# The Knee Injuries in Women Soccer Players in South Africa

**Ehab Elsayed Mohamed**

**Submitted in partial fulfillment of the requirements for the degree of**

## MASTERS OF MEDICAL SCIENCE

## (PHYSIOTHERAPY)

**In the Department of Physiotherapy, Faculty of Health Sciences, Medical University of Southern Africa Campus, University of Limpopo**

**2010**

**Supervisor**

Dr BF Mtshali

**Co-supervisor**

Dr U Useh

# Declaration

I, Ehab Elsayed Mohamed, hereby declare that the work on which this project report is based, is original (except where acknowledgments indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree at this or any other university or tertiary education institution or examination body.

______________________________

**Signature of candidate**

______________________________

**Date**

# Acknowledgements

First of all, I am grateful to my Creator, who made all things possible for me.

To my family, I have done it because of your support and encouragement; you were there for me in my best and worst times. Special thanks to my wife, Fatima.

I am deeply indebted to my supervisor Dr BF Mtshali, who guided me and taught me a great deal both morally and academically. You truly are an inspiration to me.

Special thanks to my co-supervisor, Dr U Useh, whose support, stimulating suggestions and encouragement helped me in all the phases of this research.

I also thank the Department of Physiotherapy for the opportunity extended to me to perform this research work and use of their departmental facilities.

To the staff and my colleagues in the Department of Physiotherapy, I thank you all for your support, interesting ideas, and camaraderie.

My thanks also go to Dr DA Ramagole, who facilitated the meetings and arrangements with South African national team U-23 and for her useful suggestions and assistance during the data collection process for this study.

My many thanks to Dr M Makanya, for help with interpretation of the X-rays, and Miss MA Managa and Mr Y Negussie for help with the statistical analyses.

I would like to thank Dr Mkuli, L and Dr K J Rankapole for editing this dissertation.

I'd like to thank my extended family in Sudan; my mother Asma, my sibling in Wad Medani and my other family members in Aboadam for the encouragement and inspiration.

.

# Dedication

I wish to dedicate this work to my late father, Elsayed Ellithey, who passed on before I started this study, may his soul rest in peace and all those who have contributed to my progress in any form.

# Keywords

Knee

Injury

Women

Soccer

Player

South Africa

# Abbreviations

The following Abbreviations are used in this research report

| | |
|---|---|
| ACL | Anterior cruciate ligament |
| ASIS | Anterior Superior Iliac Spine |
| CT Scan | Computer Tomography Scan |
| FIFA | Federation of International football Association |
| INW | Intercondylar notch width |
| IOC | International Olympic Committee |
| LCL | Lateral collateral ligament |
| LM | Lateral meniscus |
| MCL | Medial collateral ligament |
| MM | Medial meniscus |
| MRI | magnetic resonance Imaging |
| NCAA | National College Athletic Association, USA. |
| PCL | Posterior cruciate ligament |
| Q-angle | Quadriceps angle |
| ROM | Rang of motion |

| | |
|---|---|
| SAFA | South Africa Football Association |
| WSPSA | Women Soccer Project In South Africa |
| WUSA | Women United Soccer Association |

# Abstract


## The knee Injuries in Women Soccer Players in South Africa

The Knee is a common site for injuries in soccer players. The reasons for the increased rates of knee injuries in women soccer players are not clear, but some theories suggested the reason to lie in the difference in anatomy. This research investigate the prevalence of knee injuries in women soccer players in South Africa and sought to find out whether three of the anatomical factors (Q-angle, pelvic width and Intercondylar notch width) have a role in increasing knee injuries in these individuals. The study design was case –control study. Methodology: Twenty four players of South Africa women soccer team (Under 23) participated in this study. X-rays of the hip were taken and the Q-angles were thereafter measured manually. Association between anatomical factors and knee injuries were determined.

The result of this study showed that 17% of the players were having non contact knee injuries. Statistical analysis showed no significant relation between knee injuries among women soccer players and each of the anatomical factors. The P-values of both t-test and ANOVA test were larger than the 0.05 level of significance. The study found that the prevalence of knee injuries among the young women playing for the South African national team U-23 was relatively high. However, this study could not identify significant relationship between the anatomical risk factors and the incidences of knee injuries among the participants.

# Table of contents

# List of Figures

# List of tables

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the study

Physical activity is very important for all human beings and the benefits are well-documented for both genders (Strong *et al.,* 2005; Majewski, Habelt & Steinbruck, 2006). The level of physical activity will differ in frequency, intensity, and duration depending on gender, age, and type of physical activity. An example of such activity is sport.

Sport is defined as physical activity involving a structured competitive situation governed by rules (Casperson, Powell & Christienson, 1985), for example football is considered as a sport while aerobics is classified as exercise (Mandelbaum & Putukian, 1999). Numerous benefits of sport to women have been documented (Strong *et al.,* 2005). Amongst these are lifestyle improvements, low teenage pregnancy rate, low drug and alcohol use and abuse, higher graduation rate, improved self-esteem and body image (Strong *et al.,* 2005). Other beneficial effects of sport also include increased bone mass, cardiovascular function and weight control (Strong *et al.*, 2005).

Soccer is the most popular sport in the world (Mandelbaum& Putukian, 1999). Over the last 20 years, there has been a dramatic increase in interest in women's soccer. Women make up 22% of the world's soccer players (Mandelbaum & Putukian, 1999). The first women's football cup was held in China in 1991, and since 1994 the Olympic Games have included a women's football tournament. Furthermore, since 2002 the Federation of International Football Association (FIFA) has organized a biennial U-19/ U-23 World Championship (Junge & Dvorak, 2007).

Women in most countries including South Africa, have a national team and a local league. According to the South African Football Association (SAFA), South African women have been involved in soccer for over a decade, albeit on a disjoined and local basis. There are currently more than 300 women's soccer clubs in SAFA's 25 regions, including a pool of about 50 000 players. In Africa the first women's soccer tournament was held in 1995 and South Africa played against Nigeria in the final (SAFA, 2006).

Increasing incidences of injuries have been reported in female soccer. It is therefore necessary to develop preventive and rehabilitative programmes for these players (Wong& Hong, 2005). The most common injuries among female athletes are knee injuries, especially injury to the anterior cruciate ligament (ACL) (Pollard, Davis, & Hamill, 2004). Adolescent females suffer a disproportionate number of knee and anterior cruciate ligament (ACL) injuries compared to adolescent males. Knee injuries predominate even in elite female soccer players (Giza, Mithofer, Farrell, Zarins, & Gill, 2005; Giza & Micheli, 2005). McAlindon, (1999) found that female athletes have four to ten times more ACL injuries than male athletes. This was further reiterated by Ireland and Otto (2004) who stated that female athletes have an increased rate of ACL injuries and patelofemoral disorders compared with their male counterparts. Participation in sport rather than gender was implicated as the cause of injuries (Ireland & Otto, 2004).

Knee injuries in soccer generally occur without contact from another person and most often occur while the player is participating in the training programme. These training programmes include deceleration, twisting, jumping, and other sport specific manoeuvers (Arendt & Dick, 1995). There have been many studies comparing injury rates between male and female players (McAlinton, 1999: Steinacker, Steuer, & Holtke , 2005; Hewett, 2004), but all of these studies found that the women soccer players are more affected by knee injury compared to their male counterparts ( Steinacker *et al.,* 2005).

According to Austermuehle, (2001) the most common knee injuries are ACL, the medial collateral ligament (MCL) and acute injuries to the menisci. The mechanism of injury to the ACL is a noncontact pivoting or twisting injury with the foot planted. Other mechanisms of this injury are non-contact hyperextension, sudden deceleration, forced internal rotation, or a sudden valgus impact. The MCL mechanisms of injury reported includes valgus contact stress or an external rotation with the leg planted on the ground. These are also most commonly seen in football and basketball sports.

