THE RELATIONSHIP BETWEEN EXPOSURE TIME AND INJURY INCIDENCE IN YOUTH FOOTBALLERS AT A SOUTH AFRICAN YOUTH FOOTBALL ACADEMY

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ABSTRACT

Background : Football is reportedly the most popular team sport among youth participants in South Africa. However, the epidemiology of injury occurrence in youth football in South Africa has not been fully researched. In order to devise age - appropriate conditioning and injury management strategies, the nature of injuries and the risk factors associated with injury in this population needs to be described.

Aims : The study aimed to determine if a relationship exists between exposure time and injury incidence in youth footballers. Furthermore, the study aimed to design an injury prevention strategy specific to this population.

Methods : A retrospective cohort study design was used. The cohort consisted of all players who were registered at the academy for the duration of the study period. These players were grouped into 5 academy teams classified by chronological age i.e. under 11; under 13; under 15;under 17 and under 19.These teams were collapsed into 3 categories viz. under 13 (u13); under 15&17 (u15&17); and under 19 (u 19).The ages of the players ranged from 9 to 19 years, mean age = 13.8 years(± 3.3 years).Anthropometric data ,injury data and exposure times were recorded by the academy medical staff on validated and standardized data collection forms used by the FIFA Medical and Research Committee(FMARC) in previous epidemiological research . Exposure data consisting of match and training times per team (expressed in hours), was extrapolated from attendance sheets(completed by academy staff). Analysis of data was done using the Statistical Package for Social Sciences (SPSS) version16. Descriptive data was expressed as means, percentages, frequencies and standard deviations. Inferential statistics (chi -square analysis) was used to determine if correlations exist between injury incidence and demographic factors and exposure time. An alpha level was set at 0.05. Relative risk was calculated with a 95% confidence

interval and significance set at ($p < 0.05$). 387 injuries were documented at the academy over the study period. The total exposure time was 42 424 hours , with 4 666 (match) and 37 758 (training) hours. A systematic literature review on injury prevention strategies in youth football was conducted. Written permission and ethical approval was sought from the Higher Degrees Committee of the University of the Western Cape ,as well as from the head of the Ajax Cape Town Football Club Youth Academy, prior to commencing the research. Ethical considerations with regards to confidentiality, anonymity and permission was be strictly observed.

Results : The resultant overall injury incidence rate at the academy was 9.12 injuries per 1000 hours exposure per player .The u13 category had significantly higher injury rates for both match(97.50 injuries per 1000 hours exposure; $p = 0.02$) and training (10.92 injuries per 1000 hours exposure; $p = 0.01$) than the u15 &17 , and u 19 categories respectively. The u15 & 17 category played the most number of matches (n = 76; 36.55%), followed by the u13 category (n= 70; 33.65 %) and the u19 category (n = 62; 29.80 %) . The knee (21.70%), ankle (19.89 %), and hip/groin (15.24 %) were the most frequently injured areas. The u13 category had a higher risk of sustaining a knee injury than the u15 & 17 category (R.R = 1.43 ; $p = 0.017$;95% CI 1.09 - 1.87)

Conclusion: The overall injury incidence rate at the Ajax Cape Town Football Club Youth Academy was high. The u13 category was most at risk of sustaining injury. There was a definite inverse relationship between exposure time and injury incidence at the academy. The outcomes of the study as well as the results of the systematic literature review was then used to design an injury prevention strategy. A Delphi study was conducted to gain consensus on the content of the proposed injury prevention strategy. Multi- component neuromuscular control training programs appear to be most effective at reducing the risk of injury in youth football players.

KEYWORDS

Youth

Football

Injury

Exposure

Overuse

Prevention

Adolescent growth spurt

Age- specific training

Overtraining

South Africa

DECLARATION

I hereby declare that: **"The relationship between exposure time and injury incidence in youth footballers at a South African youth football academy"**, is my own work, that it has not been submitted, or part of it, for any degree or examination in any other university, and that all the sources used or quoted have been indicated and acknowledged by complete references.

November 2013

Signature: .....

Ian Meder

Witness: .....

Prof. Julie Phillips

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO THE CHAPTER

This study investigates the relationship between exposure time and injury incidence in youth footballers. In addition the study aims to design an injury prevention strategy for the youth footballers. This provides the background to the study, highlighting the risk of injury for youth footballers. The overall aim and specific objectives are outlined. The chapter ends with the definitions of terms and abbreviations used in the study, and an overview of the thesis.

1.2 BACKGROUND

Football is widely regarded as the most popular team sport in the world. Federation Internationale de Football Association (FIFA) reported figures of football participation in 2008 to be 200 million registered players in 186 countries (Fuller,2006; Fuller, Ekstrand , Jung , 2006)In a recent survey by the Department of Sport and Recreation of South Africa in 2006, football was identified as the sport played and supported by most South Africans, as well as the most popular sport among the 8 million youth participating in sport in South Africa. BMI Sport Info® estimates the number of football playing youths in South Africa to be at 1.2 million(Sports Trader , 2007). In the Department of Sport and Recreation South Africa (DSRSA) survey, 42 % of respondents remarked that young children with potential in sport should receive the most attention from DSRSA. Football players were also found to be the most recognizable sporting celebrities among all demographic groups (Department of Sport and Recreation South Africa, 2006). These

figures could, in part, be as a result of South Africa hosting and competing in the 2010 FIFA World Cup, but it does show that a large proportion of the population is involved or interested in football at some level, especially the youth.

Professional clubs have established football academies with teams of varying age groups where the young talented players of today are groomed to be future professional footballers. These young players are now being scouted by the academies with the hope of achieving financial gain and acclaim, for the players (upon graduating to the professional ranks) and the clubs. Players are also scouted by academy staff at increasingly younger ages as competition among football academies is strict and the most talented players are highly sought after. Academy teams consist of highly skilled players training and playing at intensities well above that of the social sporting environment. Scientific research has concluded that it takes 8 – 12 years of training for a talented player/ athlete to reach elite levels" (Wright,2008)(Balyi,2004).This was described as the 10 000 hour rule and equates to just over 3 hours of practice daily for ten years (Salmela,et al.1998)This high frequency and intensity of training may expose young players to a higher risk of injury(Spinks & McClure, 2007)In a prospective study by Hawkins & Fuller (1999) on the injuries at four British football clubs, the authors observed senior and youth players for a period of three years .The authors reported that the increasing injury frequency rates for youth players as the season progresses emphasizes the importance of controlling the risk levels to young players caused by excessive exposure to competition . In the study by Hawkins & Fuller (1999) the authors concluded that the injuries in youth football players is due to exposure to matches. However, the study did not control for maturity levels. Furthermore the exposure time of the youth as opposed to the senior players was also not significantly higher. This would indicate a need for further research using multivariate models, to more accurately explain injury occurrence in youth football players.

The English Football Association expressed concerns about the total number of matches played by youth players during the course of a season .This prompted the formation and adoption of a charter (Wilkinson, 1997) which set out guidelines regarding match exposure in hours for each age group. It also included details on how youth football academies can implement the strategies. Currently no such guidelines exist in South African football (South African Football Association, personal communication). There is limited research on the causation of injury in youth football players in South Africa. Most of the studies were conducted during tournaments and can therefore not factor for exposure time. " Increasing numbers of chronic overuse injuries in young athletes may be related to limited recovery time from longer competitive seasons and year round training" (Cassas & Cassettari – Wayhs , 2006). Overuse injuries are defined as tissue injuries sustained as a result of repetitive submaximal loading, usually of an insidious nature (Brukner & Khan, 2003).This repetitive loading fatigues a specific tissue structure, with adequate recovery the tissue can adapt and withstand further loading without injury. In the absence of adequate recovery microtrauma develops causing local tissue damage. Continued loading of the structure can lead to degenerative changes in the tissue structure, causing weakness, loss of function and chronic pain. Overuse can therefore simply be described as too much load sustained over too long a period. Questions that need to be answered by empirical research are the exact limits of the load (quantity and speed) and the time frame in order to safely and effectively stimulate body tissues .This can be difficult to quantify for team sports as the loading capacity of individuals may vary tremendously.

There exists a need in youth football to identify groups most at risk of injury and the factors affecting the rates of injury of these groups, specifically in the South African context .This will allow for the implementation of effective injury prevention and treatment strategies. It becomes especially important as youth football players are engaging in strenuous training and match regimes at increasingly younger ages .Coaches and conditioning staff at youth academies need to be advised on the identification and management of risk factors affecting injury in the youth football

player. These recommendations need to be evidence based which necessitates empirical research. The majority of research in this field is done in a European context and as factors such as climate, socio- economic status of players, access to appropriate medical care differ greatly to that of African players , therefore it is important to establish norms based on an African model.

1.3 RESEARCH QUESTION

Does a relationship exist between exposure time and injury occurrence in youth football players at a South African football academy?

1.4 RESEARCH HYPOTHESIS

Exposure time is a significant risk factor in injury occurrence among youth footballers in a South African football academy.

1.5 AIMS OF THE STUDY

The overall aim of the study is to determine if a relationship exists between exposure time and injury incidence in youth footballers. Furthermore the study aims to design an injury prevention strategy for the youth football players at a football academy.

1.6 OBJECTIVES OF THE STUDY

I To collect baseline information regarding injuries among youth football players at the Ajax Cape Town Football Club(A.C.T. F.C)Youth Academy :

(a) To establish the prevalence of injuries in youth football players at a football academy

(b) To establish if a link exists between exposure time and injury occurrence in youth academy football players

(c) To identify age groups at higher risk for injury within the study population

II To find the best evidence in the scientific literature on injury prevention strategies in youth football

III To design an injury prevention strategy for youth footballers at the Ajax Cape Town F.C Youth Academy

1.7 SIGNIFICANCE OF THE STUDY

Questions that need to be answered by empirical research are the exact limits of the load (quantity and speed) and the time frame in order to safely and effectively stimulate body tissues .This can be difficult to quantify for team sports as the loading capacity of individuals may vary tremendously. There exists a need in youth football to identify groups most at risk of injury and the factors affecting the rates of injury of these groups, specifically in the South African context .This will allow for the implementation of effective injury prevention and treatment strategies. It becomes especially important as youth football players are engaging in strenuous training and match regimes at increasingly younger ages .Coaches and conditioning staff at youth academies need to be advised on the identification and management of risk factors affecting injury in the youth football

player. These recommendations need to be evidence based which necessitates empirical research. The majority of research in this field is done in a European context and as factors such as climate, socio- economic status of players, access to appropriate medical care differ greatly to that of African players , it is therefore important to establish norms based on an African model. This study aims to add to the limited data on injury prevalence at South African youth football academies. Thereby increasing awareness among players and coaches alike, by highlighting the common injuries sustained by players at the academy . The current study may also provoke a discussion among the various role players on the effect of variables such as maturity levels, exposure time etc. on injury prevalence. Furthermore it aims to stimulate further research in this field.

1.8 ABBREVIATIONS USED IN THE STUDY

ACL	Anterior Cruciate Ligament
ACTFC	Ajax Cape Town Football Club
BMAS	Bone Mass Accrual Study
CI	Confidence Interval
DSRSA	Department of Sport and Recreation South Africa
FIFA	Federation Internationale de Football Association
F-MARC	FIFA Medical Assessment and Research Centre
NEISS	National Electronic Injury Surveillance System
NMC	Neuro Muscular Control
OSICS	Orchard Sports Injury Classification System
PHV	Peak Height Velocity
RCT	Randomized Controlled Trial
RR	Relative Risk

SAFA	South African Football Association
SD	Standard Deviation
TOYA	Training Of Young Athletes
UEFA	Union of European Football Associations

1.9 DEFINITION OF TERMS

(a) Youth football player

The National Youth Act 1996 (Statistics South Africa 1996) defines youth in South Africa as persons in the age group 14 -35 years.The term " youth football player" shall , for the purpose of this study be defined as amateur players under the age of 19 years, competing in age classified teams.

(b) Injury

Defined as all physical complaints sustained by a player during official match, training and reported or attended to by the academy medical staff

Most studies of football injuries use one , or a combination of, 3 models to define injury(Fuller, et al 2006; Hägglund, et al 2005).

These are:

Tissue injury - any physical complaint suffered by a player during official matches training regardless of whether or not it causes absence from matches or training.

Time loss - a recordable injury being one that causes absence from official matches and / or training

Medical attention - any incident causing the player to seek medical attention from a qualified medical practitioner

Researchers contend that each model has either a subjective component or practical difficulty which complicates standardization and / or introduces observer and player bias(Fuller, et al. 2006; Hägglund, et al. 2005). Furthermore, the medical attention definition is considered by the authors to be impractical as it would include minor injuries that are not significant for the overall injury risk. The authors also state that this model may introduce a bias when study groups do not have equal access to medical care. Tissue injury requires expensive diagnostic measures such as ultrasonography or magnetic resonance imaging in order to ensure objectivity (Hägglund, et al. 2005)The A.C.T. F.C academy medical staff recorded all injuries (minor and serious) presented to them during training and matches. This is the preferred method of recording injury data at the academy. All teams at the academy have equal access to the same level of medical care.Excluding the minor injuries may also lower the reporting threshold as the term "minor" can be subjective,especially when dealing with children and adolescents.Therefore , with regards to defining the term injury a combination of the tissue injury and medical attention models was selected.

(c) Recurrence

Defined as an injury of the same type and at the same site as an initial injury occurring after the player has successfully returned to play from the initial injury(Orchard, 1995)

(d) Severity

Defined as the time that has elapsed from the date of initial injury to the date of the players return to all squad activities and his availability for selection, expressed in days.

This was subdivided into transient (0 – 7 days) , mild (8 – 14 days) , moderate (30 - 90 days and severe (> 90 days) as adapted from Fuller, et al(2006) ,based on the phases of tissue healing.The time frame was estimated by the attending academy physiotherapist at the initial assessment and then calculated and/or re adjusted from the attendance record

(e) Match Exposure

Defined as matches between teams from different clubs (Fuller, et al. 2006).

Any match or training activity forming part of a player's rehabilitation was recorded as match or training exposure.

(f) Training Exposure

Defined as team based and individual physical activities under the guidance of the academy's coaching and fitness staff. (Fuller,et al. 2006).

(g) Overuse

Defined as injuries sustained as a result of repetitive submaximal loading, usually of an insidious nature(Brukner & Khan, 2003).

(h) The Adolescent Growth Spurt

A period of rapid growth characterized by increases in height, muscle mass and bone density associated with secondary sexual maturation (Di Fiori, 1999)

1.10 OUTLINE OF THE THESIS

The first chapter presents the basis for the study.It discusses the background to the study, as well as the overall aim and specific objectives.

In chapter two the relevant literature regarding injuries among youth footballers is reviewed.This is discussed in two parts .The first part reviews the literature pertaining to the epidemiology of injuries among youth football players.The second part of this chapter outlines the systematic review that was conducted on injury prevention strategies in youth football .

Chapter three describes the research setting,design,study sample as well as the research instruments used. It outlines the methodology used to collect baseline information regarding injuries among youth football players at the Ajax Cape Town Football Club (ACTFC) Youth Academy .This chapter also describes the procedure of conducting the pilot study, as well as issues pertaining to the reliability and validity of the research instruments.

In chapter four the results of the statistical analysis is discussed . It presents , in tabular and graphic form , the training and match exposures as well as the injury incidence at the ACTFC Youth Academy. Furthermore this chapter describes the methods used to establish the prevalence of injuries and to establish if a link exists between exposure time and injury occurrence in youth football players at the academy.

Chapter five outlines the first phase of the procedure used in designing an injury prevention protocol for youth footballers.It discusses and compares the definitions of injury, injury incidence rates and injury characteristics used in the present study to those discussed in the systematic literature review.

In chapter six the second phase of the procedure used in designing an injury prevention protocol for youth footballers is described .It further outlines the various rounds of the Delphi study used to gain consensus on the efficacy of the proposed injury prevention protocol .

The final chapter provides a summary of the main arguments of the study. This chapter also presents the conclusions drawn from the study and discusses recommendations for future research in the field of youth football.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION TO THE CHAPTER

This chapter is presented in two parts . The first part constitutes a narrative literature review of studies pertaining to football injuries in the youth population. The second part of this chapter outlines the systematic review that was conducted on injury prevention strategies in youth football .

PART A : NARRATIVE LITERATURE REVIEW

2.2 FOOTBALL INJURIES IN THE YOUTH POPULATION

Fuller et al (2006), in a consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries, defined injury 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." Time - loss injury being injury that causes a player to be unable to take part in training or matches , whereas medical attention injuries are injuries that cause a player to receive medical attention from a qualified medical practitioner .There are significant differences in the types of injuries sustained by the young athlete as compared to adult athletes as a result of the anatomical differences in the musculoskeletal structures. These anatomical differences are:

(a) The articular cartilage in adolescents is thicker than in adults and can remodel more freely

(b) Ligament/tendon - to bone attachments are weaker in the adolescent, predisposing the adolescent athlete to avulsion injuries, as opposed to ligament / tendon sprains in adults

(c) The growth plates in adolescent long bones are unfused and can thus easily be disrupted by shear forces leading to incomplete fractures which are not sustained

by adults .Undiagnosed, these injuries can lead to permanent growth disturbances.

