Rarely	Sometimes	Often	Always
☐	☐	☐	☐	☐

S3. Does your foot/ankle catch or hang up when moving?

Never	Rarely	Sometimes	Often	Always
☐	☐	☐	☐	☐

S4. Can you straighten your foot/ankle fully?

Always	Often	Sometimes	Rarely	Never
☐	☐	☐	☐	☐

S5. Can you bend your foot/ankle fully?

Always	Often	Sometimes	Rarely	Never
☐	☐	☐	☐	☐

Stiffness

The following questions concern the amount of joint stiffness you have experienced during the **last week** in your foot/ankle. Stiffness is a sensation of restriction or slowness in the ease with which you move your joints.

S6. How severe is your foot/ankle stiffness after first wakening in the morning?

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

S7. How severe is your foot/ankle stiffness after sitting, lying or resting **later in the day**?

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Pain

P1. How often do you experience foot/ankle pain?

Never	Monthly	Weekly	Daily	Always
☐	☐	☐	☐	☐

What amount of foot/ankle pain have you experienced the **last week** during the following activities?

P2. Twisting/pivoting on your foot/ankle

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

P3. Straightening foot/ankle fully

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

P4. Bending foot/ankle fully

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

P5. Walking on flat surface

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

P6. Going up or down stairs

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

P7. At night while in bed

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

P8. Sitting or lying

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

P9. Standing upright

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Function, daily living

The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities please indicate the degree of difficulty you have experienced in the **last week** due to your foot/ankle.

A1. Descending stairs

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A2. Ascending stairs

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

For each of the following activities please indicate the degree of difficulty you have experienced in the **last week** due to your foot/ankle.

A3. Rising from sitting

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A4. Standing

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A5. Bending to floor/pick up an object

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A6. Walking on flat surface

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A7. Getting in/out of car

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A8. Going shopping

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A9. Putting on socks/stockings

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A10. Rising from bed

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A11. Taking off socks/stockings

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A12. Lying in bed (turning over, maintaining foot/ankle position)

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A13. Getting in/out of bath

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A14. Sitting

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A15. Getting on/off toilet

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

For each of the following activities please indicate the degree of difficulty you have experienced in the **last week** due to your foot/ankle.

A16. Heavy domestic duties (moving heavy boxes, scrubbing floors, etc)

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

A17. Light domestic duties (cooking, dusting, etc)

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Function, sports and recreational activities

The following questions concern your physical function when being active on a higher level. The questions should be answered thinking of what degree of difficulty you have experienced during the **last week** due to your foot/ankle.

SP1. Squatting

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

SP2. Running

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

SP3. Jumping

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

SP4. Twisting/pivoting on your injured foot/ankle

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

SP5. Kneeling

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Quality of Life

Q1. How often are you aware of your foot/ankle problem?

Never	Monthly	Weekly	Daily	Constantly
☐	☐	☐	☐	☐

Q2. Have you modified your life style to avoid potentially damaging activities to your foot/ankle?

Not at all	Mildly	Moderatly	Severely	Totally
☐	☐	☐	☐	☐

Q3. How much are you troubled with lack of confidence in your foot/ankle?

Not at all	Mildly	Moderately	Severely	Extremely
☐	☐	☐	☐	☐

Q4. In general, how much difficulty do you have with your foot/ankle?

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Thank you very much for completing all the questions in this questionnaire.

Questionnaire and User's Guide can be downloaded from: www.koos.nu

APPENDIX M

FIFA F-MARC
For the Good of the Game

Exposure Report Form
(for the documentation of team exposures)

(Team) Player-code: _____

LOGO

Date	Match / Training	No. of players (fully participating in training)	Duration of training session (minutes)	Study specific variable	Study specific variable

APPENDIX N

PROPRIOCEPTION TRAINING PROGRAMME IN PICTURES

1 Single-leg stance on Field/floor (eyes open)

2 Single-leg stance while swinging the raised leg (Field/floor /eyes open)

3 Single-leg squat (30-45) (Field/floor /eyes open)

4 Single-leg stance (Field/floor /eyes closed)

5 Single-leg stance while swinging the raised leg (Field/floor /eyes closed)


6 Single-leg squat (30-45) (Field/floor /eyes closed)


7 Single-leg stance (board/eyes open)

8 Single-leg stance while swinging the raised leg (board/eyes open)


9 Single-leg squat (30-45) (board/eyes open)

10 Double-leg stance while rotating on board (board/eyes open)

11 Single-leg stance (board/eyes closed)

12 Single-leg stance while swinging the raised leg (board/eyes closed)

13 Single-leg squat (30-45) (board/eyes closed)


14 Double-leg stance while rotating on board (board/eyes closed)

15 Single-leg stance (board/eyes closed)


16 Single-leg stance while swinging the raised leg (board/eyes closed)

17 Single-leg squat (30-45) (board/eyes closed)


18 Single-leg stance while rotating on board (board/eyes closed)


19 Single-leg stance while catching and kicking a ball (board/eyes open)


20 Simple jump and land on trampoline (eyes open)

21 Jumping higher and landing on forefoot (trampoline/eyes open)

22 Single-leg jump (trampoline/eyes open)

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26 August 2017

To Whom It May Concern

I hereby confirm that Mr Moussa Hakizimana sent me a corrected version of his PhD thesis for proofreading and editing. I checked his draft version for spelling and grammatical errors and made suggestions regarding style, clarity and consistency. I thereafter returned his draft to him to make the final corrections and changes as he saw fit.

Yours sincerely

Shirley Leibbrandt