Injuries to the menisci occur more often to the medial menisci than the lateral. The mechanism of injury to the medial meniscus is usually from a non-contact injury and a rotational force applied to a partly or completely flexed knee. These injuries commonly happen when coming rapidly from squatting to standing. The lateral collateral ligament (LCL) and posterior cruciate ligament (PCL) are rarely injured (Austermuehle, 2001).

A lot more information on ACL injuries compared to other knee injuries have been documented (Souryal, Moore, & Evans, 1988; Tilton, 1998; Austermuehle, 2001). ACL provides 85% of the total restraining force to anterior translation of the tibia (Souryal *et al.,* 1988). This injury usually occurs during a sudden deceleration, as it typically is a noncontact injury (Souryal *et al.,* 1988). An ACL tear is a common injury in all sports. Epidemiological studies of the ACL injury among female athletes revealed that female soccer players sustained 2.29 times more ACL injuries than male soccer players (Ireland,1999).This study was conducted between 1990- 1998, from the National Collegiate Athletic Association of United State of America. Giza *et al.,* (2005) analyzed 173 injuries that occurred during the 2001- 2002 seasons of the Women's United Soccer Association (WUSA). They found that the most common site for injuries was the knee with (31.8%) and ACL injuries accounted for 4.8%. The reasons for the higher rate of knee injuries in women are not clear but some theories indicate that this is due to differences in the anatomical configuration between genders, knee ligament, ligament laxity and muscle strength. These can be considered as internal factors (Stephanie, 2002). There are other factors however, which can be considered as external factors, such as conditioning, type of training and the development of muscle coordination, (Ireland, 2002) .

The anatomical factors that increase the incidence of the knee injuries among female athletes include the variation of the Q angle, which is considered to be higher in females (Hahn& Foklspang, 1997). The mean Q angle for women was 15.8 $\pm$ 4.5 degrees and for men 11.2 $\pm$ 3.0 degrees (Horton & Hall, 1989). Li *et al.,* (2004) found that an increased Q-angle may contribute to an increase in the contact pressure applied to the patellofemoral joint. The results of Li *et al.,* (2004) were able to link one of the anatomical factors (Q-angle) and to knee injuries in females. A valgus knee and a pronated foot are often implicated as an explanation for the increase in knee injuries (Lewis, 2000). Intercondylar notch configuration has received a great deal of attention as a potential factor in knee injury (Soural, & Freeman1993). Studies have shown that players with smaller intercondylar notch dimensions are at greater risk for ACL injury because it accommodates the ACL (Soural & Freeman 1993; LaPrade & Burnett 1994, Souryal *et al.,* 1988). Other studies have found no relationship between the anatomical factors and predisposition to knee injuries (Loudon, Jenkins & Loudon K.L.1996; Teitz, Lind &Sacks, 1997). There is however, limited empirical information on the association between anatomical factors and knee injuries amongst female soccer players in South Africa. It is hoped that this study will address this issue.

## 1.2 Study problem

The scarcity of information on this topic in South Africa and an increasing interest towards professional women's soccer have resulted in a greater need to assess the situation and provide scientific evidence. The reasons behind increased levels of knee injuries in women soccer players are not well understood (Wong & Hong, 2005; Pollard *et al*., 2004). In the researcher's clinical experience most knee injuries reported where those of female athletes. This led the researcher to investigate empirical evidence to ascertain if there is a causal relationship between anatomical factors and gender. The present research will look at the relationship between specific anatomical factors (pelvic width, Q- angle and the width of the Intercondylar notch) and knee injuries in women soccer players.

## 1.3 Aim of the Research:

The aim of this study was to establish the relationship between specific anatomical factors and knee injuries in women soccer players in South Africa.

## 1.4 Objectives:

The objectives of this study are to:

1. Determine the prevalence of knee injuries in women soccer players.
2. Establish the association between knee injuries and each of the following anatomical factors:
    - Q angle

- Pelvic width
- Intercondylar notch width

## 1.5 Hypotheses

The following hypotheses were tested in this research:

(1) There will be significant association between knee injuries and Q angle among female soccer players.

(2) There will be significant association between knee injuries, pelvic width among female soccer players.

(3) There will be significant association between knee injuries and intercondylar notch width among female soccer players.

## 1.6. Significance of this study

### 1.6.1 Significance of the study to SAFA and the players

Hopefully, this study will help SAFA with the selection of players with lower risk factors of injury and manage players with a higher risk of injury. This study will also be significant to players as it will help identify players who are at risk.

### 1.6.2 Significance of the study to the physiotherapy profession

It is hoped that the outcome of this study will assist physiotherapists to better understand the impact of the anatomical risk factors on knee injuries it is also hoped that physiotherapists will identify the risk of these injuries amongst players and develop preventative and rehabilitative training programmes for them.

This study will add to the body of literature concerning anatomical risk factors relating to knee injuries and will be significant to South Africans as it is one of the few based on the South African context.

## 1.7 Definition of terms

1. An injury was defined as any disruption to soft tissue during active participation in soccer game or training session that causes pain and/or cessation of play. An injury was categorized as contact and non contact injury.

2. Contact injury: it is that injury which happened during contact with another person, e.g. (another player).

3. Non contact injury: it is that type of injury which happened without contact with another player.

4. Anatomical Factors: anatomical factors in this study mean (Q-angle, pelvic width and intercondylar notch width).

## 1.8 Summary

Female soccer players are more likely to suffer certain sports related injuries than their male counterparts. The knee joint and its structures, especially the anterior cruciate ligament, are susceptible to injuries. Many explanations regarding possible contributing factors to increased prevalence of injuries have been put forward, including gender-related skeletal variation such as pelvic width, femoral anteversion, femoral intercondylar notch dimensions, and increased Q-angle. Awareness of the possible causes of increased knee injury rates in women and girls provides a basis for strategic assessment to this potentially devastating injury.

The next chapter, literature review, is an analysis or synthesis of studies carried out in the area. This includes literature about the prevalence of knee injuries in women soccer players, the possible causes for these injuries, with special regard to the anatomical factors. The mechanism of non contact knee injuries will form part of the discussion.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

Databases (Pub Med, E Medicine & Science direct, 1980 to 2008) related to the issue under discussion were searched. Only articles published from 1980 to 2008 were consulted. This period of search is chosen because it covers the beginning of women soccer globally, precisely in the 1970s. Approximately 7500 abstracts were found. Searching for articles was specified by looking at "knee injuries in women soccer player". This reduced the search to 80 articles. A second search was done with the same database for article related to anatomical risk factors in women knee injuries. This search yielded 134 articles and 220 abstracts. These abstracts were reviewed to eliminate non English articles and those that were not relevant to this study. Only 52 articles on the prevalence of knee injuries in women soccer players and the impact of anatomical factors in these injuries were finally selected. Relevant articles were critically reviewed and summarized. Articles published earlier than 1980 were excluded, unless they contained significant scientific evidences.

The literature available on this topic in South African data bases was rather scarce. This is possibly due to the fact that women's professional soccer only commenced internationally around the 1970s and 1990s in South Africa (SAFA, 2006). This literature is reviewed under the following subheadings: Prevalence of knee injuries, the impact of anatomical factors and injury mechanism.

## 2.2 Prevalence of knee injuries in women soccer players

The prevalence of knee injuries has been documented by different authors in different groups. Arendt and Dick, (1995) carried out a prospective study to evaluate the knee injury patterns among men and women in collegiate soccer and basketball in USA. The study revealed a higher significant anterior cruciate ligament injury rates. It also found that female soccer players are twice as likely to have an ACL injury as a result of player contact, and three times more likely to sustain such an injury through non-contact mechanisms as their male counterparts. They also found an injury rate of 1.6 per 1000 exposure hours in female, as compared to a rate of 1.3 per 1000 exposure hours in the age matched male control group.