(d) Rapid bone growth during the adolescent growth spurt causes a lag in the development of strength and co ordination of the muscles and tendons, manifesting as awkwardness of movement in the adolescent (Brukner & Khan, 2006)

"Children and adolescents are therefore more susceptible to repetitive microtrauma; avulsion injuries; growth plate fractures and developmental disturbances" (Maffulli & Campbell, 2003). This highlights the importance of correct diagnosis and treatment of injuries sustained by young athletes. Most intervention studies are done on adults and these treatment protocols could be highly inappropriate and/ or detrimental when applied in a blanket fashion to the younger athlete (Olsen, et al. 2004). A high prevalence of injuries are sustained by young footballers , as indicated hereafter.

The British Sports Council initiated a prospective study on injury occurrence in highly trained young athletes - encompassing different sporting codes - TOYA (Training Of Young Athletes) study (Cunningham, 2002). In the aforementioned study the highest number of injuries were found in football, although this was found to be statistically insignificant overall.The United States National Electronic Injury Surveillance System (NEISS) reported that of the 150 000 football related injuries occurring each year, 45 % of these occur in participants younger than 15 years(Wright, 2008). Risk for injury in youth football ranges from 0.4 to 35 per 1000 hours played (Junge, Edwards & Dvorak, 2004).

Injury prevalence depends on the definition of injury used, whether rates are computed for games or both games and practices,age, gender and skill level of players. In a study on the incidence of football injuries in different age groups and skill levels, the authors found more than 80 % of players were injured, with the rate of severe injury (lasting more than four weeks) being 29%

(Peterson et al. 2000).The majority of injuries were sprains (54%) and strains (34%) of the lower extremity with the knee being the most injured site (46%). This is consistent with the findings of several other studies (Schwebel, et al 2007; Price, et al. 2004; Junge, Cheung et al. 2004; Junge, Chomiak & Dvorak, 2000; Dvorak & Junge, 2000). A systematic review by Olsen et. al (2004) on the strategies for prevention of soccer related injuries found 44 relevant articles, 4 of which met the inclusion criteria. The selected articles were based on studies conducted in Europe (3) and the United States of America (1) Alarmingly, only one included article specifically addressed prevention strategies in young players. The authors expressed a concern about the current injury prevention strategies in use highlighting the need for epidemiological studies on injuries in young football players. This would establish baseline data, ensuring a strong empirical basis for further research. The overwhelming majority of these studies are conducted in Europe and there exists a strong need for this type of research in an African context.

2.3 THE ADOLESCENT GROWTH SPURT

Adolescence is a time of rapid growth in height, characterized by the adolescent growth spurt, during which time children gain physical, mental and emotional maturity in a short period of time. The adolescent growth spurt occurs between the ages of 10 – 14 years in males and 9 – 12 years in girls, but varies widely between individuals. During puberty, height velocity increases and peaks during the adolescent growth spurt. Peak height velocity (PHV) occurs at a mean of 13.5 years in boys, and 11.5 years in girls.The Saskatchewan Bone Mass Accrual Study (BMAS) found that PHV averages 10.3cm/year with a range of 5.8cm to 13.1 cm in the normal male. The BMAS study was longitudinal with a large sample but the population was exclusively Caucasian, due to the geographic context of the study, yet the authors felt that results could still be relevant to other ethnic groupings "A risk factor (for injury occurrence) of particular interest is whether periods of rapid growth relate to an increased risk of injury "(Di Fiori, Maffulli, 2006). Price & Hawkins ,et al. conducted a study in 2004 on the injuries in youth football at 38 English football academies. The

study showed that growth related conditions accounted for 5 % of the total amount of injuries. The study also found peaks of injury occurrence in the under 13 age group for Osgood - Schlatters disease; and in the under 11 age group for Sever's disease. These findings corresponded with the starting and end points of the adolescent growth spurt in males .The conditions described also typically occur in the young athlete as a result of a rapidly growing neuro –musculoskeletal system. (Maffulli, 2005). " These findings illustrate (to football academies) the importance of identifying these growth spurts to start early effective treatment, management and even prevention of these injuries" (Hawkins & Fuller, 1999) Classification for participation in youth sport continues to rely on chronological age.This is thought to have been sufficient to create equal competition. "Recent research has shown that this line of thinking may be flawed "(Wright, 2008).Children of the same chronological age may vary considerably in biological maturity status, which influences measures of growth and performance in adolescence.There are definite structural, functional and performance advantages of early maturity boys in sports requiring size, strength and power (Malina, 2004).There is a concern that unbalanced competition between early – and late maturity boys in contact sports may contribute to a significant amount of the serious injuries in youth sport." In contact sports, factors such as maturity, fitness levels and achievement of skill in the sport must be considered as measures for equalizing competition among peers and avoiding unnecessary injury "(Caine &Lindner ,1999)There is, however, some disagreement amongst researchers on the effect of maturity levels on injury occurrence (Johnson, Doherty & Freemont, 2009)

2.4 OVERUSE INJURIES IN YOUTH FOOTBALL PLAYERS

Overuse injuries are defined as injuries sustained as a result of repetitive submaximal loading, usually of an insidious nature(Brukner & Khan, 2003).The American College of Sports Medicine (2003) estimates that 50 % of overuse injuries sustained by children

and adults are preventable.Watkins & Peabody (1996) studied the incidence of sports injuries in children and adolescents at a sports injury clinic in South Africa.The authors found that 49.5% of the 394 documented injuries were classified as overuse injuries.In a study by Baxter - Jones, Maffulli & Helms (1993) it was found that athletes who had sustained overuse injuries lost 54% more playing time than those who sustained acute injuries.The authors stated that this may precipitate social and peer group pressure which may lead to young players not reporting injuries or returning to play too soon.Le Gall, et al. (2006) investigated the incidence of soccer related injuries in elite French youth players.In the study, injuries in players up to 16 years old were documented over 10 seasons.The authors found that 69.1% of injuries were sustained in training. Furthermore, players younger than 14 years suffered more injuries in training and sustained more growth related overuse injuries than older players in the study population. These findings were consistent, for the most part, with a study by Volpi , Pozzoni & Galli (2003) where the authors documented injuries in players at the youth division of a professional club aged 9 – 19 years.Participants were divided into two groups for analysis, younger than 15 years and older than 15 years.The authors found that growth related injuries i.e osteochondroses, avulsions and growth plate fractures were more prevalent among players younger than ,15 while overuse injuries such as tendinopathies were more common among players older than 15.Overuse injuries(35%) were found to be outnumbered by acute injuries(65%) in this study. However only major injuries (defined as those injuries sidelining a player for at least 4 weeks) were included in the study.This may have created a bias as some overuse injuries may not necessitate the player being sidelined for 4 weeks and would thus not have been included in the study. The authors did conclude that as age increases, competition intensifies and practice sessions become more frequent and more physically demanding.Concurrently the technical and tactical demands are similar to those placed on adult players.The defining difference being that as the sport becomes ever more physical and technical the neuro-musculoskeletal system of the young player may not be developing at an equivalent rate

in order to sustain such pressures.This may predispose the young football player to an increased risk of injury.

PART B : SYSTEMATIC LITERATURE REVIEW - INJURY PREVENTION STRATEGIES IN YOUTH FOOTBALL

2.5 INTRODUCTION TO THE SECTION

This section outlines the results of a systematic literature review on injury prevention studies in youth football.This review was performed to assist in the development of an injury prevention strategy for youth footballers.

2.6 INTRODUCTION

Injury incidence in youth football has been described in several studies (Junge & Dvorak, 2004; Junge et al 2002 ; Soderman et al, 2001; Peterson et al, 2000 ; Schmidt-Olsen et al ,1991 ; Nielsen & Yde, 1989). In a study by Junge et al (2004) in adolescent male footballers, the authors found injury incidence rates of 16.2 (match) and 3.7 (training) injuries/1000 exposure hours.This was consistent with the findings of Yde & Nielsen (1991) in a similar study i.e 14.4 (match) and 3.7 (training) injuries/1000 exposure hours.Many of the various warm-up, conditioning and rehabilitative protocols used in football currently have been tested in various research studies with strong statistical significance(Askling et al, 2003; Soderman et al, 2000). However, according to Abernathy & Bleakely (2007) , relatively few of these protocols have been tested on adolescent subjects .

The purpose of this review was to evaluate published , peer reviewed injury prevention studies , conducted in youth football.This was done to :

1. determine the extent to which injury prevention studies are conducted on youth footballers
2. determine the percentage of these studies that are conducted on male youth footballers
3. evaluate the methodological content and efficacy of the strategies tested in order

to design a planned injury prevention protocol for a specified population.

2.7 SEARCH STRATEGY

A comprehensive search was conducted on selected electronic databases of research reports available to the researcher .The databases searched were Medline , SportDiscus , EMBASE , Psycinfo , Pubmed , The Cochrane Database for Systematic and Complete Reviews , The Cochrane Controlled Trials Registry .Four keywords were used in the search : intervention strategies ; injury prevention; youth football ; youth soccer with boolean operators and including all culturally accepted synonyms.During the first stage of the search , abstracts and titles collected were scanned for relevance to the current review .The full text articles of potentially relevant studies were retrieved and then assessed against the inclusion criteria listed below .

2.8 SELECTION CRITERIA

Studies were deemed eligible for inclusion in this review based on the following criteria:

- Studies should contain a control group in its methodological design or use other types of comparative measures i.e randomized controlled trials (RCT); non -randomized intervention studies and cohort studies.The reviewer only considered studies published in the English language.

- Studies should address injury prevention in youth football/soccer.Youth footballers defined as amateur players under the age of 19 years. Studies based on adult and youth subjects were only included if the youth age groups were clearly defined and studied separately .

- Studies should evaluate the efficacy of an injury prevention strategy.This could be in the form of an educational strategy; a policy / regulation change; environmental or equipment modifications and /or a structured neuromuscular training regime.

- Studies should have an outcome measure in the form of injury incidence/rate (per player; per 1000 exposures or per 1000 exposure hours) and/or injury severity(time missed from training and/or matches due to injury.

2.9 STUDY RATING

The methodological quality of included studies was assessed using a rating key (Appendix A) developed for use in a similar review (Abernathy & Bleakely , 2007).This rating key was designed based on similar tools used by the Cochrane Collaboration Injuries Group and the Cochrane Collaboration Bone , Joint & Muscle group to evaluate the quality of studies that are not randomized controlled trials .The researcher used this key to evaluate all included studies in order to maintain conformity in analysis and ensure comparability across different study designs.Once studies were rated and classified the overall quality score of each study was converted into a percentage value. This percentage value was used to rate and compare studies , using a system designed by Olsen et al (2004) which classifies percentage values as :

0 % - 49% poor

50% - 89% average

≥ 90% good

The rating scores are represented in Table 2.1

*Table 2.1 Study quality rating scores**

STUDY	RATING ITEM I	II	III	IV	V	VI	VII	VII	IX	Total/18 (%)
Kiani et al	0	1	2	2	2	2	2	2	2	13 (72 %)
Pfeiffer et al	0	1	0	0	1	2	2	2	2	10 (55.5 %)
Heidt et al	2	0	0	2	1	0	2	2	2	11 (61 %)
Hewett et al	0	0	1	0	1	0	2	2	2	8 (44.4 %)
Soligard et al	1	1	2	2	2	2	2	2	2	16 (88.9 %)
Junge et al	1	0	0	0	1	0	2	2	2	8 (44.4 %)
McGuine et al	1	0	2	0	2	1	2	2	2	12 (66.7 %)
Mandelbaum et al	0	0	0	0	2	1	2	2	2	9 (50 %)
Steffen et al	1	1	0	1	2	2	2	2	2	13 (72 %)
Elias et al	0	0	0	0	2	1	2	2	1	8 (44.4 %)
Malliou et al	0	1	0	0	0	2	2	2	2	9 (50 %)

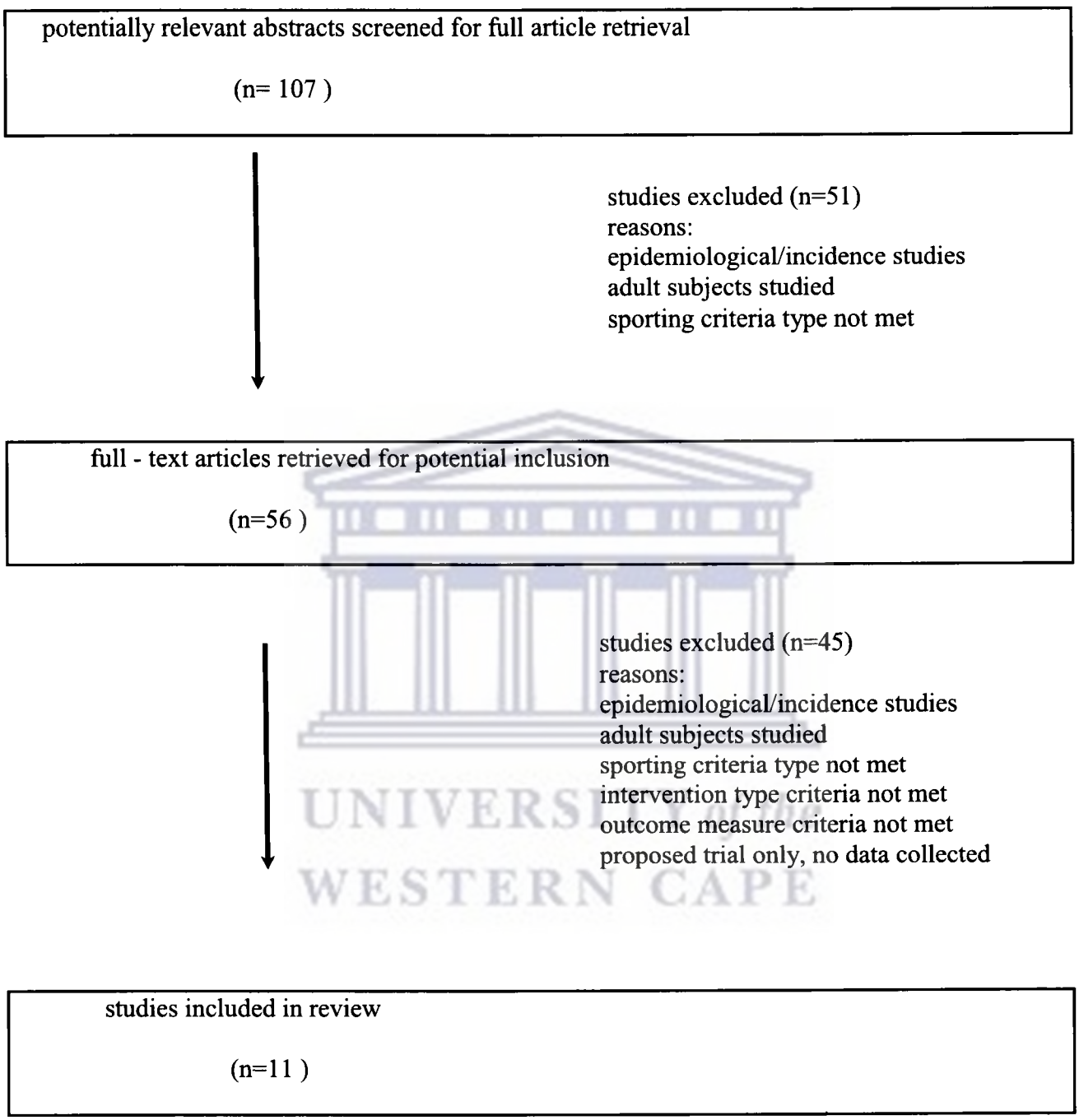
**adapted from Abernathy & Bleakely (2007)*

2.10 DATA EXTRACTION

The researcher analyzed all included studies and grouped the data relative to study design,type of intervention strategy and outcomes measured onto a self- designed spreadsheet . This was conducted by the primary researcher therefore blinding to author, publication and/or database was not possible.

A flow diagram representing the systematic literature search process with reasons for exclusion is depicted in Figure 2.1

Figure 2.1 Summary of Outcome of Retrieved Articles



2.11 RESULTS

A total of 107 abstracts were collected during the first stage of the literature search. These abstracts were scanned by the researcher and 51 studies were excluded (based on criteria delineated in Fig.1).The full text articles of 56 studies were retrieved and reviewed leading to a further 45 studies being excluded.The remaining 11 studies were deemed eligible and thus included in the review.

Table 2.2 Study population, intervention types & outcome measures

study author & type	participants	intervention type, content and timing	primary outcome measure
Heidt et al (2000) Randomized controlled trial	female 14 -18 yrs	NMC training program pre season , 7 weeks , 3 sessions/ week plyometrics, strength , flexibility sports specific endurance training	all injuries injury incidence reduced 33.7 % untrained group 14.3 % trained group ($p < 0.05$)
Hewett et al (1999) Prospective intervention study	female male (control) 13 - 18 yrs	NMC training program pre season , 6 weeks , 3 sessions/ week flexibility,plyometrics, weight training landing mechanics	knee ligament sprain/rupture reduction in serious knee injuries 0.22 * intervention group 0.52 * control group
Soligard et al (2008) randomized controlled trial (cluster)	female 13 - 17 yrs	NMC training program in season, before every training and match warm up,strength , core stability postural control, running mechanics	lower limb injuries 32 % reduction in overall injuries
Kiani et al (2010) intervention trial	female 13 - 19 yrs	NMC training program in season warm up, muscle activation,core stability jump and land technique drills	acute knee injuries 77 % reduction in all knee injuries 99% reduction in non contact knee injuries
Mandelbaum et al (2005) Prospective intervention study	female 14 -18 yrs	NMC training program in season, before every training and match	non contact ACL injuries injury incidence reduced

study author & type	participants	intervention type, content and timing	primary outcome measure
		warm up ,strength , flexibility, plyometrics	(0.05) * yr. 1, (0.13) * yr. 2 trained
		soccer specific agility drills	(0.47) * yr. 1, (0.51) * yr. 2 control
Pfeiffer et al (2006) prospective cohort study	female	NMC training program	non contact ACL injuries
	14 -18 yrs	in season, 2 sessions/week	no significant reduction shown due to lack of cases
		Knee Ligament Injury Prevention (KLIP) program agility drills,jump and land technique training running mechanics	
Steffen et al (2008) Randomized controlled trial (cluster)	female	NMC training program	all injuries
	13 - 18 yrs	pre season & in season, before every training for	no significant reduction shown due to low compliance rate
		15 consecutive sessions,thereafter 1 session / week FIFA F-MARC " 11 + " core stability,postural control,strength running mechanics	
Junge et al (2002) Prospective intervention study	male	NMC training program, in season , before every	all injuries
	13 - 18 yrs	training and match, core stability, postural	no significant reduction shown when skill level matching applied
		control,strength, running mechanics	
Malliou et al (2004) Randomized controlled trial (cluster)	NR	balance training program	lower limb injuries
		in season ; 20 min sessions 2 x/week	significant reduction in lower
		balance and proprioceptive drills on	limb injuries

study author & type	participants	intervention type, content and timing	primary outcome measure
		Biodex™ stability system soccer specific proprioceptive drills	68 injuries (intervention group) 88 injuries (control group)
McGuine et al (2006) Randomized controlled trial	male & female 13 - 18 yrs	balance training program pre - & in season ; 10 min sessions 3 x/week 5 phase balance board training phases 1 -2 performed on floor phases 3 - 5 performed on balance board	acute ankle sprains significant reduction in incidence of ankle sprains = 38%
Elias et al (1991) time series	male & female 9 - 19 yrs	emergency prevention measures to avert heat injury throughout a 6 day tournament education on heat injuries to coaches , players etc: prior to tournament environmental modifications : from day 3 players sprayed with water game modifications : from day 3 shorter match times unlimited substitutions	incidence of heat exhaustion reduction in heat injuries 21 cases pre intervention 13 cases post intervention

*injury incidence measured as injury/1000hrs exposure; NMC = neuromuscular control

The studies included in this review were analyzed and grouped into five categories i.e

1. outcome measure used
2. intervention applied
3. compliance
4. study subject profile
5. implementation

These groupings were selected and designed by the researcher in order to facilitate data extraction relevant to the purpose of this review .The results will be discussed within these groupings

2.11.1 Outcome Measure

In the current systematic review there was some variation in the definition of injury used in the included studies. .The majority of the studies included in this review (Soligard et al, 2008 ; Steffen et al, 2008; Malliou et al,2004; Junge et al, 2002; Hewett et al, 1999) used a time-loss definition of injury, as described by Fuller et al (2006).Kiani et al (2010) used the medical - attention definition of injury , while McGuine et al (2006) ,in their study,used a combination of the time-loss and medical - attention definitions .McGuine et al (2006) studied the effects of a balance training program on the risk of ankle sprains in high school athletes.The authors of this study used a combination of time - loss and medical attention/tissue damage to define injury in the study sample.Severity of injuries was described, by all the studies in this review, using the model first developed by Van Mechelen et al (1992).This model classifies severity according to the length of time a player is absent from sporting activity i.e training and matches.Minor injuries are classified as leading to 1 - 7 days absence from sporting activity.Moderate and major injuries are classified as causing absence from sporting activities for 8- 21 days and more than 21 days respectively . The time frames applied to these categories were varied across all studies included in this review .Soligard et al(2008) defined moderate injuries as causing 8- 28 days absence , while Malliou et al (2004) assigned 7 -14 days' absence to the same category. The researchers in the study by Kiani et al (2010) added a further category i.e severe injuries, defined as absence for more than 56 days.This study used all new acute knee injuries as a primary outcome measure .The authors of this study reasoned that the prolonged recovery times of severe knee injuries such as anterior cruciate ligament (ACL) reconstructions, necessitated the addition of an extra category.

Seven of the studies included in this review used a physician/orthopaedic surgeon / physiotherapist to record and/or verify the injury data (Kiani et al, 2010 ; Steffen et al, 2008 ; McGuine et al,

2006; Pfeiffer et al, 2006 ; Mandelbaum et al, 2005; Malliou et al, 2004; Junge et al, 2002; Hewett et al, 1999;) This verification was done(by telephonic interview with coaches /players or a physical assessment) where coaches / trainers were responsible for capturing injury data.Players self- reported injury data in 1 study (Junge et al, 2001) and were then followed up by the authors .This may have led to recall bias on the part of the players which may have influenced the accuracy of the data.Only Kiani et al (2010), Pfeiffer et al(2006) ; Mandelbaum et al (2005) and Hewett et al (1999) used further investigations such as magnetic resonance imaging(MRI) or diagnostic arthroscopy to confirm diagnoses.Seven of the studies reviewed investigated the prevention of specific types of injuries such as heat exhaustion injuries, ACL injuries and ankle injuries(Kiani et al 2010; McGuine et al, 2006; Pfeiffer et al, 2006 ; Mandelbaum et al, 2005; Malliou et al, 2004; Hewett et al, 1999 ; Elias et al, 1991;).The studies by Soligard et al (2008), Steffen et al (2008), Heidt et al (2000), Junge et al (2002) investigated the effect of an injury prevention protocol on all injuries sustained by the study subjects.

2.11.2 Intervention Applied

Several categories were identified i.e neuromuscular control training programs (pre & in season),balance and proprioceptive training,multimodal interventions.

2.11.2 (a) Neuromuscular Training Program

Nine of the eleven reviewed studies investigated the effect of a neuromuscular training program .These programs consisted of a series of exercises designed to improve various components of football fitness and improve a player's technique and body control in certain activities which, during a match / training, may increase the risk of injury (tackling , jumping and landing, change of direction , sudden acceleration/deceleration etc.)

(i) pre season

In the studies by Hewett et al (1999) and Heidt et al (2000) , the intervention was introduced as a pre season conditioning program.The injury prevention strategy used Hewett et al (1999) consisted of a 6 week pre season training program aimed at improving strength,flexibility and neuromuscular control during jump & land activities.The study was conducted over a full athletic season with a sample of 799 female high -school soccer, volleyball and basketball players, and a control group of 434 adolescent males.The authors of this study found that this program reduced the total number of serious knee injuries sustained through the following season.Knee injury incidence ,measured per 1000 player exposures, were 0.52 (untrained subjects) and 0.22 (trained subjects).The subjects in this study were not randomly assigned into intervention/control groups and there was no blinding of subjects and assessors to the allocation of intervention.This may have influenced the statistical significance of the findings and as such this study scored poorly on the quality rating scale.

Heidt et al (2000), in a randomized controlled trial , investigated the effects of a 7 week preseason conditioning program on injury incidence in female adolescent footballers.The intervention aimed to improve flexibility, sports specific cardiovascular fitness,lower limb strength and power, with the control group receiving no pre season training.After a 2 season follow up the injury rate of the intervention group(14.3%) was found to be significantly lower than the control group (33.7%) p value of less than 0.05.

(ii) In season

Five studies used a structured warm - up program throughout the season to reduce the incidence of injuries in youth football.Pfeiffer et al (2006) tested a plyometric based conditioning program in female high school footballers.The intervention was implemented in two sessions per week over the course of two football seasons.This study did not find any significant decreases in knee injury

incidence as a result of implementing the intervention.The low number of injuries reported as well as the non - randomized design may have influenced the results of the study.This study also rated poorly on the methodological quality rating scale.

The remaining studies in this subgroup (Kiani et al,2010; Soligard et al, 2008; Steffen et al,2008; Mandelbaum et al,2005; Junge et al, 2002) all showed significant reductions in injury risk when a structured warm - up program is applied. The study by Soligard et al(2008) scored the highest of all studies on the methodological quality rating scale.The authors of this study found a significant reduction in injury risk in the intervention group when compared with the control group.This was particularly evident from the analysis of secondary outcomes i.e

overuse injuries : (2.6 %) intervention group & (5.7 %) control group , (0.012) *p* value ;

severe injuries : (4.3 %) intervention group & (8.6 %) control group , (0.005) *p* value

Values were expressed as percentages of total injuries.Overuse injuries were defined as gradual onset injury without known trauma and severe injuries were defined as injuries causing absence from matches and training for more than 28 days.The intervention used in this study consisted of strength and balance training,active stretching,postural control training, planting and cutting maneuvers for running retraining . Mandelbaum et al (2005) used a similar intervention to evaluate its efficacy in reducing the number of ACL injuries in female soccer players.This study was conducted over 2 years and the intervention consisted of stretching,strengthening,plyometric and soccer specific agility drills.The authors found an 88% (year 1) and 74 % (year 2) reduction in ACL injuries in the intervention group, as compared to the control group.This study scored relatively low on the methodological quality rating scale but the researcher found this to be mitigated by the use of a large sample size (n= 2946) as well as age and skill level matching of the intervention and control groups

2.11.2 (b) Balance and Proprioceptive Training

Malliou et al (2004) investigated the effects of a balance and proprioceptive training program on lower limb injuries in a sample of 100 youth footballers.Participants performed various balance exercises twice a week , with sessions lasting 20 minutes each.The control group did not receive any extra balance training but followed all other training regimes of the intervention group.This study showed significant differences between the intervention group (68 injuries) and the control group (88 injuries) with regard to the incidence of lower limb injuries, more specifically when injuries of moderate severity (absence from matches/training for 1 - 2 weeks) were analyzed. The results from this analysis was 11 % (intervention group) and 24 % (control group) .This study scored poorly on the study quality rating scale (50 %), largely owing to the non - randomized study design used and non - blinding of outcome assessors to the intervention protocol and intervention subjects.The RCT by McGuine et al (2006) scored higher on the study quality rating scale (66.7 %).The authors of this study investigated the effect of a balance training program on the risk of ankle sprains in high school athletes(soccer and basketball)The intervention consisted of a 5 phase progressive ankle stability program implemented through a full athletic season.The results of this study demonstrated a reduction in the incidence of ankle sprains when the intervention was applied: 1.87 ankle sprains/1000 athlete exposures (control group) & 1.13 ankle sprains/1000 athlete exposures (intervention group) $p = 0.033$.

The authors did however note some limitations to the study i.e recall bias (injuries were self reported) and a lack of blinding of the study subjects to the intervention.

2.11.2 (c) Multimodal Intervention

Elias et al (1991) assessed the effects of emergency preventive measures to prevent heat exhaustion in youth footballers. The study was conducted during a 6 day football tournament and the intervention consisted of education and various game and environmental modifications .Information on heat injury prevention was given to coaches,officials and referees, prior to the tournament.Game

modifications (shorter match duration, unlimited substitutions) and environmental modifications (players were sprayed with water) were introduced on the third day of the tournament.The authors found fewer heat related injuries ,21 cases (day 1 - 2) and 13 cases (day 3 - 6) , as a result of the interventions, when compared with similar studies.However, due to the short duration of the study (6 days) and limited number of heat related injuries (n = 34), the study lacked statistical power and further investigation into the efficacy of the interventions is warranted.

2.11.3 Compliance

Compliance can be defined as a measure of the accuracy and consistency with which the specified intervention is implemented by the study subjects .Junge et al (2002); Malliou et al (2004),Heidt et al (2000) and Elias et al (1991) did not report any monitoring or analysis of compliance , although in the study by Junge et al (2002) participants were supplied with instructional material and outcome assessors supervised 1 intervention session per team per week.The studies that did report on compliance used one / a combination of three definitions by which to measure compliance.

These were :

training session compliance - the percentage of training sessions in which the intervention was used (Kiani et al,2010; Soligard et al,2008;Steffen et al,2008)

participant compliance - the percentage of participants adhering to the intervention protocol (Soligard et al,2008; Steffen et al,2008; McGuine et al, 2006; Hewett et al, 1999)

team compliance - the percentage of teams adhering to the intervention protocol (Mandelbaum et al, 2005)

The study by Kiani et al (2010) on the prevention of soccer -related knee injuries demonstrated a compliance rate of 97.9 % .Compliance was monitored and recorded by the coaches in the study using a compliance rating scale designed by the authors of this study.Compliance was estimated at

either < 50% ; =50% ; ≤75 % or between 76% and 100%.Education of the relevant role players(coaching and conditioning staff, players) on the purpose and benefits of the study as well as reference material for participants to access were provided during the study period.The outcome assessors also monitored the application of the intervention through weekly on - site visits. These measures were implemented to enhance compliance.The authors also noted that the high compliance rate may also have been due to the fact that the intervention was easily incorporated into regular training.A one- year follow up found that 44% of the teams included in the study continued to use some components of the intervention and 19% of the teams continued to use the intervention in its entirety.

McGuine et al (2006) in their study defined non - compliance as missing 4 consecutive intervention sessions, with 8.7 % of the intervention subjects being classified as non - compliant resulting in a 91.3% compliance rate.The study data extracted from the non-compliant subjects was included in the data analysis.Instructional material was given to the players ,coaches and parents at pre season meetings and the authors surmised that the parent involvement significantly influenced the compliance rate. Steffen et al (2008)studied the effect of a structured warm up program on the incidence of injuries in female youth footballers.Coaches of the relevant teams were requested to complete compliance forms detailing the duration of each intervention session and the number of attending players.The coaches also completed a training course , which instructed them on the theory and practice of the intervention program as well as how to teach this program to the players . Teams in the intervention group were visited 4 times during the study period and regular contact was maintained via email/ telephone and/or on site visits.Despite all these measures to enhance compliance the authors found a compliance rate of only 52%, with the average player only completing 15 intervention sessions out of a possible average total of 44 sessions. The authors defined compliance as subjects who completed at least 20 intervention sessions and non - compliance as subjects who completed less than 20 intervention sessions. When these subgroups were analyzed for the effect of compliance on the risk of injury, the authors found no difference in

the incidence of overall injuries between the subgroups , or between the compliant subjects and the control group:

control group (3.7) ; intervention group (3.6) ;

compliant subgroup (3.4); non compliant subgroup (3.8)

Injury incidence was expressed as injury per 1000 exposure hours with a confidence interval of 95 %.The authors attributed the low compliance to the relatively low average training frequency of the study teams (3 days per week) and lack of motivation on the part of the participants.

2.11.4 Study Subject Profile

Seven of the studies included in this review observed female subjects exclusively Kiani et al,2010; Soligard, et al, 2008 ; Steffen, et al,2008 ; Pfeiffer et al, 2006; Mandelbaum, et al, 2005; ; Heidt et al, 2000) . Hewett, et al , in their study used a sample of adolescent males as control.Male subjects were observed in the studies by Junge et al (2002) and Malliou et al (2004), while the remaining 2 studies (McGuine et al ,2006;Elias, et al, 1991) studied samples of male and female subjects.The age range for the majority of the studies was 13 - 19 years and only one study (Elias et al ; 1991) included subjects between the ages of 9 - 12 years. McGuine et al (2006) found that gender had no significant effect (p= 0.565) on the incidence of ankle sprains in the study sample .However the female subjects in this study did outnumber the male subjects by a ratio of 2 : 1, creating an imbalance in the gender - matching of subjects which may have impacted on these results.

2.11.5 Implementation

Ten of the eleven included studies implemented a structured training protocol to reduce injury incidence.60% percent of these studies implemented the respective protocol throughout the football season, with 20 % of the studies implementing the protocol during the pre season.McGuine et al

(2006) and Steffen et al (2008) implemented their strategies during the pre - and in - season periods.The intervention sessions had a mean duration of 23.6(± 5.6) minutes ($p < 0.05$)

2.12 DISCUSSION

The incidence of injuries in youth football has been widely described in several studies (Schwebel, et al 2007; Price, et al. 2004; Junge, Edwards & Dvorak, 2004; Junge, et al. 2002; Junge, Chomiak & Dvorak, 2000; Dvorak & Junge, 2000; Peterson et al. 2000; Hawkins & Fuller 1999). This data is crucially important when designing injury prevention strategies as in order to prevent an occurrence of an event, the nature of that event has to be described and understood.It is only once this is achieved that strategies to prevent /limit the occurrence of that event may be tested and described comparatively(Van Mechelen et al, 1992).The studies included in this review reported injury incidence rates varying from 0.4 to 35 injuries per 1000 hours of exposure .As discussed there was some variance ,amongst the included studies, in the definition of injury and severity as well as data collection methods . This variance may explain the wide range in incidence rates reported.Injury prevention strategies generally aim to reduce injury incidence by the modification of various intrinsic(age, gender, fitness level etc.) and extrinsic factors(playing time, playing surface, rule changes etc.)These factors were delineated in a model of potential causative factors for injury first described by Meeuwisse et al (1994)The majority of the studies in this review (91 %) implemented an injury prevention strategy which focussed on modifying intrinsic factors and 80% of these studies used a multi component neuromuscular control (NMC) program as intervention.These programs consist of exercises designed to improve flexibility, strength,power, sports specific agility as well as enhance postural control (jumping and landing activities) and running technique . Kiani et al (2010) Soligard et al (2008), Pfeiffer et al (2006), Mandelbaum et al(2005) Heidt et al (2000), Hewett et al (1999) reported significant reductions in injury risk when implementing this type of injury prevention strategy in youth football.Activities such as tackling, sudden deceleration or change of direction have been shown to increase the risk of sustaining ACL

injuries (Benjaminse et al,2010; Kiani et al,2010; Fauno et al, 2006; Mandelbaum et al, 2005).This is thought to be due to the increased valgus and high torsional stress experienced at the knee during these activities.These types of injuries can lead to prolonged absence from football as well as expensive medical treatment.The NMC training programs have been designed specifically to increase a player's postural control during these activities, thus reducing the risk of ACL injuries when performing these maneuvers.The NMC training programs also incorporate sport specific drills which can be integrated into the teams' regular training with relative ease. McGuine et al (2006) and Malliou et al (2004) implemented a balance and proprioceptive training program as intervention in their respective studies.These studies reported significant reductions in injury incidence,however, the prevention strategies implemented focussed on the reduction of specific injury types and required the use of relatively expensive equipment.