The study of Arendt and Dick, (1995) was carried out in the United State of America (USA) amongst intercollegiate athletes. However, a study amongst professional soccer player might have skewed this result and revealed a higher incidence of injuries. Dick, Putukian, Agel, Evan, & Marshal, (2003) carried out a descriptive epidemiology study for collegiate Women's Soccer using injury Surveillance System of the National College for Athletic Association (NCAA). They tried to identify potential areas for injury prevention initiatives. This study used the information of injury registered between 1988 and 2003. The outcome of the study revealed that the rate of injury in women soccer players was more than their male counterparts and the rate of injury was 3 times higher in games than in practice. Preseason practices had an injury rate that was 3 times greater than the rate for in- season practice. The authors also found that the highest rate of injury was ankle sprain (18.3%) while knee rate of injuries stood second at (15.9%). Injuries were categorized as attributable to player contact (contact with another player, the ball or an object) and non contact injuries as those occurring without contact with another player. Wong and Hong, (2005), in a study on soccer injuries in lower extremities focused on the occurrence of knee injuries in women. The data for this study were collected by reviewing and analyzing 37 articles about female professional soccer injuries. It was found that women are six to eight times as likely as men to sustain some kind of knee injury. They reported that there seems to be differences between male and female players in the body parts most often injured. According to Wong and Hong (2005), the results of the National Collegiate Athletic Association show that the three most commonly injured body parts for male players were ankle (20%), upper leg (17%), and knee (15%), and those for female players were knee (24%), ankle (21%), and upper leg (16%). They related the differences in the injury rates and sites to the inherent anatomical differences between male and female players. These differences were in pelvic width and alignment of the leg bones, which made women more likely to injure their knees. The authors also reported in their conclusion that prevention of these injuries should be through the strengthening of the surrounding muscles.

Giza *et al.,* (2005) in a study on injuries in women's professional soccer, found that the most common site of injuries in women soccer players was the knee, with 31% of the total body joint injuries. Anterior Cruciate Ligament (ACL) injuries accounted for 4.6% of all injuries and the incidence of ACL tears was 0.09 per 1000 player hours practice 0.04, game 0.90.

Majewski *et al,* (2006) studied the Epidemiology of Athletic knee injuries in 6434 patients. They conducted their study by analyzing all sport related knee injuries treated in their clinic over a 10-year period. All knee injuries were examined clinically regarding pain, swelling, range of motion, stability, and meniscus pathology. The clinical examination was followed by radiological evaluation (Anterior –posterior and lateral view). The result showed that: 39.8% of the cases were minor knee distortions without damage to any particular structure; the ACL was damaged in 45.4% of the cases, while medial meniscus (MM) was the second with injury rate of 24%; medial collateral ligament (MCL) was 17.6% more often than the lateral collateral ligament (LCL) 2.5%, and posterior cruciate ligament (PCL) stood at 1.5. Majewski *et al*, (2006) reported that most of the knee injuries occurred while engaging in two popular sports namely soccer 35% and skiing (26%). The results also showed a higher prevalence of knee injuries among male athletes with injury rate at 68.1%, while the injury rate among female athletes was 31.6%. For both genders, the highest number of knee injuries was observed between the ages of 20 and 29 yrs.

Majewski *et al.*, (2006) was the first study to report that male athletes have a higher rate of knee injuries than women that may be due to discrepancies in the sample, as 68.1% of the sample size were men while only 31.6% were women. The study by Majewski *et al*, (2006) also found that the highest rate of knee injuries occurred to the footballers at the ages of 20and 29, although 43% of the sample size was between the ages of 20 and 29 at the time of injury.

Junge and Dvorak, (2007) analyzed the incidence, characteristics and circumstances of injury in elite female football players in top-level international tournaments. This study was a prospective survey in which injuries incurred in seven international football tournaments were analyzed using an established injury report system. Medical team of all participants' teams reported all injuries after each match on standardized injury reporting form. They were able to collect 387 injury reports from 174 matches, equivalent to an incidence of 67.4 injuries/1000 player hours or 2.2 injuries per match. The injuries most commonly involved the lower extremity (65%), followed by injuries of the head and neck (18%), trunk (9%) and upper extremity (8%).Out of these 387 injuries there was (ankle sprain 61;16%) and injuries of the knee ligaments (23;6%). They concluded that injury history and playing position are the main causes for the knee injuries in women soccer players. This study concentrated on the external factors regardless of the internal factors.

Renstrom *et al.,* (2008) reviewed International Olympic Committee (IOC) concepts on the non- contact ACL injuries in female athletes. They reviewed different reports from Norway (2004), Denmark (2005), and Sweden (2006) and found that the incidence of ACL injury remains high, especially in young women players aged 15-19 years. According to the IOC the most common mechanism of ACL injuries for the sports commonly was non contact in nature (Renstrom *et al.,* 2008). In spite of the fact that some successful prevention programmes have been introduced, a knee injury continues to be the main problem in sports medicine, especially in female athletes. The mechanism of ACL injury is an important focus of discussion, as an ACL tear is more often a non contact event with a deceleration or change of direction manoeuver than a contact or direct blow injury (Renstrom *et al.,* 2008). Usually the IOC reports deal with injuries in different type of sports related to Olympic Games. Although women football has recently been recognized in the Olympic Games, the mechanism of injury and the event for knee injuries in different sports are still the same, as has been described by Renstrom *et al.,* (2008).

The risk factors for injury to the ACL are divided into intrinsic and extrinsic factors. The main intrinsic factor is body biomechanics, while the external factors include the playing ground, player shoes and training, and weather environment (Mandelbaum & Putukian, 1999).

## 2.3 The impact of the anatomical risk factors.

The role of the anatomical risk factors that are considered the cause for increasing the incidence of knee injuries among female soccer players will be reviewed. These anatomical risk factors are: the variation of the Q angle, pelvic width and intercondylar notch configuration.

### 2.3.1 The Q- angle as risk factor to knee injury

Horton and Hall, (1989) in a study do document the relationships between Q angle, gender, and selected anatomical measurements revealed that the mean Q angle for women was 15.8± 4.5 degrees and for men 11.2 ±3.0 degrees. They found a relationship between gender and Q angle (r = -.517). It is clear from the study of Horton and Hall, (1989) that women have a higher Q-angle than the men have. These findings were similar to those of Hahn and Foklspang (1997). Hahn and Foklspang (1997) investigated 339 athletes and observed Q-angle asymmetry within subjects, and their experiment also found that the Q-angle was greater in females. Moeller and Lamb (1997) found the increased female Q angle is often explained by females possessing a wider pelvis than males, thus increasing the obliquity of the femur and consequently the valgus orientation of the knee, considered to be the cause for injuries. These findings were supported by Cox and Lenz (1994) and Ferretti et al.,(1992).

Hertel *et al.,* (2004) investigated the relationship of ACL injury history to gender, navicular drop, Q-angle, and pelvic tilt using a case control design. Females, regardless of injury history, demonstrated significantly larger Q-angle measurements. The results of this study also suggest increased navicular drop, and anterior pelvic tilt, regardless of gender while larger Q-angle measures for females appear to have no relation to this type of injuries. The findings by Hertel *et al.,* (2004) were similar to those of Loudon *et al.,* (1996), who found no statistical association with the increased ACL injury risk.

Loudon *et al.,* (1996) and Hertel *et al.,* (2004) were retrospective studies. They add other anatomical risk factors for non contact knee injuries like the pelvic tilt, navicular drop and hip internal and external rotation range of motion while they excluded the Q-angle from being a risk factor for the knee injuries. However, they didn't include the intercondylar notch width in their study as one of the anatomical risk factors for the non contact knee injury.

Emami *et al.,* (2007), studied the relation between the Q-angle and the patellofemoral pain. Their study defined the patelofemoral pain as nonspecific anterior knee pain, and is the most common knee problem. Patellofemoral disorders are generalized to the anterior part of the knee. The study was performed on two groups. The case groups Consisted of 100 outpatients (44 men and 56 women) aged between 15 and 35 years. These had anterior knee pain. The control group consisted of 100 outpatients (50 men and 50 women) with their age range similar to the other group, but without knee problems. The Q-angle of each knee was measured in all participants, using a universal goniometer. The Results of the study showed that the mean Q-angle for men, women, and all participants in the case group was 15.2, 20.1, and 18.0 degrees, respectively. In the control group the angles were 12.1, 16.7, and 14.9 degrees, respectively. All these differences were statistically significant ($P < 0.001$). Emami *et al.,* (2007) concluded that patients with anterior knee pain have larger Q-angles than healthy individuals. This study was carried out in general population patients and non patients but still the results can be generalized to the sport population and women soccer players as they are part of it.