Compliance has been proven to be a significant factor in the success of injury prevention trials(Kirkendall et al, 2010).Generally interventions with a high compliance rate showed significant reductions in injury incidence (Kiani et al, 2010; Soligard et al, 2008 McGuine et al,2006; Mandelbaum et al, 2005; Hewett et al,1999). McGuine et al (2006) reported a 91 % compliance rate with a 38% reduction in the incidence of acute ankle sprains .Mandelbaum et al(2005) in their study reported a 100 % compliance rate with an 88% reduction in ACL injuries.In the study by Hewett et al (1999) the authors reported an 85% compliance rate and the incidence of serious knee injuries was reduced by 72%.Conversely , the study by Steffen et al (2008) reported a 52 % compliance rate and found no significant difference in injury incidence when comparing the intervention and control groups . Junge et al(2002) reported significant reductions in injury incidence , 11.1 injuries per 1000 hours exposure (control group) to 6.95 injuries per 1000 hours exposure (intervention group) when implementing a NMC training program as prevention strategy.However , when the study groups were matched for skill level , these results were only found in the low skill level group and not replicated in the high skill group (6.78 injuries per 1000

hours exposure - control group, to 6.35 injuries per 1000 hours exposure - intervention group). The authors of this study surmised that a lower training - to - match ratio in the low skill level group as compared to the high skill level group may lead to low skill level teams being inadequately prepared for the physical demands of a match. However,Dvorak et al (2000), in a risk factor analysis on injuries in football players, reported that poor endurance was the only performance variable to have an effect on injury incidence.

2.13 CONCLUSION

The purpose of this review was to evaluate the injury prevention strategies currently used in youth football.The researcher found very few eligible studies,11 out of a potential 107.This appears to be consistent with the findings of similar studies (Frisch et al, 2009; Abernathy & Bleakely, 2007; Olsen et. al ,2004) .None of the studies in this review were conducted in developing countries and very few used male youth footballers as study subjects.This is alarming as a recent report by FIFA lists adolescent males as the most numerous football playing demographic (FIFA, 2010).This would indicate that the prevention strategies currently in use have not been tested on the demographic in which it would most frequently be applied . The existing evidence would suggest however, that a structured NMC training program is best suited to reduce injury incidence in youth football players.These programs provide a combination of strength,power,endurance ,flexibilty, postural control and sports specific skills training .These components,together with the implementation of the program throughout the season (and possibly the pre- season) seem to provide youth football players with the most effective protection against injury.

Implementing these strategies throughout the football season allows the player a greater time frame in which to adopt and perfect its application.The results of previous studies have shown the importance of a high rate of protocol compliance in achieving significant reductions in injury incidence.Football, as a team sport, has structured , time - defined activities which facilitate the incorporation of active injury prevention strategies.As such, challenges with compliance can be

overcome with peer assisted correction and co operation from parents, coaches and training staff.The paucity of research is alarming , but this review may highlight possible areas for future research in youth football.

2.14 SUMMARY OF THE CHAPTER

This chapter reviewed the relevant literature regarding injuries among youth footballers.It further outlines the procedures used and the results of a systematic literature review regarding injury prevention strategies in youth football.An alarming finding was that none of the studies were conducted in developing countries. The methodology used to collect baseline data, i.e to establish the prevalence of injuries and to establish if a link exists between exposure time and injury occurrence in youth academy football players, is discussed in the following chapter.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION TO THE CHAPTER

This chapter outlines the methods used to reach the first objective of the study as stated in chapter one.It describes the research setting,design,study sample as well as the research instruments used.It further outlines the procedure and ethical considerations.

3.2 RESEARCH SETTING

Ajax Cape Town Football Club (ACTFC) Youth Academy is the youth division of a professional club competing in the Premier Soccer League of South Africa.The club was established in 1999. It is modeled after the Association Football Club Ajax(AFC Ajax) of Amsterdam ,Holland and serves as one of its many feeder clubs.ACTFC also implement the training and player scouting principles utilized by AFC Ajax.The ACTFC scouting network comprises of coaches and ex players who recommend talented youth footballers for trials at the ACTFC academy . Scouting is done nationally with a specific focus on the Western Cape province. Prospective youth players are invited to trials via these scouting networks and assessed (by ACTFC coaches) according to various criteria, among which are: fitness,skill and trainability. Successful trialists are then integrated into the various academy teams which are grouped according to chronological age into 5 squads i.e under 11, under 13, under 15, under 17 and under 19 years.

3.3 RESEARCH DESIGN

The study design was that of a retrospective cohort . There is a challenge regarding recall bias when using a retrospective design (Fuller, et al 2006).The researcher asserts that this challenge was overcome in the study as the data was collected by the academy staff at the time of occurrence.The academy staff are all well versed in using the data collection forms as it has been in use at the academy since 2007.The effect of recall bias could have been further diminished if individual exposure data was collected as originally planned.However, this proved unsuccessful due to an unwillingness of the coaches to record the data. A retrospective design was settled on for ease of use.Notwithstanding the above mentioned challenges,this type of study design was deemed appropriate for investigating a perceived link between exposure time and injury occurrence.

3.4 STUDY POPULATION AND SAMPLING

The researcher included all youth football players registered at Ajax Cape Town Football Club Youth Academy for the seasons spanning July 2009 to April 2011 as participants in the study. There were 5 youth squads at the academy grouped according to the following chronological ages; 11 yrs, 13 yrs, 15 yrs, 17 yrs, and 19 yrs. The squads consisted of a maximum (under 19) of 28 players and a minimum (under 11) of 14 players, with the mean number of players per squad being 22 players (± 5 players)

Table 3.1 ACTFC Youth Academy Team Classification

team	mean number of players	total players in squad 2009/2010	total players in squad 2010/2011
U 11	14	15	13
U 13	19	18	20
U 15	25	25	25
U 17	25	25	25
U 19	28	29	27
total	111	112	110

3.4.1 Inclusion Criteria

All consenting players between the ages of 9 and 19 years, who were registered at the Ajax Cape Town Football Club Youth Academy during the defined study time.

3.4.2 Exclusion Criteria

Players who were in the defined age range during the study but were playing / training with the senior team were not be included in the study.

Injuries sustained outside scheduled team training/ matches were not included in the study.

Individual training sessions were not included in the study as it was difficult to standardize and may not have been documented.

Matches and training with the national teams were not included as data could not be obtained for these events

3.5 RESEARCH INSTRUMENT

UEFA (Union of European Football Associations) Medical Committee initiated a research project in 1999 to develop an optimal method for descriptive epidemiological studies on football , as well as to develop a football specific injury reporting system.(Hagglund et al 2005) In 2006, the Federation Internationale de Football Association Medical Assessment and Research Centre (F-MARC) convened an Injury Consensus Group comprised of experts involved in the study of football injuries (Fuller et al 2006).The aim of this group was to expand and refine the research of the UEFA project and distribute the findings globally .The data collection forms used in the current study were first designed by the UEFA model and later refined by the F - MARC Injury Consensus Group during their discussions.

These forms comprised of :

- Pre - competition medical assessment form

  This form included data such as age, playing position, dominant throwing / kicking limb, anthropometric data etc. to establish baseline medical and injury information.

- Injury reporting form

  This form included information on the nature and location of injury, type of injury, mechanism and duration of injury, context of injury (match / training) and diagnosis. Diagnoses were recorded by the team physiotherapist using the Orchard Sports Injury Classification System(Orchard, 1995)

- Exposure reporting form

  This form consisted of data on the number of hours spent training / playing per player/team

3.6 PILOT STUDY

A pilot study was conducted during the preseason (3 months) to assess the accuracy and consistency of data recording.Two teams (under 19 & under17) as well as the academy medical and coaching staff participated in the pilot study..The validity and reliability of the reporting forms were also tested through monthly workshops with the academy medical staff.These workshops identified a need for further training on the use of the Orchard Sports Injury Classification System (OSICS). Instructional leaflets and posters were designed by the researcher as reference for the medical staff to aid in understanding and consistent application of the OSICS. The injury reporting forms were also assessed by two independent sports medicine professionals on a weekly basis.

However only 1 of the 5 teams consistently recorded individual match exposure times i.e substitution times etc.The researcher then conducted another information session with the coaches and staff at the academy to ascertain the reasons for the poor recording of data.The coaches all pointed to an extra administrative load as well as the recording of data being a distraction from game analysis, which is a coach's primary function during a match.It was then decided to record exposure data on a team level to ease the administrative load on the coaches .

3.7 VALIDITY

Validity can be defined as the extent to which an instrument measures what it was designed to measure (Sarantakos, 2005).The validity of the reporting forms was ensured through debate among experts in the field of football injury prevention and management, as described in the UEFA Medical Committee Research Project and F-MARC Consensus Statement (Hagglund et al. 2005; Fuller et al. 2006)

3.8 RELIABILITY

Reliability is referred to as the ability of the instrument to produce consistent results when the measurement is repeated at more than one occasion (Sarantakos, 2005).

Several studies were conducted to test the reliability of the reporting forms (Hawkins & Fuller, 1999 ; Junge & Dvorak, 2000 ; Hagglund et al, 2001; Junge, Dvorak , Graf - Baumann ,2001 ; Junge,Dvorak, Graf - Baumann et al. 2004; Walden et al, 2005).During the pilot study , two independent medical professionals reviewed the injury reporting forms to assess the reliability of the forms. These professionals found the reporting on injury description to be accurate, thus verifying the reliability of the instruments.

3.9 PROCEDURE

The researcher provided a presentation (pre data extraction) to the medical and coaching staff of ACTFC youth academy. This included a discussion on the aims of the research, the procedure as well as the perceived benefits of the study. This was to ensure an understanding of the relevance of the study, promote participation and compliance with regards to access to the relevant information. ACTFC have an on-site database where all the relevant data of all registered players is stored and updated.Data was obtained from this database for two complete football seasons from July 2009 to July 2011. The inter tester reliability of the reporting forms was assessed by four academy physiotherapists in a pilot study conducted during the pre season. At the beginning of each season players underwent a brief pre-season medical screening conducted by the academy physiotherapists. This was documented on a pre-competition medical assessment form developed by F-MARC.. This form included data such as age, playing position, dominant throwing / kicking limb, anthropometric data etc. to establish baseline medical and injury information.Injury data was recorded on validated F - MARC injury reporting forms(Fuller, et al 2006; Junge, et al 2004; Hawkins & Fuller 1999) The forms include information on nature and location of injury, type of injury, mechanism and duration of injury, context of injury (match / training) and diagnosis. Football exposure was divided into training exposure and match exposure.Training exposure was recorded by the academy biokineticist by means of attendance sheets as training times are standardized for each age group.Training exposure was calculated per team using the attendance

sheets to calculate mean attendance rates per team. The researcher then transcribe the attendance data,during a weekly site visit, onto the validated F - MARC training exposure form(Fuller et al 2006; Junge, et al 2004; Hawkins & Fuller, 1999). Match exposure was calculated from the weekly match schedule , relative to the amount of players on the field during a match .Matches played during team training sessions or against teams from within the academy were categorized as training exposure rather than match exposure. General stoppages during a match, match sanctions(red cards); substitutions (injury enforced / tactical) and time of substitutions were not recorded.

3.10 DATA ANALYSIS

Analysis of data was done using the Statistical Package for Social Sciences (SPSS) version16 . Descriptive data was expressed as means (*n*), percentages (%), frequencies and standard deviations(± *sd*). Inferential statistics (chi -square analysis) was used to determine if correlations exist between injury occurrence and demographic factors and exposure time. An alpha level was set at 0.05. Relative risk (R.R) was calculated with a 95% confidence interval (C.I) and significance set at ($p < 0.05$)

The players at the academy were grouped into 5 teams classified by chronological age i.e. under 11; under 13; under 15;under 17 and under 19.These teams were collapsed into 3 categories to assess the effect of the adolescent growth spurt on injury incidence. these categories were:

under 13 (u13) = under 11 plus the under 13 team ,

under 15&17 (u15&17) = under 15 plus the under 17 team ,

under 19 (u 19)

Match exposure was calculated according to the formula : (Nm × Pm × Dm) /60

Where Nm = number of matches played ; Pm = the number of players in the team during a match; and Dm = the duration of matches in minutes (Fuller et al,2006)

Training exposure was calculated according to the formula : (Nt × Pt × Dt)/60

Where Nt = number of training sessions; Pt = the mean training session attendance;

and Dt = the duration of training sessions in minutes (as adapted from Fuller et al,2006)

Incidence rates were expressed as injuries per 1000 hours exposure per player/ team / category. Extra or reduced playing time and reduced playing numbers due to red cards and other stoppages were not accounted for as this data was not available .

3.11 ETHICAL CONSIDERATIONS

Ethical approval to perform the study was granted by the Higher Degrees Committee of the University of the Western Cape .Written permission to use the relevant data and conduct the study was obtained from the players, parents/guardians as well as from the head of the Ajax Cape Town Football Club Youth Academy,prior to commencing the research.When registering at the ACTFC Youth Academy, players and / or their parents /legal guardians sign a document permitting use of all information collected by the academy medical and coaching staff in any research conducted at the academy and sanctioned by the head of the ACTFC Youth Academy.Strict adherence to anonymity and confidentiality was maintained throughout the study period .Data sheets were coded and did not contain any personal identifying information of the participants.The data sheets remained in a locked filing cabinet in the office of the head of medical sciences at Ajax Cape Town Football Club.The researcher and academy medical staff had sole access to this cabinet. All participants were assured of their rights to withdraw from the study at any time without incurring any negative ramifications.The results of the study will be made available to the academy staff , players and parents / guardians at an information session, which is to be scheduled on completion of the research.

3.12 SUMMARY OF THE CHAPTER

This chapter outlined the methods used to obtain data for the first objective of the study, i.e to collect baseline information regarding injuries among youth football players at the ACTFC Youth Academy .The next chapter will present the findings of the data analysis and a discussion of the results.

CHAPTER 4

RESULTS

4.1 INTRODUCTION TO THE CHAPTER

This chapter presents the results of the statistical analysis which attempted to reach the first objective of the study,as indicated in chapter one.

4.2 DESCRIPTION OF STUDY SAMPLE

The Ajax Cape Town Football Club youth academy consists of 5 squads grouped according to chronological age i.e under 11, under 13, under 15, under 17 and under 19 years.The teams compete in divisional leagues of the Tygerberg Football Association, under the auspices of the South African Football Association (SAFA).All teams (except the U11 and U 19 teams) train once a day from 16h00 to 18h30, with Wednesday being a rest day and 1-2 matches on the weekend. The U 11 team trains once a week between 15h30 and 17h00, with 1 match on a Saturday. The U 19 team can train twice a day for 2 days of the week with a maximum of 3 matches during the week.There are 3 physiotherapists and 2 biokineticists who work with the academy players exclusively. A sports physician spends one afternoon per week at the academy and is consulted on an ad hoc basis.

The incidence of football injuries at the Ajax Cape Town F.C youth academy was observed over a period of two full seasons , from June 2009 to April 2011. The mean number of players registered at the academy during this time was 111 (± 2 players),with an average dropout rate of 5%.Teams at the academy aim to keep the number of players per squad consistent , therefore a replacement was registered from the feeder clubs for every player that left the academy. The injury data for both new recruits and dropouts were included in the analysis.The players ranged in ages from 9 -19 years with a mean age of 13,8 years (± 3.3 years).

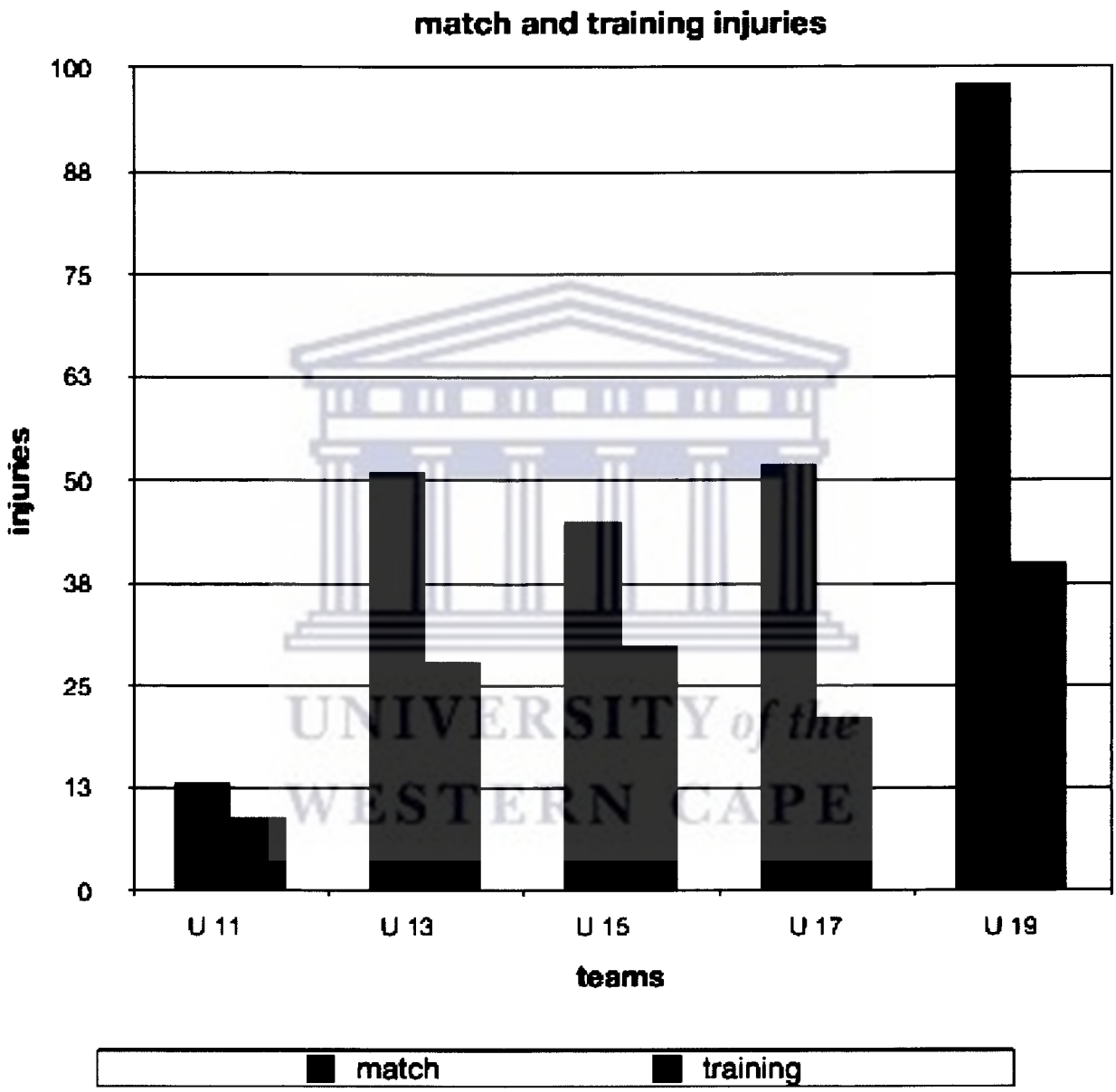
4.3 INJURY INCIDENCE

A total of 387 football injuries occurred during the study period.This was further subdivided into 259 match injuries and 128 training injuries. Injury incidences for all team groupings are represented in Tables 4.1 & 4.2 , and Figures 4.1 & 4.2. Injury incidence rates were generally expressed as injuries per 1000 hours exposure per group.

Table 4.1 Match and Training Injuries

team	mean number of players	injuries		
		match	*training*	*total*
U 11	14	13	9	22
U 13	19	51	28	79
U 15	25	45	30	75
U 17	25	52	21	73
U 19	28	98	40	138
totals	111	259	128	387

Figure 4.1 Match and Training Injuries



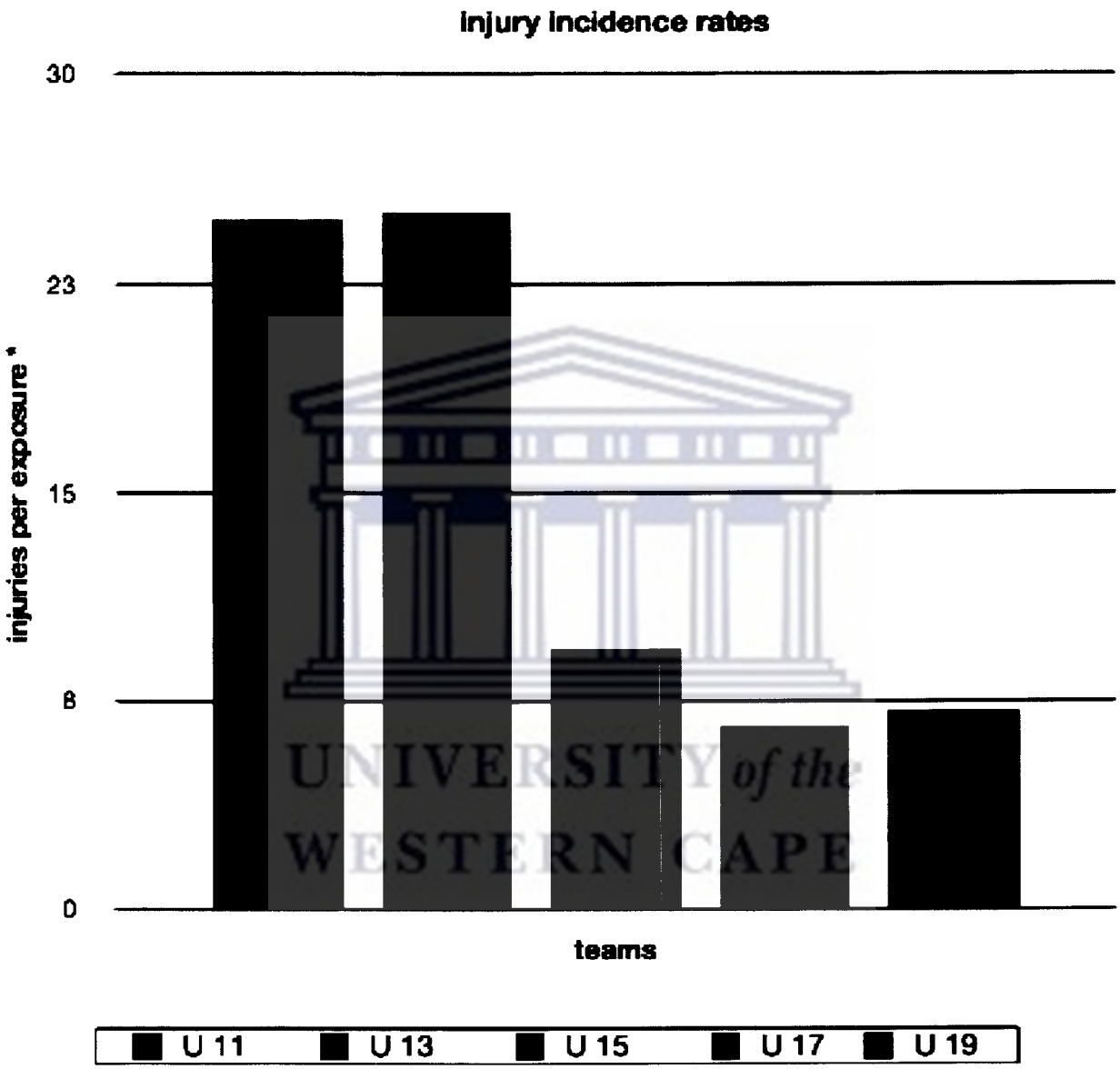
The total injury incidence rate at the academy was 9.12 injuries per 1000 hours exposure per player.Match injury and training injury incidence rates were 55.50 injuries per 1000 hours exposure; and 3.39 injuries per 1000 hours exposure respectively.

Table 4.2 Injury Incidence

team	mean number of players	injuries per exposure per team*		
		match	*training*	*total*
U 11	14	60.75	13.40	24.83
U 13	19	116.01	10.30	25.05
U 15	25	56.82	4.16	9.38
U 17	25	44.30	2.11	6.57
U 19	28	47.90	2.32	7.15
totals	111	55.50	3.39	9.12

**injuries expressed as injuries /1000 hrs exposure*

Figure 4.2 Injury Incidence Rates



**injuries expressed as injuries /1000 hrs exposure*

4.4 EXPOSURE

The number of matches and training sessions are represented in Tables 4.3 & 4.4 and Figure 4.3.

The u15 & 17 category played the most number of matches (n = 76; 36.55%), followed by the u13 category (n= 70; 33.65 %) and the u19 category (n = 62; 29.80 %) .

The match duration for the u19 category was 90 minutes.The u15 & 17 category had a mean match duration of (70 minutes ; ± 10.19 minutes). The mean match duration of the u13 category was (30 minutes ; ± 14.14 minutes)

The u15 & 17 category completed the highest number of training sessions (n= 264; 43.85%), followed by the u19 category (n= 216; 35.90%) with the u13 category completing the fewest number of training sessions (n= 122 ; 20.25%)

The u13 category had the highest match to training session ratio (1:1.88), followed by the u15 & 17 (1:3.47) and u19 (1: 3.48) categories.

Chi - square analysis showed a significant relationship between injury incidence and exposure time among the categories ($p = 0.001$)

The u13 category had significantly higher injury incidence rates for both match(97.50; $p = 0.02$) and training (10.92 ; $p = 0.01$) when compared with the u15 & 17 , as well as the u19 categories.

There was no significant difference in injury incidence rates between the u15 & 17 and u19 categories ($p = 0.34$)

Table 4.3 Match Exposure

team	mean number of players	number of matches	match duration in minutes	match injuries
U 11	14	40	20	13
U 13	19	30	40	51
U 15	25	36	60	45
U 17	25	40	80	52
U 19	28	62	90	98
totals	111	208	290	259

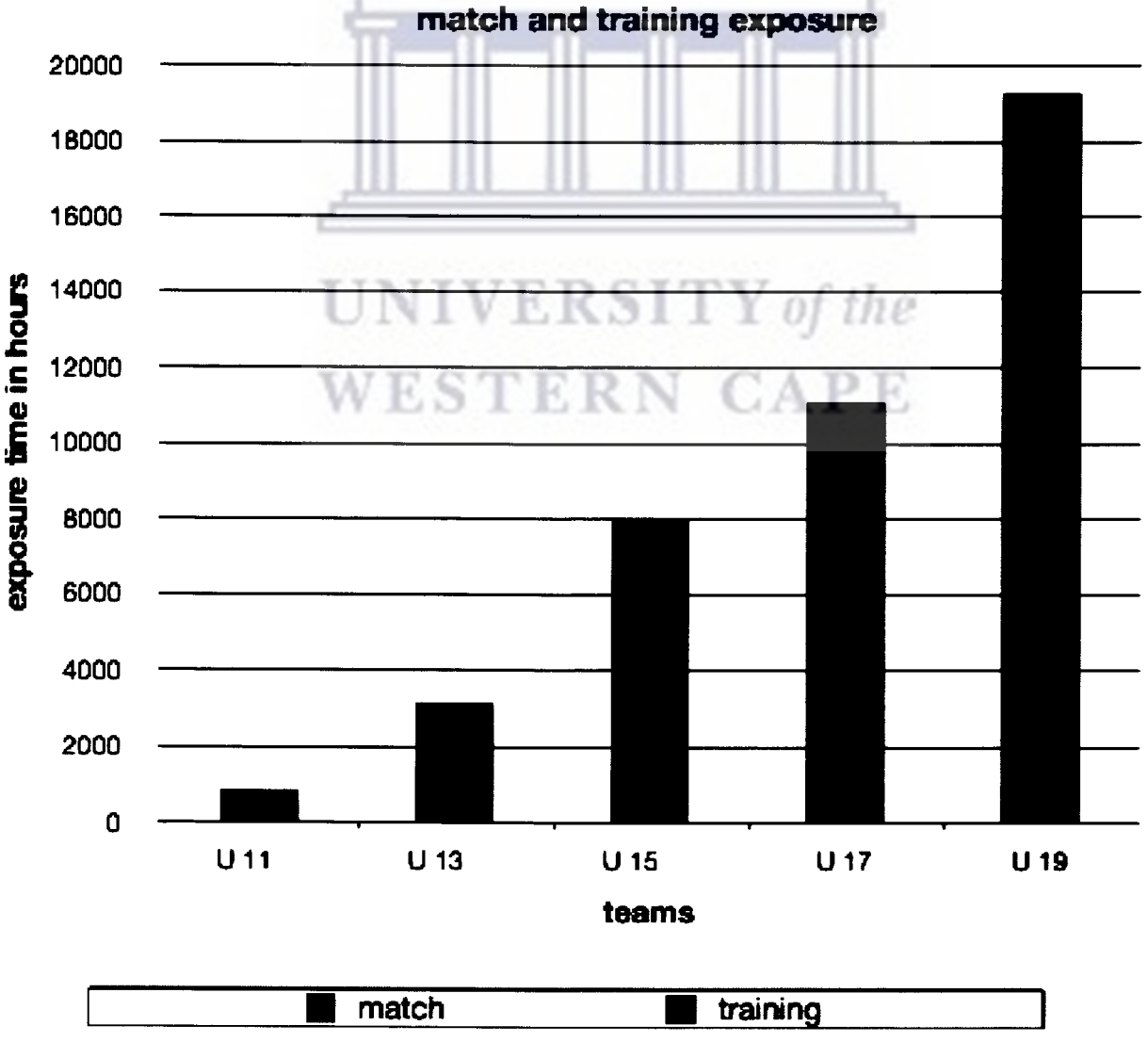
Table 4.4 Training Exposure

team	mean number of players	total number of training sessions	duration of training sessions/week in minutes	training injuries
U 11	14	48	180	9
U 13	19	84	270	28
U 15	25	120	480	30
U 17	25	144	480	21
U 19	28	216	540	40
totals	111	612	1950	128

Table 4.5 Ratio of Match to Training Sessions

	Number of Sessions		Ratio of match to training sessions
	match	*training*	
U13	70	122	1: 1.88
U15 + U17	76	264	1 : 3.47
U19	62	216	1 : 3.48
totals	208	602	

Figure 4.3 Match and Training Exposure



4.5 INJURY CHARACTERISTICS

Injury characteristics were described under the following headings :

injury location; injury type; injury mechanism; injury severity ; and stage of injury and are represented in Tables 4.6 to 4.10.

The injury characteristics (as described under the above mentioned headings) for the Academy as a whole are represented in Figures 4.4 to 4.8

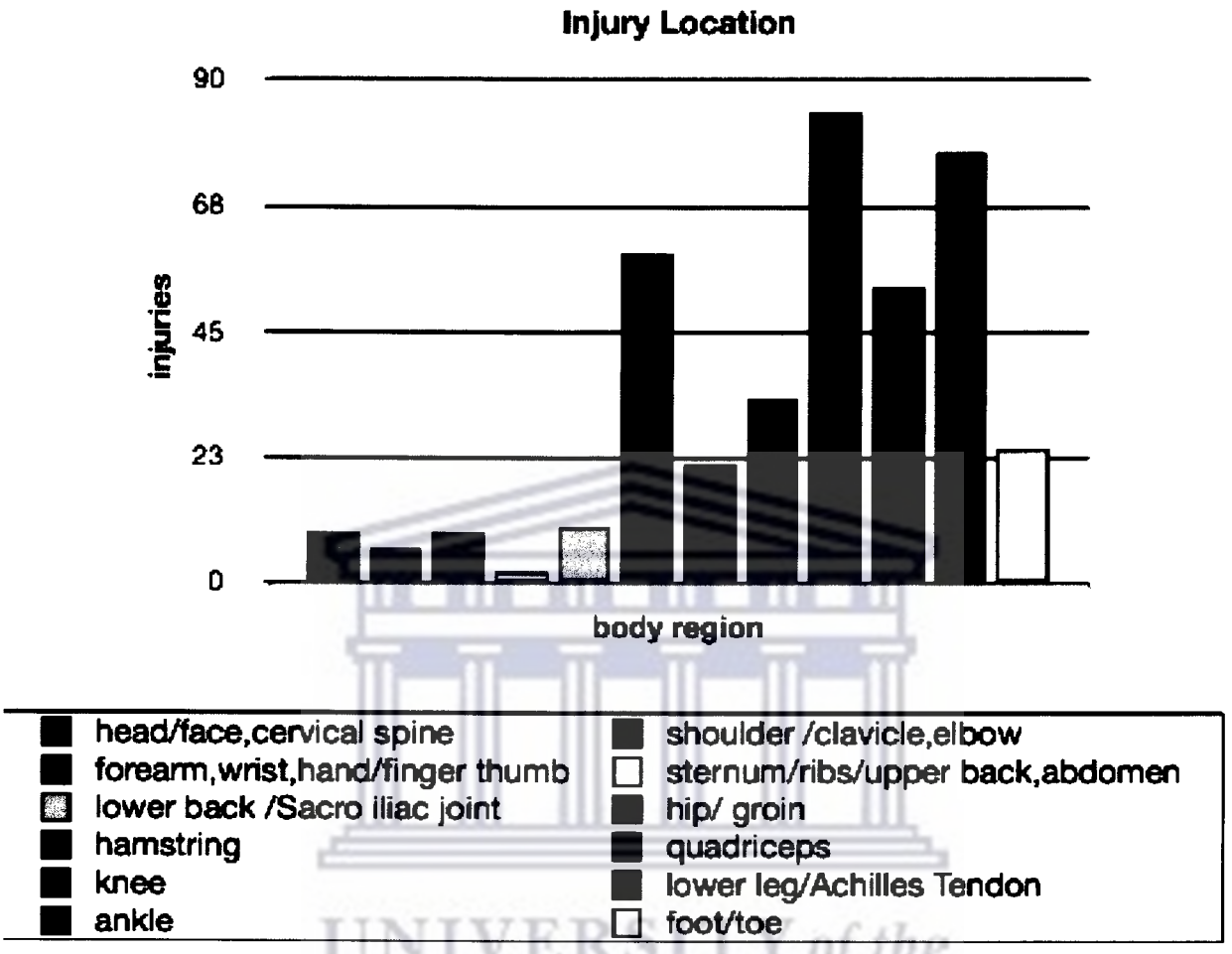
4.5.1 Injury Location

The majority of injuries (93 %) were sustained in the lower limb, of these, the knee(21.70%), ankle (19.89 %), and hip/groin (15.24 %) were the most frequently injured areas. When combined these groups accounted for 56% of all lower limb injuries.The u13 category had a higher risk of sustaining a knee injury than the u15 & 17 category , with R.R = 1.43 ; p = 0.017 and 95% CI (1.09 - 1.87).The u15 & 17 category accounted for 40% of all ankle injuries but there was no significant difference(p = 0.16) between categories.The u15 & 17 category had a higher risk of sustaining an injury to the hip/groin than the u13 category(RR = 1.44 ; p = 0.009; 95% CI 1.16 - 1.79) as well as the u19 category (RR = 1.44 ; p = 0.009; 95% CI 1.16 - 1.79