The British Association of Clinical Anatomy discussed the anatomical risk factors for the knee injuries during their annual scientific meeting in 2007. A paper titled "Anatomical basis of knee injuries" by Bayramoglu, Bayramoglu and Demiryurek, (2007) documented that anatomical variations around the knee have been associated with various clinical symptoms and conditions. The differences in the Q-angle and the size of the intercondylar notch, which when small restricts ACL movement, give rise to high risk of ACL injuries.

According to Bayramoglu *et al.,* (2007), anatomical factors may be considered as risk factors to knee injuries in women because women usually have smaller intercondylar notch and a higher Q-angle.

In conclusion, several authors have recognized the relationship between increased risk of ACL injury, patellar mal-tracking and anterior knee pain. There has been documented association of ACL injuries to Q-angle **(**Moeller & Lamb, 1997; Bayramoglu *et al*., 2007; Emami *et al.,* 2007). However, a few studies have also reported on the contrary. They found no relationship between Q-angle and predisposition to ACL injury (Loudon *et al*., 1996; Hertel *et al.,* 2004).

### 2.3.2 The Pelvic width as risk factor to knee injury

It is documented that females have a wider pelvis than their male counterparts (Moeller & Lamb, 1997; Ireland *et al*., 1999). Ireland *et al.*, (1999) states that a wider female pelvis increase ACL injury risk by creating a greater Coxa Vara / Geno Valgum alignment with concurrent increase in tibio-femoral rotation force, thus imposing greater stress on the ACL. Hirst, Armaeue and Parsh, (2007) conducted a prospective survey study aimed to provide the primary care practitioner with the fundamental information regarding ACL tear in female athlete. They reviewed literature relevant to the factors accounting for the prevalence to non contact knee injuries in women. They pointed out that women are very different from men structurally adding that women have a wider pelvis than men, and have more flexible hip, leading to more rotation. Women experience an increase in pelvic width during puberty. They also have a shorter femoral length than men. The wider pelvis and shorter femur in women lead to increase the Q-angle in women as compared to men. They also noted that; the larger the Q-angle, the greater the lateral pull on the patella by the quadriceps femoris, causing more stress on the knee.

There is a great relationship between the Q-angle and the pelvic width. Mechanically, an increase of the pelvic width and that of femur obliquity means an increase of the Q-angle. As far as the Q-angle should be the angle generated by a line connecting the anterior superior iliac spine (ASIS), the bottom of the groove of the femoral condyle, and the tibial tubercle (Moore & dally, 2005).

### 2.3.3 Intercondylar notch as risk factor for knee injury

Souryal and Freeman, (1993) investigated the relationship between the intercondylar notch size and anterior cruciate ligament injuries in athletes. The study used normal antero-posterior X-ray view, which measures the notch width per millimeters. The result of this study revealed that men have a wider intercondylar notch than women, indicating that players who sustained ACL injuries in noncontact manoeuvers had significantly narrow intercondylar notches. They also found strong association between intercondylar notch stenosis and ACL injuries. It is clear from Souryal and Freeman, (1993) that ACL stenosis can occur for both genders depending on the size of the intercondylar notch and the accommodated ACL.

Laprade and Burnett, (1994) suggested an association between a small intercondylar notch and sustaining an ACL tear. They evaluated the possible relationship between femoral intercondylar notch stenosis and anterior cruciate ligament injuries in pivoting and cutting sports. Laprade and Burnett (1994), in a 2-year prospective study performed on intercollegiate athletes at a Division-1 universityin USA. Bilateral intercondylar notch view radiographs were taken of all athletes enrolled in this study. The notch width index, a ratio that measures the width of the anterior outlet of the intercondylar notch divided by the total condylar width at the level of the popliteal groove, was measured for each knee. A total of 213 athletes, representing 415 anterior cruciate ligament-intact knees, were enrolled in the study. A correlation between femoral intercondylar notch stenosis and anterior cruciate ligament injuries was found. However, no statistical difference was found between genders regarding notch width indices or rate of anterior cruciate ligament tears. Teitz *et al.,* (1997) compared bilateral intercondylar notch width (INW) in 40 male and 40 female patients using radiographs. They found that INW were symmetrical within subjects and there was considerable overlap in dimensions between genders. They further observed that females displayed a smaller INW than males but this was not statistically significant, and there was also no difference in INW between patients with and without ACL tears. They also suggested that disagreement between studies may be a product of different imaging techniques used to map the dimensions of the notch.

Shelbuorne, Davis, and klootwyk, (1998) found that the intercondylar notch was narrower in women than men. This study was from a sample of 714 patients who underwent ACL construction. These patients' intercondylar notches were measured by taking weight bearing posterior-anterior radiograph. To prevent any differences or discrepancies, the same radio technician took all the measurements, using the same radiographic techniques and the same equipment for all the patients. This study found that the patient who suffered the ACL injury had narrower intercondylar notch width than the control subject. The Same researchers also proposed a different explanation for the increase in the female ACL injuries. Smaller anthropometric measurements where implicated. They believed that the narrower notch was indicative of smaller ACL within the intercondylar notch. The smaller the ACL, the weaker it is and therefore more susceptible to damage. Staeubli, Adam, Becker, and Burgkart, (1999) assessed the anatomy of the anterior cruciate ligament (ACL) and femoral intercondylar notch on cryo sections from one cadaveric knee specimen. They determined the cause of the ACL injuries, the widths of the cruciate ligaments at intersection, and the intercondylar notch configuration on coronal oblique plane magnetic resonance images in 51 adult cruciate ligament-intact knees. The participants were 25 women and 26 men, with their ages ranging from, 16 to 47 years. The intercondylar notch widths were measured at the notch entrance, at the intersection of the ACL and posterior cruciate ligament (PCL), and at the notch outlet. They also measured the absolute widths of the ACLs and PCLs. Results revealed that the relative widths of the cruciate ligaments with respect to corresponding intercondylar notch widths were not significantly different. At notch outlet, the mean notch width measured 21.4 mm in men and 18.5 mm in women. At intersection, the mean notch width measured 19.1 mm in men and 16.6 mm in women. At notch entrance, the notch width measured 14.6±1.8 mm in men and 12.7±2.1 mm in women. They recommended magnetic resonance tomography of the knee in the coronal oblique plane oriented parallel to the Intercondylar roof as the imaging modality of choice to visualize accurately the anatomic diagonal course of the ACL, and its relation to the intercondylar notch and posterior cruciate ligament complex.

Boden *et al.,* (2000) conducted a survey study to the etiology and the preventive methods of the noncontact ACL injury. Anatomical factors that were considered as the causes for the ACL injuries in women are intercondylar notch, ACL size, and lower leg alignment. According to Boden *et al.,* (2000) literature on intercondylar notch stenosis as a predictor of ACL injury has several limitations. Roentgenographic techniques for measuring intercondylar notch width vary considerably depending on knee angle, magnification, and measurement locations. Both plain films and CT scans lack ratio measurements for determining ACL injuries impingement. Boden *et al.,* (2000) added that it is plausible that ACL injuries impingement can occur through hyperextension. However, most ACL injuries occur with the knee partially flexed. In addition, the site of ligament rupture is usually more proximal to the site of impingement. If notch impingement did occur from valgus force to the knee, one would expect to see a higher rate of concomitant medial collateral ligament injuries.

Alizadeh and Kiavash, (2008) performed a cross-sectional study to investigate if a narrow intercondylar notch width is a risk factor for ACL tears. All adult patients with knee problems, who were referred to the MRI department of Poursina Hospital, Rasht, Iran, from October 2006 to October 2007, were included in their study. Axial and longitudinal MRI were performed with the patient's knee in an extended position. In all patients, the femoral notch and the distal condylar width were measured. Cases with normal ACL were used as control and patients with a complete or incomplete tear of ACL were chosen as case group. Because of the effect of osteoarthritis in decreasing the intercondylar notch index, cases with obvious osteoarthritis were not included in the study. Independent sample Student’s t test was used to compare the means. Their study showed that ACL tear was found in 148 patients. The mean ± SD NWI was 0.298±0.05. In addition, there was no significant difference in the frequency of an ACL tear in patients with and without critical notch stenosis (P= 1.0).

Considering women and men separately, they found no significant difference in the mean NWI in patients with and without an ACL tear.

Renstrom *et al.*,(2008) in their review of the International Olympic Committee's current concepts statement, stated that the dimensions of the intercondylar notch have been the most discussed anatomical feature in the published literature in relation to acute ACL injuries but pointed out that geometric differences in the size and shape of the ACL have not been well characterized.

Despite the number of methods for measuring the notch, notch width measurement of bilateral knees with ACL injury is smaller than that of unilateral knee with ACL injury, and notch widths of bilateral and unilateral knees with injury to the ACL is smaller than notch widths of normal controls (Renstrom *et al.,* 2008). This implies a strong association between notch width and ACL injury. The properties of the ACL material may differ between the genders, and there might be other factors that might be associated with ACL injury ( Renstrom *et al.,* 2008).

## 2.4 The injury mechanism

Many studies investigated the relation between the anatomical risk factors and the injury mechanism of the knee especially the non contact knee injuries in female. Wojtys and Huston (1996) in a research to identify possible predisposing neuromuscular factors for knee injuries, particularly anterior cruciate ligament tears in female athletes, investigated anterior knee laxity, lower extremity muscle strength, endurance, muscle reaction time, and muscle recruitment order in response to anterior tibial translation. They recruited four subject groups: elite female (N=40) and elite male (N=60) athletes and gender-matched nonathletic controls (N= 40). All participants underwent a subjective evaluation of knee function, isokinetic dynamometer strength and endurance tests and anterior tibial translation stress tests. Results of dynamic stress testing of muscles showed less anterior tibial translation in the knees of the athletes (both men and women) compared with the nonathletic controls. The results of this study also showed that female athletes and controls demonstrated more anterior tibial laxity than their male counterparts and significantly less muscle strength and endurance. Wojtys and Huston (1996) analyzed the mechanism of knee injuries in females, and they related the cause of injuries to different factors, including limb alignment which means that pelvic width and the Q-angle have direct effect on the biomechanics of the female body.

Olsen *et al.,* (2004) observed in a detailed video analysis of ACL injuries that 95% of the plant and cut injuries occurred while the athlete was moving in a lateral direction and attempting to change direction medially. Another common ACL injury mechanism reported in the study occurred during single leg landing, with all the injuries occurring on the same leg used to take-off. The direction of the landing whether it was medially or laterally was not reported. Olsen *et al.,* (2004) supported the finding of Wojtys and Huston (1996).

Li *et al.,* (2004) studied the effect of tibio-femoral joint kinematics on patello-femoral contact pressures under simulated muscle load amongst eight fresh frozen human cadaveric knee specimens and they tested it using a robotic testing system. Weights were hung from a system of ropes and pulleys to simulate muscle loads. Their results showed that loading on flexion angle had significant interaction effects on both the translation and rotation of the tibia.

Results of Li *et al.,* (2004) indicate that tibio-femoral knee kinematics directly affect patello-femoral joint contact pressures. Therefore, increased Q-angle may also contribute to increasing the contact pressure in the patellofemoral joint. The Results of this study implicated Q-angle and the biomechanics of knee joint to knee injuries.

Pollard *et al.,* (2004) studied the influence of gender on hip and knee mechanics during a randomly cued cutting manoeuver. Data for this study were collected on 24 collegiate soccer players (12 females and 12 males) while each performed the cutting manoeuver. Subjects were signaled by a lighted target board that directed them to perform one of three tasks (cutting manoeuver, a straight ahead run and jump stop). Kinematic data were collected using seven high quality cameras. Three dimensions analysis system was used to analyse the data. Hip and knee joint mechanics were compared between genders using one-tailed t-tests. It was reported that females demonstrated significantly less peak hip abduction than the males. Otherwise, there were no gender differences in selected peak hip and knee joint kinematics (pollard *et al.,* 2004).They suggested that collegiate athletes who acquired similar training and exposure to sport result in similar hip and knee joint kinematic and kinetic patterns.

The study of Pollard *et al.,* (2004), excluded mechanical differences to be a cause for increased non contact knee injuries among women soccer players but they could not exclude the Q-angle from being a risk factor.

Bahr and Krosshaug (2005) tried to develop a comprehensive model for knee injury causations. They suggested that there were two major theories on how the notch width could influence injury rates. One is a possible association between notch width and the ligament width. The other hypothesis involves the interaction between an internal risk factor (that a narrow intercondylar notch can lead to impingement of the ACL on the medial aspect of the femoral condyle) and the injury mechanism that may be more likely to occur when the knee is loaded in valgus and external rotation of the tibia. According to their hypothesis, it is even possible this type of injury occurs on high friction floors (external risk factor) or to player with suboptimal neuromuscular control (internal risk factor). Bahr and Krosshaug (2005) used the previous model of intercondylar notch to study the interaction between the external and internal risk factors, and they proved the relation between the external and internal risk factors. Hirst *et al.,* 2007suggested that this model can be used to study the interaction between different factors causing injury and address the potential for prevention.

Bowerman *at al.,* (2006) in a study to investigate the factors influencing knee injuries amongst male and female athletes and non-athletes in fifty-four (27 male, 27 female) athletes and fifty-three (25 male, 28 female) non- athletes compared knee joint laxity and muscular strength. They found that laxity is related more to athletics participation than gender; therefore, knee joint laxity may not explain the higher incidences of knee injuries in females. They suggested that there should be no difference between genders regarding the risk factors, if they were participating in the same sport and underwent the similar training routines at the same intensity level.

## 2.5 Limitations of the previous studies

One of the clear limitations of previous studies is the comparison of the anatomical risk factors between genders. It is revealed that women have a higher Q-angle, wider pelvic and smaller intercondylar notch when compared to men (Souryal &Freeman, 1993; Moeller & Lamb, 1997; Emami *et al.,* 2007; Hirst *et al.,* 2007) but they do no necessarily present with knee injuries. This study compares the risk factors between two groups from the same genders to avoid this limitation.

Other limitation of previous studies was the lack of standardized method to measure the Q-angle and the intercondylar notch. This was the cause for the large differences in the results of previous studies. In general, studies on ACL geometry and notch dimensions are difficult to interpret because of the lack of standardized methods to obtain the data (Teitz *et al.,* 1997; Boden *et al.,* 2000; Renstrom *et al.*,2008). In the present study, the method used by Souryal and Freeman, (1993) to measure the intercondylar notch width through plain X-ray was used.

## 2.6 Summary

The literature reviewed confirms that women soccer players are more susceptible to non contact knee injuries than their male counterparts. Different approaches to the causes of this type of injuries were also documented. Some of the researches suggested that the anatomical risk factors have a role on this type of injuries, while other studies reject the idea of the anatomical risk factors having any association with this type of injuries. The last section of the literature reviewed the mechanism of non contact knee injuries with relation to the anatomical risk factors and summarized the limitations of the previous studies.

The next chapter discusses the methods used in this study. It provides details on the study design, population, and sample size, procedure for data collection, reliability, and validity of the instrument as well as ethical considerations.

# CHAPTER THREE
# METHODOLOGY

## 3.1 Introduction

This chapter discusses the methods and the procedures used in this study, including the study design and the instrument used to obtain the data. Study population and sample, sampling technique, reliability, and validity of the instrument as well as the ethical considerations are also discussed.

## 3.2 Study design

The design for this study was prospective study design with a case and control. Prospective study is a research method that follows over time a group of individual who are alike in many ways but differ by certain characteristics and compare them for a particular outcome (Struwig and Stead, 2001).