Table 4.6 Injury Location

team	u11	u13	u15	u17	u19	group totals
injury location						
head/face cervical spine			2	2	5	9
shoulder /clavicle elbow		1	4		1	6
forearm ,wrist hand/finger/ thumb		2	3	2	2	9
sternum/ribs/upper back abdomen		1			1	2
lower back /sacro iliac joint	1	2	3	1	3	10
hip/ groin	1	9	17	9	23	59
hamstring		3	5	2	11	21
quadriceps	2	3	5	8	15	33
knee	8	24	9	14	29	84
lower leg/Achilles Tendon	4	9	10	11	19	53
ankle	4	20	15	16	22	77
foot/toe	2	5	2	8	7	24
total	22	79	75	73	138	387

Figure 4.4 Injury Location



4.5.2 Injury Type

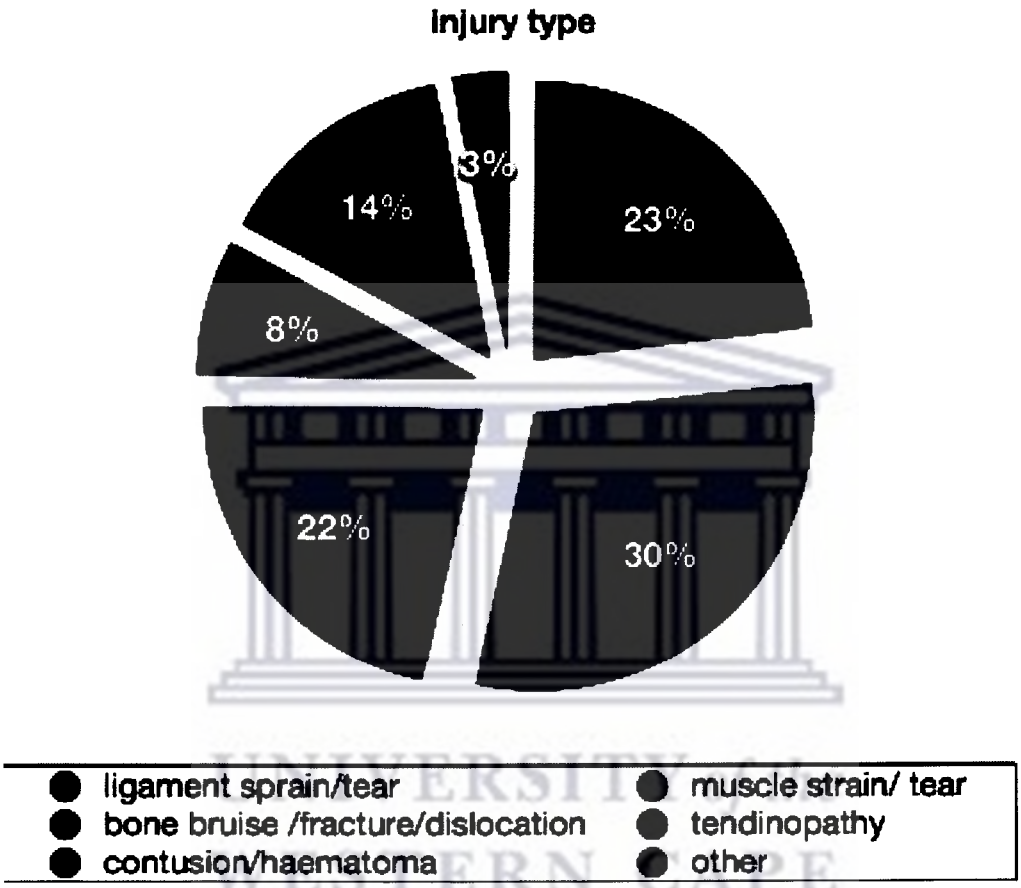
The most common injury type was muscle strain/tear (30.23%) , followed by ligament sprain/tear (23.25%); bone bruise/fracture/dislocation (21.70%); contusion/haematoma(13.95%) and tendinopathy (7.75%).The u15 & u17 category had a higher risk of sustaining a muscle strain/tear than the u13 category(RR = 1.26 ; p = 0.03; 95% CI 1.03- 1.47).Additionally, the u15 & u17 category had a higher risk of sustaining a ligament sprain/tear than the u19 category(RR = 1.26 ; p = 0.04; 95% CI 1.02 - 1.56). The u19 category had a higher risk of sustaining a bone bruise/fracture/dislocation than the u15 & u17 category(RR = 1.35 ; p = 0.01; 95% CI 1.08 -

1.69).There was no significant difference ($p = 0.78$) in the distribution of injuries among the three categories ,with regards to the remaining injury types.

Table 4.7 Injury Type

team injury type	u 11	u 13	u 15	u 17	u 19	total
ligament sprain/tear	3	23	17	25	22	90
muscle strain/ tear	4	14	32	19	48	117
bone bruise /fracture/dislocation	6	20	8	12	38	84
tendinopathy	3	10	4	4	9	30
contusion/haematoma	4	10	12	11	17	54
other*	2	2	2	2	4	12
total	22	79	75	73	138	387

Figure 4.5 Injury Type



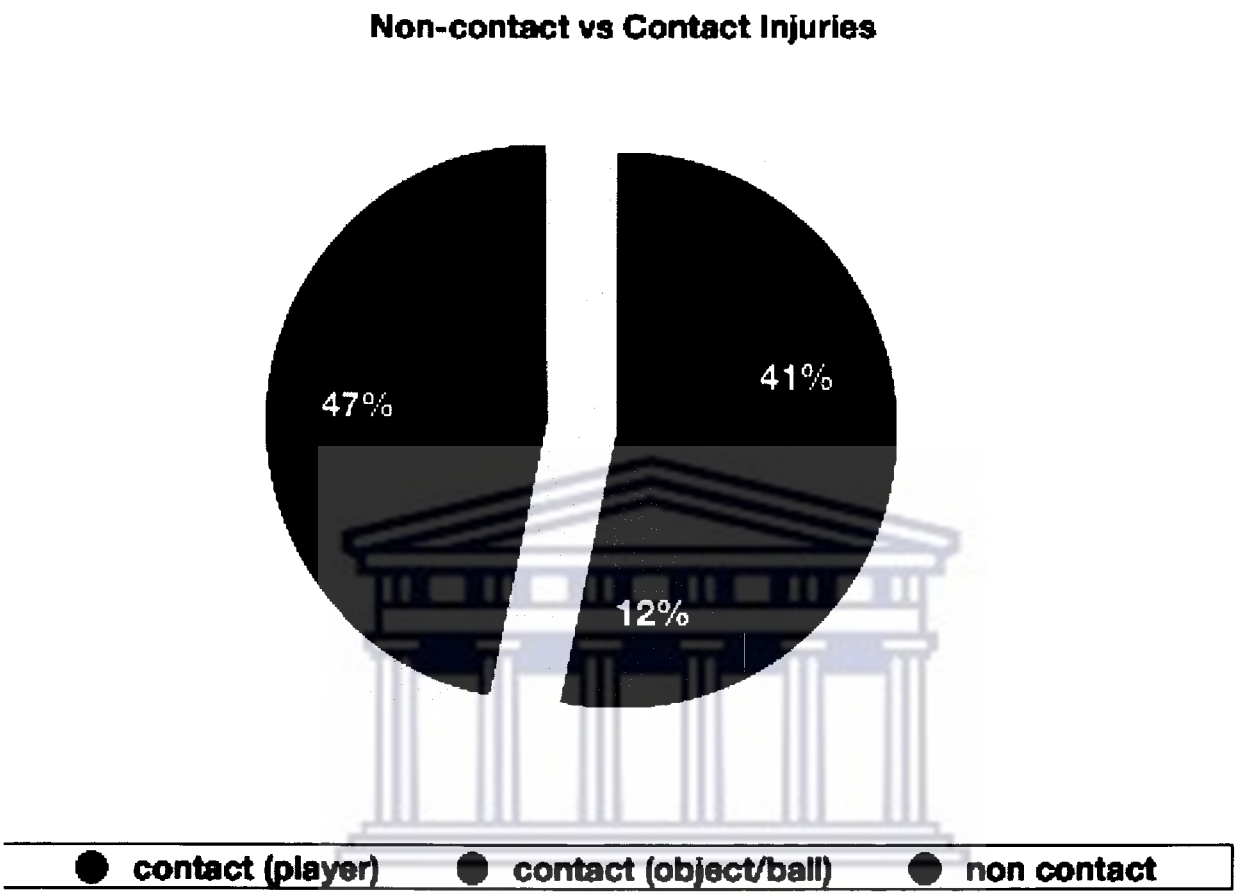
4.5.3 Injury Mechanism

A total of 206 (53.22%) of the 387 injuries were sustained during contact, of these, 75.72 % were sustained during contact with another player (player contact), while 23.30 % were sustained during contact with the ball /another object (ball/object contact). In 181(46.78%) of the injuries sustained there was no contact (non- contact injuries) .The u15 & 17 category sustained significantly more player contact injuries than the u13 and u19 categories ($p = 0.009$; 95% CI 0.02 - 0.27), as well as significantly more non- contact injuries than the u13 category ($p = 0.02$; 95% CI 0.08 - 0.23).

Table 4.8 Injury Mechanism

	Injuries	**non- contact**	**contact**		
team			**total**	player	object/ball
u 11	22	6	16	10	6
u 13	79	35	44	36	8
u 15	75	34	41	29	12
u 17	73	29	44	41	3
u 19	138	77	61	42	19
	387	181	206	158	48

Figure 4.6 Injury Mechanism



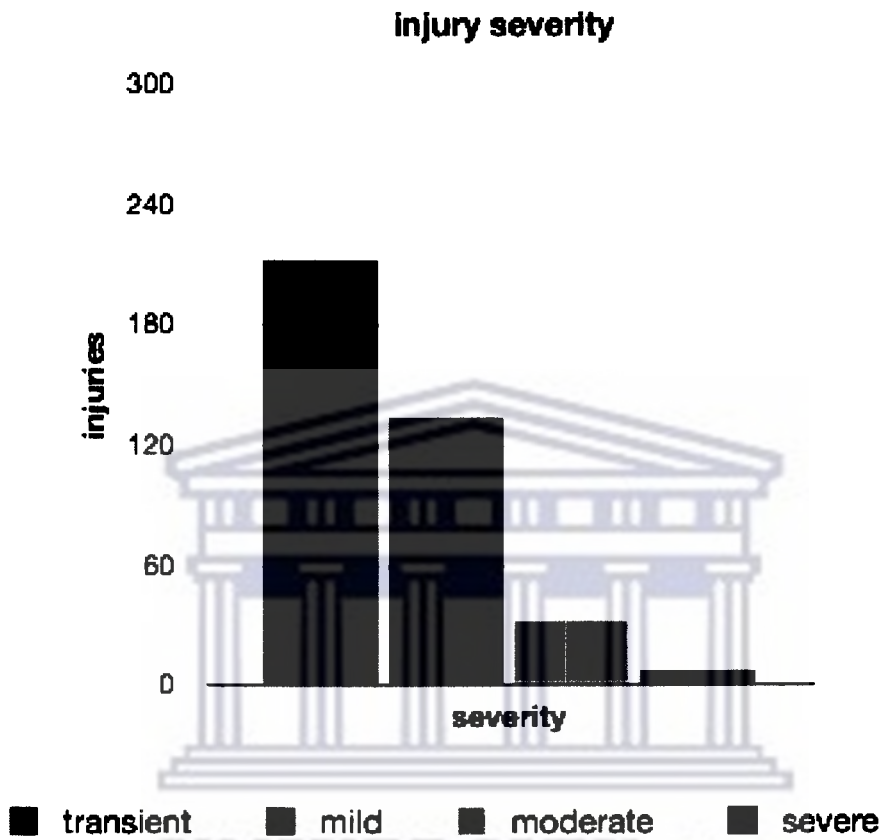
4.5.4 Injury Severity

In the study sample, most (55.03 %) of the injuries sustained were of the transient type , followed by mild (34.62%) and moderate injuries (8.5 %). Only 7 severe injuries were sustained during the study period.

Table 4.9 Injury Severity

severity team	transient	mild	moderate	severe	totals
U 11	21			1	22
U 13	67	10	1	1	79
U 15	55	19	1		75
U 17	30	28	13	2	73
U 19	40	77	18	3	138
totals	213	134	33	7	387

Figure 4.7 Injury Severity



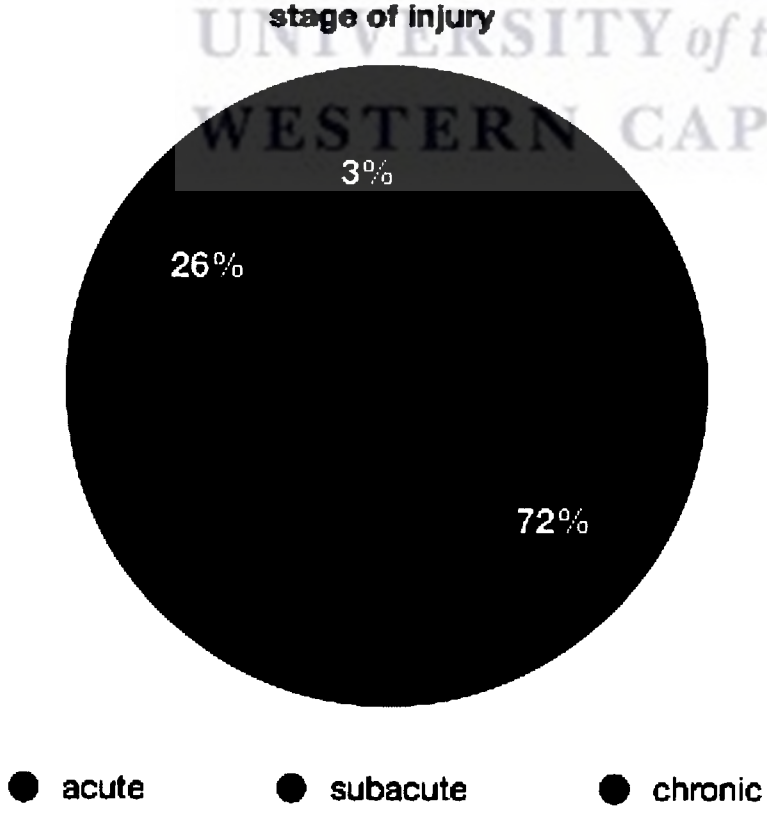
4.5.5 Stage of Injury

A total of 277(71.5%) of all injuries were acute type injuries, 99 (25.6%) were subacute and 11 (2.9%) were of the severe type.

Table 4.10 Stage of Injury

stage of injury	acute	subacute	chronic	totals
team				
u11	22			22
u13	76	2	1	79
u15	69	5	1	75
u17	52	21		73
u19	58	71	9	138
totals	277	99	11	387

Figure 4.8 Stage of Injury



4.6 SUMMARY OF THE CHAPTER

In this chapter the results of the baseline data was presented.A total of 387 injuries were recorded over the study period.Totals of 259 match injuries (injuries occurring during a match) and 128 training injuries (injuries occurring during training) were recorded at the academy during the study period. The total injury incidence rate at the academy was 9.12 injuries per 1000 hours exposure per player.Match injury and training injury incidence rates were 55.50 injuries per 1000 hours exposure; and 3.39 injuries per 1000 hours exposure respectively. The next chapter outlines the procedure used in designing an injury prevention protocol for youth footballers.This protocol was designed based on the systematic literature review (chapter 2) and the results discussed in chapter 4.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION TO THE CHAPTER

This chapter will outline the first phase of the procedure used in designing an injury prevention protocol for youth footballers.This protocol was designed by collating the information gathered from the systematic literature review (chapter 2) and the results discussed in the preceding chapter(chapter 4).

5.2 DEFINITIONS

The definition of injury used in this study was a combination of the time - loss and medical attention definitions.This definition tends to yield higher injury rates as the scope of reporting injury is broader(Bahr,2009). The medical guidelines at the academy also compel players to have all injuries assessed by the academy medical staff,thus leading to a higher number of documented injuries . The definition of injury used in the present study differed somewhat from the literature as most of the studies on injury incidence in youth football use one of the aforementioned definitions , i.e either time loss definition (Le Gall et al, 2008; Soligard et al, 2008; Steffen et al , 2008; Malliou et al,2004; Junge et al, 2002; Hewett et al, 1999) or a medical attention definition(Kiani et al,2010; Elias et al, 1991)

McGuine et al (2006) investigated the effect of a balance training program on the risk of ankle sprains in high school athletes(soccer and basketball) using a combination of the time loss and medical attention definitions of injury.The authors of this study reported a total rate of 1.51 injuries per 1000 athletic exposures, although this study focussed exclusively on the rate of ankle injuries as outcome measure.

5.3 INJURY INCIDENCE

The overall injury incidence rate at the academy, reported in this study (9.12 injuries per 1000 hours exposure) was higher than the findings of similar studies(Johnson et al, 2009; Soligard et al, 2008; Steffen et al , 2008; Junge et al, 2002)The present study reported a significantly higher injury rate in the U13 category(25 injuries per 1000 hours exposure) as compared to the u15 &17 (7.74 injuries per 1000 hours exposure) , and u 19 categories(7.15 injuries per 1000 hours exposure).This relationship was also evident when comparing the match and training injury rates of the respective categories.

5.4 EXPOSURE

There was some disparity in the exposure times of the three categories.Regarding match exposure, there was no significant difference in the number of matches played by the respective categories, however the match duration of the u13 category (n= 30 minutes ; ± 14.14 minutes) was significantly lower than that of the u15 & 17 (n= 70 minutes ; ± 10.19 minutes)and u19 categories (n= 90 minutes).The u13 category also had a significantly higher risk of sustaining an injury during match play than the u15 & 17 and u19 categories. The u13 category players completed half as many training sessions as the u15 &17 and u19 category players respectively.Additionally, the u13 category players had a significantly higher risk of sustaining an injury during training than players in the u 15 & 17 and u19 categories.There were no significant differences in the risk for training and match injuries in the u15 & 17 and u19 categories.These findings would suggest an inverse relationship between exposure time and age versus injury incidence in the sample of the present study.However , there is conflicting evidence in the existing literature as to how age and exposure time affects injury incidence in youth football.Johnson et al (2009);Le Gall et al(2008); Emery et al (2005); Volpi et al (2003); all reported increased risk of injury in younger age groups in studies on youth football players. Le gall et al(2008) reported that , in their study, the under 15 age group had

a higher incidence of injury compared to the under 19 age group. Volpi et al (2003) in a study on the major traumas in youth football also reported a higher incidence of injury in the age group 13 - 16 years, as compared to the 9 - 12 years and 17 - 19 years age groups.Conversely Price et al(2004) and Stuart et al (2002) reported that the injury incidence rates were higher in the older age groups. Price et al(2004) in an audit of injuries in academy youth football found that players aged 17 -19 years were more likely to sustain an injury than players aged 9 - 16 years.The results of the present study may be explained by the high ratio of matches to training sessions in the u13 category . Players in this category may not be as prepared for the physical demands of a match as players in the u15 &17 and u19 categories where the match to training session ratios are much lower, thus explaining the high injury incidence in the u13 category.

Contrasting measurements of exposure also makes comparative analysis of injury incidence rates very difficult. Johnson et al (2009) in an investigation of growth,development and factors associated with injury in elite schoolboy footballers expressed injury incidence rates per season while Stuart et al (2002) expressed injury incidence rates per 1000 hours of football. Stuart et al (2002), in a study on injuries in youth football among players aged 9 to 13 years, reported the actual playing time during a 40 minute youth football match to be only 8 minutes when accounting for stoppages.The authors suggested that controlling for such factors is essential in analysis of injury data in order to better reflect the risk of injury in a specific sport.In the present study it proved too difficult to obtain individual exposure data and the researcher concedes that this may also have lead to the high injury incidence rate.

5.5 INJURY CHARACTERISTICS

5.5.1 Injury Location and Type

In this study the most frequently injured body area was the lower limb (93%) and more specifically the knee (21.70 %), ankle (19.89 %) and hip (15.24 %).This was consistent with the findings of other studies on injuries in youth football (Johnson et al, 2009; Junge & Dvorak, 2004; Volpi et al,2003) Muscle strain /tear was the most common type of injury in the present study.This was followed by ligament sprain/tear(%),bone bruise/dislocation/fracture (%) and tendinopathies. Price et al (2004) and Stuart et al (2002) reported similar results in their respective studies.Volpi et al (2003) found joint/ ligament sprains to be the most frequent injury type , followed by fractures, osteochondral lesions and muscle injuries.The authors reported that joint/ ligament sprains and muscle injuries were more numerous among the over 15 years age group, whereas osteochondral lesions were more frequent in the under 15 years age group.The authors surmised that the over 15 years age group had more frequent and more intense training sessions than the under 15 years age group, also match play was more competitive in the over 15 years age group.In the present study , 1 osteochondral lesion was reported and it was sustained in the u13 category.

5.5.2 Injury Mechanism

The majority of injuries (53.22%), in the present study, were sustained during contact.Player contact accounted for (75.72%) of all contact injuries The u15 & 17 category sustained significantly more player contact injuries than the u13 and u19 categories ($p = 0.009$; 95% CI 0.02 - 0.27), as well as significantly more non- contact injuries than the u13 category ($p = 0.02$; 95% CI 0.08 - 0.23).These results were consistent with the findings of several studies(;Le Gall et al,2008; Steffen et al,2008; Emery et al,2005).The high rate of player contact injuries in the present study, specifically among the u15 &17 category, may be explained by the elite level of competition at the academy.Players are acutely aware that they are competing for limited positions in the hope of

graduating to the professional/ senior teams leading to fierce competition during matches and even training sessions.

5.5.3 Injury Severity

The majority of injuries (55%) were classified as transient.Mild and moderate injuries accounted for (34.6%) and (8.5%) of all injuries respectively.The variance in definitions of severity, as discussed in the systematic literature review, makes comparison between studies very difficult.

5.5.4 The Adolescent Growth Spurt

The teams at the academy were grouped into the following age categories :

u13 = under 11 plus the under 13 team , initial phase of adolescent growth spurt

u15 &17 = under 15 plus the under 17 team , approaching peak height velocity

u19 = end stage of adolescent growth spurt

This was done to facilitate analysis of the effect of the adolescent growth spurt on injury incidence.The present study found a significantly higher injury incidence rate in the u13 category(for match and training injuries) compared to u15 &17 and u19 categories .Significantly, of the 4 fractures reported , 3 were sustained by the u15 &17 category and 1 by the u13 category. Maffulli & Caine (2005) reported that studies of the frequency of physeal and other childhood injuries noted an increased occurrence of fractures during pubescence. Bailey et al (1989) reported an association between peak height velocity and peak fracture rate in a study on the epidemiology of fractures in children associated with growth.Admittedly , the previously mentioned study focussed on upper limb fractures in gymnasts but the researcher contends that the findings may still be applicable to football.The u15 &17 category in the present study also sustained significantly more player contact injuries than both other age categories($p < 0.05$).The players in the u15 &17 category would be competing at varying levels of skeletal maturity, even though they are grouped according to

chronological age, possibly increasing the risk of injury. This theory seems to be supported by the literature (Johnson et al, 2009; Volpi et al,2003)

5.6 METHODOLOGICAL CONSIDERATIONS

The present study made use of a retrospective design.A prospective cohort is regarded as methodologically superior to a retrospective design(Fuller et al,2006).This is mainly as a result of recall bias.The medical staff at the academy documented injuries as the players were assessed therefore the effect of recall bias was minimized.The observation period was for 2 full football seasons and all registered players at the academy were included in the study.The findings of this study can therefore be considered to be representative of players at the academy. However , the researcher concedes that the lack of individual exposure data as well as the relatively small numbers of players per team did influence the significance of the results.Another component which may have added significant value to the analysis was measuring skeletal maturity levels.Similar studies should, in future, document individual exposure times and calculate actual playing and /or training times by controlling for stoppages during a match and /or training session.Injury incidences at 2 or more academies should be compared to increase the statistical significance of the results. Players should also be matched for skeletal maturity, although this may prove difficult as football associations currently group players according to chronological age.

5.7 SUMMARY OF THE CHAPTER

This chapter outlined the first phase of the procedure used in designing an injury prevention protocol for youth footballers.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 describe the second phase of the procedure used in designing an injury prevention protocol for youth footballers.

CHAPTER 6

THE DELPHI STUDY

6.1 INTRODUCTION TO THE CHAPTER

This chapter describes the second phase of the procedure used in designing an injury prevention protocol for youth footballers. It further outlines the results of the the Delphi method used in this study to gain consensus on the efficacy of the proposed injury prevention protocol .

6.2 BACKGROUND

The Delphi method can be characterized as a structured group communication process,whereby a panel of experts (through interactive discourse) may , as a group, accurately predict the outcome / efficacy of an event.(Linstone &Turrof ,2002).The Delphi method was used for this study to determine the efficacy of a proposed injury prevention protocol for youth academy football players.This protocol was developed by the researcher based on collation of the following sets of information , namely :

I. a systematic review of the literature on injury prevention protocols in the described population

II. an analysis of the injury statistics obtained during the study period .

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 program. The efficacy of an active injury prevention strategy is dependent on acceptance and compliance by all the relevant stakeholders (players,rehabilitative & conditioning staff, coaches) .

This can be facilitated by:

- integrating the intervention into the participants' usual training regime
- making audiovisual 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

A systematic review by Olsen, et al (2004) on strategies for the prevention of soccer injuries reported that the lower extremity is the most frequently injured anatomical area in youth football.The researcher thus decided to focus the prevention strategy on reducing the risk of lower limb injuries.The majority of the studies in the systematic literature review conducted by the researcher(91%), used a structured multi component training program in order to reduce the relative risk to injury in the studied populations.These protocols consisted of,amongst others, a series of proprioceptive, plyometric and football specific drills designed to improve a player's neuromuscular control .The results of previous studies in this field (Kiani et al,2010; Kirkendall et al,2010; Soligard et al, 2008; Mandelbaum et al, 2005 ; Junge et al,2002) have indicated a reduction in the incidence of injuries sustained by football players when these protocols were applied . There were some methodological challenges within these studies (lack of randomization ; compliance) that may have influenced the statistical validity of the outcomes , but the researcher noted a

generally positive effect and it was concluded that the proposed prevention protocol would be based on the above mentioned interventions

6.3 PARTICIPANTS

Participants in the Delphi study are professionals (physiotherapists, exercise physiologists, biokineticists, athletic trainers) working with youth football players. 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 ten professionals were contacted via e-mail by the researcher, informing them about the purpose and content of the study as well as requesting their participation.Eight (80%) professionals agreed to participate and two declined,citing reasons of increased administrative workload.The participants were informed that anonymity and confidentiality would be strictly maintained .

6.4 METHOD

An epidemiological study on injuries at a South African football academy, conducted by the researcher , reported the following results :

The body areas most frequently injured were the knee (21.70 %) ankle (19.89 %) and hip/groin (15.24%).Mean injury incidence in the study sample was 55.50 (match) and 3.39 (training) injuries/1000 exposure hours. An injury prevention protocol was designed to be included as part of a pre match/ training routine and to be applied for the duration of the football season. The underlying principle of this intervention was to facilitate and reinforce efficient biomechanical alignment of the ankle , knee and hip joints in various activities.These drills would progress from static postures to more dynamic activities simulating certain movements a player may experience during a match/training.The Delphi method was used in this study to gain consensus on the efficacy of the proposed injury prevention protocol and was conducted over three rounds.

6.5 INSTRUMENT

Participating professionals were requested to rate the efficacy and frequency of each item in the protocol by means of a self administered questionnaire using a 5 point Likert -type scale with commentary where applicable.

The first section of the questionnaire was centered on demographic data of the participants, such as country of origin, years of experience, field of interest/specialization. The second section of the questionnaire focused on the content of the proposed injury prevention protocol .In this section two questions were posed for each item in the proposed injury prevention protocol i.e

" would this exercise be effective in aiding to reduce the risk of injury ? "

" would the frequency (sets & repetitions) be sufficient to produce the desired outcome ? "

Responses to each question were reduced to binomials, i.e agree or disagree, after each round.This data was then expressed as percentages in order to calculate level of consensus. Consensus was defined as $\geq 65\ \%$ agreement amongst participants on all items in the injury prevention strategy. The second and third rounds of the survey evolved from consensus and/or suggestions from the first round of the Delphi study.

6.6 DATA COLLECTION

The study was conducted via e-mail.The questionnaire, together with the proposed injury prevention protocol, was mailed to the consenting participants.The participants were then requested to complete the questionnaire and mail it to the researcher. This process of discussion and feedback was repeated for a total of three rounds until consensus was reached.

6.7 RESULTS

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

6.7.1 Characteristics of the Participants

The group of 8 participants consisted of 5 physiotherapists, 1 exercise physiologist , 1 athletic trainer and 1 biokineticist .Occupational experience was defined as the amount of time in years spent working in the field of youth football(clinical practice and/ or research).The number of years of experience among the participants ranged from 8 - 23 years . The mean number of years of experience among the participants was 12.12 years (± 5.27 years).The age of the participants ranged from 32 - 58 years with a mean of 39.75 years (± 8.08 years).Five of the participants were working on the African continent , while two participants were working in Europe and the remaining participant practicing in the Arabian peninsula.The paucity of published scientific studies on youth football injuries in Africa, as opposed to those in Europe, Asia and the Americas was previously discussed by the researcher.Therefore the geographic context was deemed important by the researcher in order to compare the opinions of the "African" professionals with their "European" and "Asian" counterparts. Table --- describes the characteristics of the participants

Table 6.1 Participant Characteristics

Participant	Age (years)	Gender	Nationality	Occupation	Experience (years)	Speciality
1	58	male	Netherlands	Physiotherapist	23	Academy Football
2	41	female	United Kingdom	Physiotherapist	17	Academy Football
3	38	male	Qatar	Exercise Physiologist	12	Physical conditioning of Youth Athletes
4	42	male	Ivory Coast	Athletic Trainer	10	Strength and Conditioning Training
5	36	male	South Africa	Physiotherapist	10	Injury prevention in Football
6	34	male	South Africa	Biokineticist	9	Football Conditioning
7	32	female	South Africa	Physiotherapist	8	Youth Football Injury Prevention and Rehabilitation
8	37	male	Egypt	Physiotherapist	8	Sports Injury Rehabilitation

6.7.2 Round One of the Study

During round one ,100% (8) of the participants responded.The proposed injury prevention protocol is presented in Figure .The opinions and recommendations of the participants are discussed as follows:

(a) Efficacy of the items

Consensus was reached on the efficacy of five of the six items included in the protocol. 100% of the participants (8) agreed that exercises 1; 2; 3; 5 and 6 in the protocol would be efficient with regards to injury prevention in youth football. Regarding the efficacy of item 4 , 75% (6) of the participants required more clarity on the nature and desired outcome of the exercise ,and therefore

could not agree to its inclusion in the protocol.This exercise was then amended and discussed further in round 2 of the study.

(b) Frequency of the items

There was significant disagreement among the participants regarding the duration of most of the exercises.Consensus was reached on the frequency of item 3 (87.5%) and item 6 (87.5%) only .

Five participants (62.5%) suggested that the repetitions for item 1 were too numerous,

two of the disagreeing participants further recommended that the sets of the exercise be increased to two, thereby enabling a reduction in the number of repetitions required to achieve the desired effect.

The repetitions for item 2 were also thought to be too numerous by six (75%) of the participants.One of these participants suggested that the exercise be repeated once only , the remaining five participants did not offer any suggestions.

In relation to item 4 , two (25%) of the participants recommended that the sets be increased to 3, while the remaining six (75%) participants recommended that the sets be reduced to 1.

Five (62.5%) participants agreed that the frequency of item 5 was appropriate, while three (37.5 %) suggested the repetitions be increased to 3.

Six (75%) participants requested clarification on the definition of "correct bio - mechanical alignment" as well as the total time needed to perform the protocol.

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 6.2 below.