## 3.3 Formation of Case and Control

The participants in this study were divided into two groups. The groups were distributed according to the presence or absence of knee injuries. Those with injury were in group-1 (Case) while those without injuries were in group-2 (Control).

## 3.4 Population

The population of this study was made of 24 players from the South African national team of women soccer, U-23.

## 3.5 Sample size and technique

### 3.5.1 Sample size

All the 24 players in camp participated in this study.

### 3.5.2. Sampling technique

The sampling technique in this study was purposive. All the players in camp participated in the study.

## 3.6 Instrument for Data collection

Data collection sheet, X-ray, and goniometer were used to collect data.

### 3.6. 1 Data collection sheet

The data collection sheet was divided into four sections. The first section was for demographic data (Name, age, weight, height and position on the field, current club name, seasons played for the current club, and other clubs played for, if any). The second section was about knee injury history if any.Was it in the right or left knee, and was it contact or non contact injury. The third section was about the management of the injury. The last section required information about other injuries.

### 3.6.2: Equipments

#### 3.6.2.1 X-rays

Two X-rays were taken for each participant's lower limbs;

1. The first X-ray was a long film taken for both pelvis and knees, from the anterior superior iliac spine to the patella of both lower limbs. X-rays measurements were (66-68KV, 25 MAS, 0.12 Sec) for all participants. X-rays were taken on standing position.
2. The second X-ray film was for intercondylar notch, the position used while taking the X-rays is known as'tunnel view' position ,which is semi prone with knee flexed >$80^0$. Machine measurements were (66-68KV, 25 MAS, 0.12 Sec).

The first X-ray used conventional film while the second used a digital film.

X-rays were taken at the Department of Radiology at Dr George Mokhari Hospital. All X-rays were taken in the same room under the same conditions and by the same technician. The X-ray machine used for the test was Shimadzu, RAD speed Safire machine. The same machine was used for all the participants.

#### 3.6.2.2 Goniometer

The Q-angle measurements of the participants were taken manually using universal goniometer instrument. This angle was measured according to the methods used by Emami *et al.*, (2007). The proximal arm of the goniometer aligned at the anterior superior iliac spine, the axis at the midpoint of the patella, and the distal arm aligned with the tibial tubercle.

## 3.7 Procedure for data collection

Permission from the administrative section of the women soccer project was taken at the early beginning prior to commencement of the study. A meeting was held with South African women national team U-23yrs in Pretoria in March 2008. A presentation about the study and its objectives and aims were made to SAFA. Data collection sheet and consent forms were distributed to the players after the presentation. Two weeks after the presentation, all the players who were ready to participate in this study were taken to Dr George Mokhari Hospital for the X-rays. Q-angle measurements were taken from the players at their camps after the X-rays.

## 3.8 Reliability and validity of the instrument

Intra rater test was done to measure the reliability of the goniometer measurements (21.77/24=0.90).

## 3.9 Pilot study

A data collection sheet was piloted on four subjects from Ga-Rankuwa women soccer club to test whether the questionnaire was clear and understandable. This test provided an accurate estimation for the time needed to complete the questionnaire.

## 3.10. Ethical consideration

1. The current study was approved by the Research, Ethics and Publications Committee of the Faculty of Medicine, University of Limpopo (Medunsa Campus) and Dr George Mukhari Hospital.

2. A written permission from the administration section of the women soccer players at Johannesburg was taken prior to any procedures.

3. The University of Limpopo (Medunsa Campus) Consent form was distributed to the participants prior to the X-ray procedures.

4. Participants were provided with the information sheet which included the aims and objectives of the proposed study and were given the opportunity to ask questions. Ample time was given to them rethink the issue. The aim and objectives of the study were sufficiently clear to them. It was made clear that the participation in this study was completely voluntary and that they may withdraw from it at any time and without giving reasons.

5. Participants were fully aware that the results of this study will be used for scientific purposes and may be published. They agreed to this, provided their privacy was guaranteed.

6. Participants gave consent to participate in this Study.

## 3.11 Interpretation of the X-rays

A radiologist at the department of radiology at George Mokhari Hospital interpretated the X-rays in this study.

## 3.12 Data analysis

The data emanating from this study were analyzed with a statistical package of social sciences version 17. The following statistics were used. Descriptive statistics of means and SD, percentages were used to describe the demographic information of the participants while tables and graphs were used to present data. Inferential statistics of ANOVA was used test the relationship among the variables being evaluated. Each was categorized based on the concept or construct that they represented between the groups. The level of significance was set at 0.05.

## 3.13 Summary

This chapter described the methodology used to carry out this study. It described the method selected for this study, which is the prospective approach, with case and control methods used in this study, and the formation of the case and control groups. This chapter also described in detail the data collection sheet and the instruments used to collect the data. Reliability and validity of the instrument and ethical considerations were also presented and discussed fully. The next chapter presents the results of this study

# CHAPTER FOUR

# RESULTS

## 4.1 Introduction

This chapter presents the outcome of the measurements done in chapter 3. Results are presented using tables, and there will be a brief description of in the text. Demographics of the players will be presented first, followed by the results on the prevalence of knee injuries. Subsequently, the results related to the anatomical risk factors of knee injuries in women soccer players will be presented. Finally, statistical analysis will be presented to test the relation between the knee injuries and the risk factors.

### 4.1.1 Description of the participants

With Regards to the demographic data of the participants, Age, weight and height were described in the following tables (4.1, 4.2 and 4.3).The age of the participants was distributed between 17and 22 yrs, the mean and standard deviation for the age (18.92 $\pm$ 1.17) The weight of the participants were distributed between 55kg and 63, the mean and standard deviation for the weight was (58.5 + 2.28). The heights of the participants were distributed between 157cm and 172 the mean and standard deviation for the heights were (165 $\pm$4.46 cm). Results of the relation between the participant’s demographic data and the knee injuries can be seen in table (4.14). According to these results, there is no relation between the demographic data (Age Weight and height) and the knee injuries.

Table 4.1 Distribution of the participant's age

| Age/Years | Number of Players | Percent |
|---|---|---|
| 17 | 2 | 8.3% |
| 18 | 7 | 29.2% |
| 19 | 9 | 37.5% |
| 20 | 4 | 16.7% |
| 21 | 1 | 4.2% |
| 22 | 1 | 4.2% |
| **Total** | **24** | **100%** |

Table 4.2 Distribution of the participant's weight

| Weigh /Kg | Number of Players | Percent |
|---|---|---|
| 55 | 2 | 8.3% |
| 56 | 3 | 12.5% |
| 57 | 4 | 16.7% |
| 58 | 5 | 20.8% |
| 59 | 2 | 8.3% |
| 60 | 1 | 4.2% |
| 61 | 5 | 20.8% |
| 62 | 1 | 4.2% |
| 63 | 1 | 4.2% |
| **Total** | **24** | **100%** |

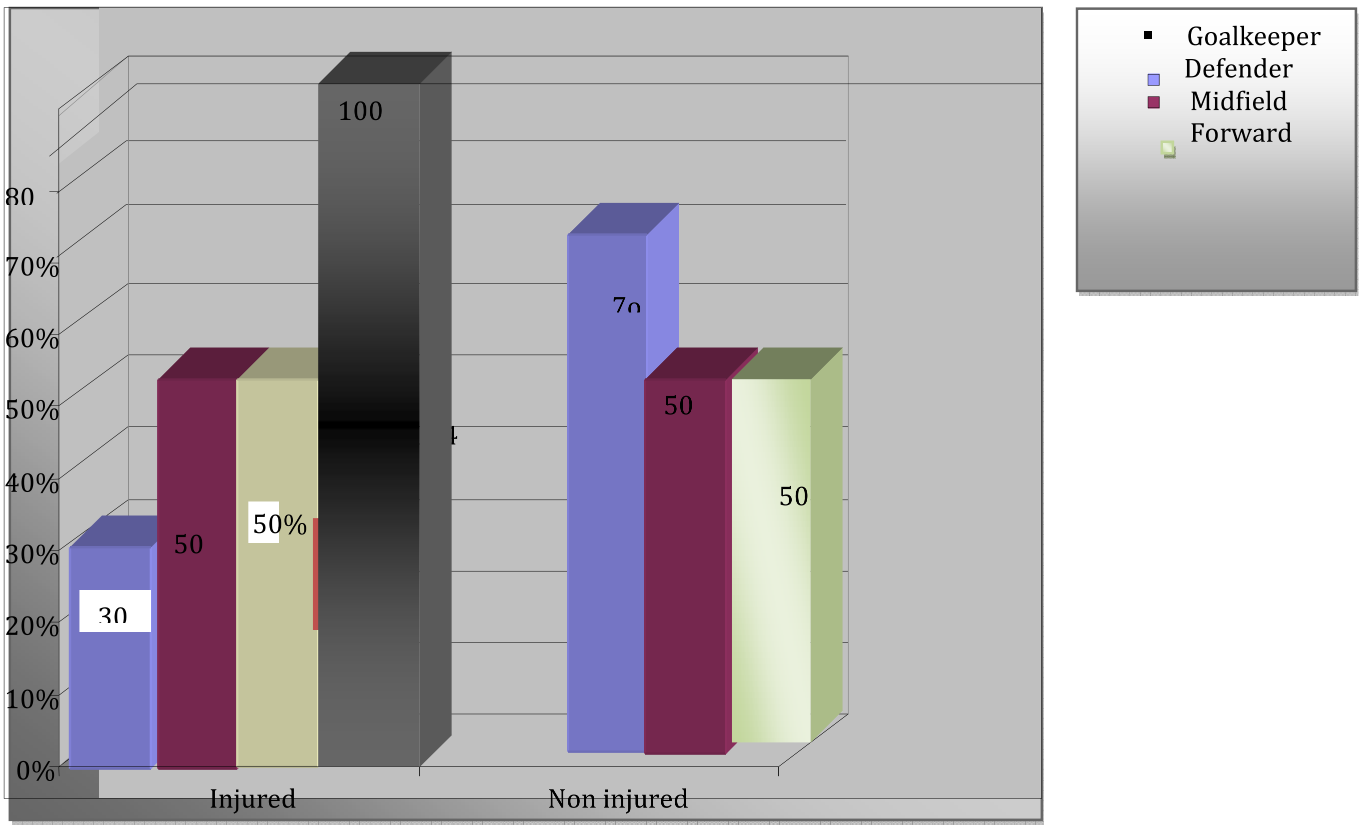
Table 4.3 Distribution of the participant's height

| **Height/Cm** | **Number of Players** | **Percent** |
|---|---|---|
| 157 | 1 | 4.2% |
| 158 | 1 | 4.2% |
| 159 | 3 | 12.5% |
| 162 | 2 | 8.3% |
| 163 | 1 | 4.2% |
| 164 | 3 | 12.5% |
| 165 | 2 | 8.3% |
| 166 | 1 | 4.2% |
| 167 | 2 | 8.3% |
| 168 | 1 | 4.2% |
| 169 | 3 | 12.5% |
| 170 | 1 | 4.2% |
| 171 | 2 | 8.3% |
| 172 | 1 | 4.2% |
| **Total** | **24** | **100%** |

### 4.1.2 Distribution of players' position

With regards to the position of the players on the field, there were two goal keepers, eight defenders, eight midfielders and six strikers. Most of the injuries occurred to the midfielders 4(50%) and strikers 3(50%). On the other hand, only one defender (12.5%) has knee injury while both goalkeepers had knee injuries. Fig 4.1 shows the distribution of the player's knee injuries with regard to their position on the field.

Figure 4.1 Distribution of players' position



## 4.2. The prevalence of knee injuries

Results of this study revealed that ten (41.7%) of the total participants (24) sustained knee injuries. Details are presented in table 4.4 below. According to the findings of this investigation, four of the participants representing 16.7% had non-contact knee injuries while six (25%) participants sustained contact knee injuries.

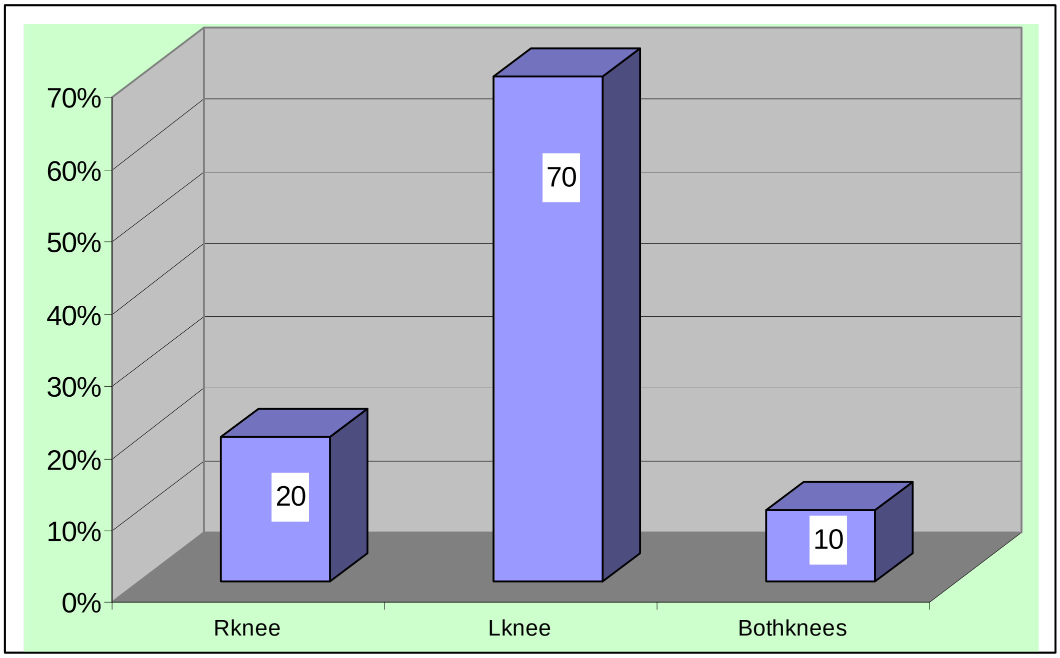
Table 4.4 distribution of the knee injuries

| **variables** | **Number of players** | **Percent** |
|---|---|---|
| **Non contact** | 4 | 16.7 |
| **Contact** | 6 | 25.0 |
| **Without knee injury** | 14 | 58.3 |
| **Total** | 24 | 100.0 |

## 4.3. Side of the knee injuries

Figure 4.2 shows that 70% of the knee injuries occurred at the left knee, while 20% of the knee injuries incidents occurred at the right knee. Only 10% of the participants sustained injuries in both knees.

Figure 4.2 Side of the knee injuries




## 4.4 A comparison of the occurrence of knee injuries with other injuries

The results of this study clearly show higher prevalence of ankle injuries with 58.3% of the total injuries, followed by knee injuries with 41.7% while the shoulder injuries were 8.3% of the total injuries. Four of the participants 16.7% had combined knee and ankle injuries while 8.2% had combined shoulder and knee injuries. (See table 4.5)

Table 4.5 Total prevalence of injuries among the participants

| Injury Side | Frequency | Percent |
|---|---|---|
| **Ankle** | 14 | 58.3 |
| **Knee** | 10 | 41.7 |
| **Shoulder+ knee** | 2 | 8.3 |
| **Knee+ ankle** | 4 | 16.7 |

## 4.5 Association between knee injuries and each of the anatomical factors

Three of the anatomical factors, namely Q-angle, pelvic width and Intercondylar notch were tested to determine the relation between each factor and the knee injuries. The results were as follows:

### 4.5.1 The Q-angle

According to the data in table 4.6, the Q-angle values ranged from $14^0$ to $18^0$ in respect of all participants. A comparison of the Q-angles between the non- injured group and non - contact injured group is reflected in table 4.10