Table 6.2 Round One of the Study (n=8)

	Item	Criteria	Agree	Disagree	Comments
1	**single leg standing**	efficacy	100% (n = 8)		
		frequency	37.5% (n = 3)	62.5% (n = 5)	5 of the participants suggested that the repetitions were too numerous while 2 suggested the sets be increased to two
2	**single leg standing with ball passes**	efficacy	100% (n = 8)		
		frequency	25 % (n = 2)	75 % (n = 6)	6 of the participants suggested that the repetitions were too numerous 1 participant suggested the exercise be completed for one set only the remaining 5 did not offer any suggestions
3	**jump and land drills**	efficacy	100% (n = 8)		
		frequency	87.5 % (n = 7)	12.5 % (n = 1)	1 participant suggested the sets be increased to three
4	**45 degree angle jump**	efficacy	25 % (n = 2)	75 % (n = 6)	6 of the participants required more detail on the exercise to assess its relevance
		frequency		100% (n = 8)	2 participants thought that the sets should be increased to three, the remaining 6 suggested the sets be reduced to one
5	**running drills**	efficacy	100% (n = 8)		
		frequency	62.5% (n = 5)	37.5% (n = 3)	3 participants suggested the repetitions be increased to three
6	**passing drills**	efficacy	100% (n = 8)		
		frequency	87.5 % (n = 7)	12.5 % (n = 1)	1 participant suggested the sets be increased to two
					6 of the participants required more detail on what is meant by correct bio - mechanical alignment of the hip and knee

Figure 6.1 Proposed Injury Prevention Protocol

PROPOSED INJURY PREVENTION PROTOCOL

1) Single leg standing

starting position : stand with feet hip width apart, execute jump by flexing at the knee, hip and trunk; land in a semi - squat position with correct biomechanical alignment of the ankle,knee and hip to absorb the impact forces

procedure : maintain balance for : ① 30 seconds each leg with eyes open
② 30 seconds each leg with eyes closed
③ 30 seconds kick-pass simulation with each leg

repetition : x 5 each leg
sets : x 1 each leg

2) Single leg standing with ball passes

starting position : stand with feet hip width apart, execute jump by flexing at the knee, hip and trunk; land in a semi - squat position with correct biomechanical alignment of the ankle,knee and hip to absorb the impact forces

procedure : maintain balance while catching /throwing a ball to a partner
①1 minute passing overhead
②30 seconds passing to the left
③30 seconds passing to the right

repetition : x 3 each leg
sets : x 2 each leg

3) Jump - and land drills

starting position : stand with feet hip width apart, execute jump by flexing at the knee, hip and trunk; land in a semi - squat position with correct biomechanical alignment of the ankle,knee and hip to absorb the impact forces

procedure : ①jump up for 1 min with a 5 second hold in the landing position
②jump forward and backward for 1 min with a 5 second hold in the landing position

repetition : x 2
sets : x 2

4) 45° angle jump

starting position : stand with feet hip width apart, execute jump by flexing at the knee, hip and trunk; land in a semi- squat position with correct biomechanical alignment of the ankle ,knee and hip to absorb the impact forces

procedure : jump forward at a 45° angle, pushing off one leg and landing on the opposite leg, land in a single leg squat position,continue for 1 minute

repetition : x 2
sets : x 2

5) Running drills

starting position : run progressively faster for a distance of 20 meters emphasizing correct biomechanical alignment of the ankle ,knee and hip

procedure : ① run forward x 2
② run backward x 2
③ run sideways x 2

repetition : x 1
sets : x 1

6) Passing drills

starting position : pass a ball to a partner , moving progressively further apart, alternating between left and right foot,emphasizing correct biomechanical alignment of the ankle ,knee and hip on the weight-bearing leg

procedure : stand 5 meters apart and pass the ball with the :
inside of the foot x 5
top of the foot x 5

repeat at 10 and 15 meters apart respectively

repetition : x 1
sets : x 1

6.7.3 Round Two of the Study

The second round of the study was commenced when the amended protocol was sent to the participants.Eight (100%) of the participants responded during this round of the study.

(a) Efficacy of the items

Consensus was reached on the efficacy of all of the six items included in the protocol. 100% of the participants (8) still agreed that exercises 1; 2; 3; 5 and 6 in the protocol would be efficient with regards to injury prevention in youth football.During the first round of the study six (75%) participants required more detail regarding item 4.The researcher therefore added a more detailed description of the exercise as well as notes on the desired effect.These amendments lead to six participants (75%) reaching consensus on the efficacy of the exercise with regards to reducing the risk of injury in youth football.However, two participants (25%) suggested that the exercise would be too complicated for youth players to understand.The researcher decided to add additional instructional notes to ensure compliance and aid in comprehension. These amendments were to be included in the subsequent rounds of the study.

(b) Frequency of the items

Consensus was reached on the frequency of items 1,2, 3, 5, and 6.Consensus was not reached on the frequency of item 4.

Seven participants (87.5%) agreed that the frequency of item 1 would be appropriate, while one participant (12.5%) suggested the repetitions be decreased to one.

Consensus of 75% (6 participants) was reached on the frequency of item 2 , while two participants (25%) suggested that the sets of the exercise be decreased to one.

Regarding item 4, five participants (62.5%) agreed on the frequency of the item, however three participants (37.5%) recommended that the sets of the exercise be increased to three. Therefore

consensus was not reached and the item was to be amended and discussed further during round 3 of the study.

Seven participants (87.5%) agreed on the frequency of item 5, thus reaching the threshold for consensus.The results of round 2 of the study are summarized in Table 6.3 below.

Table 6.3 Round Two of the Study (n=8)

	Item	Criteria	Agree	Disagree	Comments
1	**single leg standing**	efficacy	100% (n = 8)		
		frequency	87.5 % (n = 7)	12.5 % (n = 1)	1 participant suggested the repetitions be decreased to one
2	**single leg standing with ball passes**	efficacy	100% (n = 8)		
		frequency	75 % (n = 6)	25 % (n = 2)	2 participants suggested the sets be decreased to one
3	**jump and land drills**	efficacy	100% (n = 8)		
		frequency	87.5 % (n = 7)	12.5 % (n = 1)	1 participant suggested the sets be increased to three
4	**45 degree angle jump**	efficacy	75 % (n = 6)	25 % (n = 2)	2 participants suggested the exercise would be too confusing for youth players
		frequency	62.5% (n = 5)	37.5% (n = 3)	3 participants recommended the sets be increased to three
5	**running drills**	efficacy	100% (n = 8)		
		frequency	87.5 % (n = 7)	12.5 % (n = 1)	1 participant suggested the sets be increased to three
6	**passing drills**	efficacy	100% (n = 8)		
		frequency	87.5 % (n = 7)	12.5 % (n = 1)	1 participant suggested the sets be increased to two

6.7.4 Round Three of the Study

During the 2nd round of the study consensus was reached on the efficacy of all the items on the protocol.The purpose of the 3rd round of the study was to seek consensus on the items where consensus was not reached in rounds 1 and 2, namely, the frequency of item 4. Six of the eight participants responded during the 3rd round of the study .The researcher added more detailed instructional notes regarding the implementation of item 4 as well as increasing the number of sets to two.Five participants (83.3%) agreed that the item would be effective, while one participant (16.7%) did not think the item would be appropriate. Regarding the frequency of item 4, 66.7% consensus was reached and therefore the item was retained as part of the injury prevention protocol. The results of the third round of the study as well as the final injury prevention protocol are presented in Table 6.4

Table 6.4 Round Three of the Study (n=6)

Item	Criteria	Agree	Disagree	Comments
1 single leg standing	efficacy	100% (n = 6)		
	frequency	100% (n = 6)		
2 single leg standing with ball passes	efficacy	100% (n = 6)		
	frequency	100% (n = 6)		
3 jump and land drills	efficacy	100% (n = 6)		
	frequency	83.3 % (n = 5)	16.7 % (n = 1)	1 participant suggested the sets be increased to three
4 45 degree angle jump	efficacy	83.3 % (n = 5)	16.7 % (n = 1)	1 participant did not think the exercise is effective

Item	Criteria	Agree	Disagree	Comments
	frequency	66.7% (n = 4)	33.3% (n = 2)	2 participants recommended the sets be increased to three
5 running drills	efficacy	100% (n = 6)		
	frequency	83.3 % (n = 5)	16.7 % (n = 1)	1 participant suggested the sets be increased to three
6 passing drills	efficacy	100% (n = 6)		
	frequency	100% (n = 6)		

6.8 FINALIZED INJURY PREVENTION PROTOCOL

The finalized injury prevention protocol (Figure 6.2) was designed after the third round of the survey, once consensus was reached on all the items .This was then e- mailed to all the participants.

Figure 6.2 Finalized Injury Prevention Protocol

INJURY PREVENTION PROTOCOL

1) Single leg standing

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : maintain balance for : ① 30 seconds each leg with eyes open
② 30 seconds each leg with eyes closed
③ 30 seconds kick-pass simulation with each leg

repetition : x 3 each leg
sets : x 1 each leg

2) Single leg standing with ball passes

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : maintain balance while catching /throwing a ball to a partner
①1 minute passing overhead
②30 seconds passing to the left
③30 seconds passing to the right

repetition : x 3 each leg
sets : x 1 each leg

3) Jump - and land drills

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : ①jump up for 1 min with a 5 second hold in the landing position
②jump forward and backward for 1 min with a 5 second hold in the landing position

repetition : x 2
sets : x 2

4) 45° angle jump

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : jump forward at a 45° angle, pushing off one leg and landing on the opposite leg, land in a single leg squat position,continue for 1 minute

repetition : x 2
sets : x 2

5) Running drills

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : ① run forward x 2
② run backward x 2
③ run sideways x 2

repetition : x 2
sets : x 2

6) Passing drills

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : stand 5 meters apart and pass the ball with the :
inside of the foot x 5
top of the foot x 5

repeat at 10 and 15 meters apart respectively

repetition : x 1
sets : x 2

Notes for coaches/trainers/ conditioning staff

*Correct biomechanical alignment of the hip, knee and ankle : In the sagittal plane , the centre of the ankle should be aligned with the centre of the patella and the hip joint,avoid an increase in the Q angle of the femur on the hip joint .

Estimated total time of the protocol = ± 20 minutes

Protocol should be performed before all match and training activities

Exercises can be progressed by increasing the speed of execution while still maintaining good form

Encourage peer correction to facilitate compliance

6.9 SUMMARY OF THE CHAPTER

This chapter outlined the method of the Delphi study used to design an injury prevention protocol for youth footballers.Furthermore ,it described the results of the various rounds of the survey . Consensus was reached on the efficacy and frequency of all the items on the injury prevention protocol.The next chapter will discuss the perceived limitations of the study, conclusions drawn from the study , as well as suggested recommendations that may be of use to professionals who work with youth footballers.

CHAPTER 7

CONCLUSION , LIMITATIONS & RECOMMENDATIONS

7.1 INTRODUCTION TO THE CHAPTER

In this chapter the conclusions drawn from the study are summarized and presented , along with the limitations of the study . Recommendations for future research , in youth football, are also discussed with particular reference to the African continent.

7.2 CONCLUSION

The primary aim of this study was to design an injury prevention protocol for youth football players at a South African youth football academy. This was done by;

- describing the incidence of football injuries in youth players at the academy
- examining the relationship between exposure time and injury incidence
- describing the injury risk profile of selected age categories

The secondary aim of this study was to identify and analyze the best evidence for injury prevention in youth football from the existing literature.This information was then combined to design an injury prevention protocol for the academy.The systematic literature review indicated a paucity of studies on injury prevention in youth football.Very few of the included studies were conducted on male subjects and none of the included studies were conducted in Africa.However, multi component neuromuscular control training programs appear to be most effective at reducing the risk of injury in youth football players.There also seems to be a definite inverse relationship between exposure time and injury incidence in youth football, specifically when comparing players under the age of 13 years to those over the age of 13 years.Players experiencing the adolescent growth spurt, or approaching peak height velocity are more at risk of sustaining injuries than skeletally mature players.The current scientific literature provides conflicting evidence on this matter.This is largely due to differences in methodological design and measurement of exposure time. Players,

parents,coaches and academy staff all need to be educated on the injury risk profile of different age groups , as well as the benefits of injury prevention programs.The South African Football Association (SAFA) and its affiliated clubs should also be made aware of the significance of quantifying and monitoring exposure in injury prevention.Team classifications should possibly be changed from chronological age to maturity level, at least up to the age of 17 years.Admittedly matching players for maturity level would be difficult to manage administratively and organizationally, especially as consensus is lacking in the scientific community on a validated , cost effective and accurate measure of maturity.However , continued development of evidence - based practice in youth football can stimulate such paradigm shifts and is essential in balancing the pursuit of footballing excellence with the health and safety of youth players.

7.3 LIMITATIONS OF THE STUDY

The limitations of the study were identified as follows:

- The present study made use of a retrospective design.As discussed previously, a prospective cohort is regarded as methodologically superior to a retrospective design(Fuller et al,2006) , mainly as a result of recall bias.
- The researcher also concedes that the lack of individual exposure data as well as the relatively small numbers of players per team may have influenced the significance of the results.
- Measuring skeletal maturity of the players may also have added significant value to the analysis as it would have allowed more accurate comparison of players based on physiological age rather than chronological age.

7.3 RECOMMENDATIONS

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

- Similar studies should, in future, document individual exposure times and calculate actual playing and /or training times by controlling for stoppages during a match and /or training session.

- Injury incidences at 2 or more academies should be compared to increase the statistical significance of the results.
- Players should also be matched for skeletal maturity, although this may prove difficult as football associations currently group players according to chronological age.
- More studies in youth football need to be conducted on the African continent to ensure that best practice norms and recommendations are specific to the African youth football player.
- Football governing bodies should invest in the development of validated , repeatable and economically viable means of measuring skeletal age which would allow players to be matched according to maturity levels.
- A knowledge of scientifically tested injury prevention programs should be introduced as part of the curriculum for football coaching licensing.This would encourage coaches to view these programs as part of their coaching arsenal rather than something being enforced upon them.

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Appendix A: Study Quality Rating Key

Study quality score key

Study reference: Score :

(I) How was allocation to the intervention group done?
2 = random
1 = cluster random
0 = historical comparison/volunteer or convenience group

(II) Was the assigned intervention concealed before allocation?
2 =adequate
1 = unclear
0 = inadequate/impossible

(III) Were the outcomes of participants who withdrew described and included in the analysis (intention to treat/effect of compliance)?
2 = withdrawals well described and accounted for in analysis
1 = withdrawals described and analysis not possible
0 = no mention, inadequate mention, or obvious differences and no adjustment

(IV) Were the outcome assessors blinded to treatment status?
2 = effective action taken to blind assessors
1 = small or moderate chance of unblinding of assessors
0 = not mentioned or not possible

(V) Were the inclusion and exclusion criteria (age, previous injury, sport) clearly defined?
2 = clearly defined
1 = inadequately defined
0 = not defined

(VI) Were the intervention and control group comparable at entry?
2 = good comparability of groups, or confounding adjusted for in analysis
1 = confounding small; mentioned but not adjusted for
0 = large potential for confounding, or not discussed

(VII) Were the interventions clearly defined?
2 = clearly defined interventions are applied
1 = clearly defined interventions are applied but the application is not standardized
0 = intervention and/or application are poorly or not defined

(VIII) Were the outcome measures used clearly defined? (injury: self- reported injury/medically confirmed/ severity defined)
2 = clearly defined
1 = adequately defined/recorded
0 = not adequately defined/recorded

(IX) Was the surveillance period active and of clinically appropriate duration?
2 = active surveillance and appropriate duration
1 = active surveillance, but inadequate duration
0 = surveillance not active or not defined

Total score (18 = 100%)

Appendix B: Participant Consent Form

CONSENT FORM

Ajax Cape Town Football Club is always striving to provide the best football education and care for all the players at our academy.This entails up to date training techniques as well as medical care.To do this we need to consistently re evaluate these techniques by collecting information on our players.We use this information to e.g determine which position your child is best suited to, or which types of training would optimize his football development.This is why we request that all parents/guardians permit us to use the information gathered by the staff in any research we may conduct.The information will be handled confidentially and will at all times remain on the premises of the academy.The information gathered or the results of any project will in no way prejudice your child's selection or progress at the academy.At Ikamva the safety and well-being of our players are of utmost importance and will always be the most important deciding factors when undertaking any project at the academy
If you understand the above paragraph and would permit the use of your child's information please complete the section below

***Please note that you are not obliged to sign the form and may change your mind at any time should you feel your child is being disadvantaged/ placed at risk.**

For any questions /comments please contact the head of the youth academy at tel (021) 930 6403

I permit the use of all information as discussed above

Parent/Guardian _____

Player _____

Date _____

Appendix C: Baseline Information Form

F-MARC FIFA

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 2006

Appendix D: Injury Data Form

F-MARC FIFA

Injury Report Form

(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 E: Individual / Team Exposure Form

FIFA F-MARC

Exposure Report Form
(for the documentation of individual players' exposures)
(Team) Player-code: ____________________

LOGO

Date										
Training / Match										
Study specific variable										
Study specific variable										
Player Code No.	Report the duration of training and match play for each player (minutes)									

Appendix F: Injury Prevention Protocol

INJURY PREVENTION PROTOCOL

1) Single leg standing

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : maintain balance for : ① 30 seconds each leg with eyes open
② 30 seconds each leg with eyes closed
③ 30 seconds kick-pass simulation with each leg

repetition : x 3 each leg
sets : x 1 each leg

2) Single leg standing with ball passes

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : maintain balance while catching /throwing a ball to a partner
①1 minute passing overhead
②30 seconds passing to the left
③30 seconds passing to the right

repetition : x 3 each leg
sets : x 1 each leg

3) Jump - and land drills

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : ①jump up for 1 min with a 5 second hold in the landing position
②jump forward and backward for 1 min with a 5 second hold in the landing position

repetition : x 2
sets : x 2

4) 45° angle jump

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : jump forward at a 45° angle, pushing off one leg and landing on the opposite leg, land in a single leg squat position,continue for 1 minute

repetition : x 2
sets : x 2

5) Running drills

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : ① run forward x 2
② run backward x 2
③ run sideways x 2

repetition : x 2
sets : x 2

6) Passing drills

starting position : player takes a step forward , loads the body weight onto the front leg with the weight-bearing knee in a semi- flexed position, emphasizing *correct biomechanical alignment of the ankle ,knee and hip

procedure : stand 5 meters apart and pass the ball with the :
inside of the foot x 5
top of the foot x 5

repeat at 10 and 15 meters apart respectively

repetition : x 1
sets : x 2

Notes for coaches/trainers/ conditioning staff

*Correct biomechanical alignment of the hip, knee and ankle : In the sagittal plane , the centre of the ankle should be aligned with the centre of the patella and the hip joint,avoid an increase in the Q angle of the femur on the hip joint .

Estimated total time of the protocol = ± 20 minutes

Protocol should be performed before all match and training activities

Exercises can be progressed by increasing the speed of execution while still maintaining good form

Encourage peer correction to facilitate compliance