Table 4.6 Q-Angles Values for all of the participants

| **Q-angle In degree** | **Number of players** | **Percent** |
|---|---|---|
| 14 | 1 | 4.2% |
| 15 | 6 | 25.0% |
| 1.5 | 1 | 4.2% |
| 16 | 10 | 41.7% |
| 17 | 3 | 12.5% |
| 18 | 3 | 12.5% |
| **Total** | **24** | **100%** |

## 4.5.2 The Pelvic width

The results of this investigation clearly indicate that pelvic width values ranged from 24cm to 29cm in respect of all of participants (See table 4.7). A comparison of the pelvic width values between the non-injured group and the non-contact injured group can be seen in table 4.10

Table 4.7 distribution of pelvic width values for all participants

| **Pelvic width** | **Frequency** | **Percent** |
|---|---|---|
| 24 - 24.9 | 1 | 4.2% |
| 25 - 25.9 | 4 | 16.7% |
| 26 - 26.9 | 8 | 33.3% |
| 27 - 27.9 | 5 | 20.8% |
| 28 - 28.9 | 5 | 20.8% |
| 29 - 29.9 | 1 | 4.2% |
| **Total** | **24** | **100%** |

## 4.5.3 The intercondylar notch width

According to the results of this study, right intercondylar notch width ranged between 1.3 mm and 28 mm while left intercondylar notch width ranged between1.4 mm and 2.5mm for both injured and non injured groups. See table 4.8 and 4.9. A comparison of the intercondylar notch width between the non-injured group and non-contact injured group can be seen in table 4.10

Table 4.8 Right and left intercondylar notch width

| **Right intercondylar notch** | | | **Left intercondylar notch** | | |
|---|---|---|---|---|---|
| **Width** | **Frequency** | **Percent** | **Width** | **Frequency** | **Percent** |
| 1.3 | 1 | 4.2% | 1.4 | 1 | 4.2% |
| 1.6 | 1 | 4.2% | 1.8 | 6 | 25% |
| 1.7 | 3 | 12.5% | 1.9 | 5 | 20.8 |
| 1.8 | 5 | 20.8% | 2.0 | 4 | 16.7% |
| 1.9 | 2 | 8.3% | 2.1 | 6 | 25% |
| 2.0 | 8 | 33.3% | 2.3 | 1 | 4.2% |
| 2.1 | 2 | 8.3% | 2.5 | 1 | 4.2% |
| 2.3 | 1 | 4.2% | **Total** | **24** | **100**% |
| 2.8 | 1 | 4.2% | | | |
| **Total** | **24** | **100**% | | | |

## 4.6 The inferential statistics

The relation between the knee injuries and the risk factors has been tested statistically by classifying the participants into three groups (non overlapping groups). The groups were coded as follow

Group 0 = Respondents (players) without knee injuries

Group 1 =Respondents with knee injuries without contact

Group 2 = Respondents with knee injuries with contact

The results of the statistical analysis are presented in tables 4.11, 4.12, 4.13 and 4.14. The objective of the statistical was to determine whether or not the explanatory (independent) variables age, weight, height, Q-angle, P-width, INW-right and INW-left are risk factors. Series of comparisons have been made. The three groups were compared using ANOVA. The results of the global test (See table 4.13) and the multiple comparisons (See table 4.14) clearly demonstrated that none of the variables attributes to knee injury. Groups 0 and1 were compared using T-test (See table 4.11). As in ANOVA, this test illustrated that the hypothesis of no significant risk factor was not significant at the 5% levels of significance.

The P-values of both tests were much larger than the 0.05 level of significance. Table 4.11 gives additional information about the difference in means. It presents a 95% confident intervals of the differences in means of the variables of interest. In all cases the intervals include zero as one of the possible values of the differences. This simply implies that the true difference in the means is zero; implying no difference between each of the pairs considered.

The non-zero values are attributed to sampling and measurements errors. Once again these confidence intervals confirm what was proven by the ANOVA and t-tests.

Table 4.9 Two independent samples T-test

| | Groups | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Age in completed years | .00 | 14 | 19.0714 | 1.38477 | .37009 |
| | 1.00 | 4 | 18.7500 | .95743 | .47871 |
| Weight in KG | .00 | 14 | 58.3571 | 2.20514 | .58935 |
| | 1.00 | 4 | 57.2500 | 1.50000 | .75000 |
| Height in CM | .00 | 14 | 164.6429 | 4.28965 | 1.14646 |
| | 1.00 | 4 | 163.2500 | 3.77492 | 1.88746 |
| Q-ANGLE | .00 | 14 | 16.0714 | 1.07161 | .28640 |
| | 1.00 | 4 | 16.2500 | 1.25831 | .62915 |
| P-WIDTH | .00 | 14 | 27.2286 | 1.28148 | .34249 |
| | 1.00 | 4 | 26.5000 | 1.26754 | .63377 |
| INW-RIGHT | .00 | 14 | 1.8857 | .14601 | .03902 |
| | 1.00 | 4 | 1.7750 | .33040 | .16520 |
| INW-LEFT | .00 | 14 | 1.9286 | .12044 | .03219 |
| | 1.00 | 4 | 1.8500 | .31091 | .15546 |

Table 4.10: Summary of the results of t-test

| | | | | | | | 95% Confidence Interval Of the Difference | |
|---|---|---|---|---|---|---|---|---|
| | | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Q-ANGLE | Equal variances assumed | -.284 | 16 | .780 | -.17857 | .62875 | -1.51147 | 1.15432 |
| | Equal variances not assumed | -.258 | 4.329 | .808 | -.17857 | .69127 | -2.04164 | 1.68449 |
| P-WIDTH | Equal variances assumed | 1.005 | 16 | .330 | .72857 | .72506 | -.80848 | 2.26562 |
| | Equal variances not assumed | 1.011 | 4.911 | .359 | .72857 | .72039 | -1.13335 | 2.59050 |
| INW-RIGHT | Equal variances assumed | 1.005 | 16 | .330 | .11071 | .11021 | -.12293 | .34435 |
| | Equal variances not assumed | .652 | 3.342 | .556 | .11071 | .16975 | -.39955 | .62098 |
| INW-LEFT | Equal variances assumed | .801 | 16 | .435 | .07857 | .09805 | -.12929 | .28643 |
| | Equal variances not assumed | .495 | 3.261 | .652 | .07857 | .15875 | -.40450 | .56165 |

Table 4.11 DESCRIPTIVE STATISTICS

| | GRP | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|
| Q-ANGLE | .00 | 14 | 16.0714 | 1.07161 | .28640 | 15.4527 | 16.6902 | 15.00 | 18.00 |
| | 1.00 | 4 | 16.2500 | 1.25831 | .62915 | 14.2478 | 18.2522 | 15.00 | 18.00 |
| | 2.00 | 6 | 15.7500 | .98742 | .40311 | 14.7138 | 16.7862 | 14.00 | 17.00 |
| | Total | 24 | 16.0208 | 1.04756 | .21383 | 15.5785 | 16.4632 | 14.00 | 18.00 |
| P-WIDTH | .00 | 14 | 27.2286 | 1.28148 | .34249 | 26.4887 | 27.9685 | 25.00 | 29.00 |
| | 1.00 | 4 | 26.5000 | 1.26754 | .63377 | 24.4831 | 28.5169 | 25.00 | 27.60 |
| | 2.00 | 6 | 26.4500 | 1.01931 | .41613 | 25.3803 | 27.5197 | 24.50 | 27.50 |
| | Total | 24 | 26.9125 | 1.22875 | .25082 | 26.3936 | 27.4314 | 24.50 | 29.00 |
| INW-RIGHT | .00 | 14 | 1.8857 | .14601 | .03902 | 1.8014 | 1.9700 | 1.70 | 2.10 |
| | 1.00 | 4 | 1.7750 | .33040 | .16520 | 1.2493 | 2.3007 | 1.30 | 2.00 |
| | 2.00 | 6 | 2.1000 | .40988 | .16733 | 1.6699 | 2.5301 | 1.60 | 2.80 |
| | Total | 24 | 1.9208 | .27502 | .05614 | 1.8047 | 2.0370 | 1.30 | 2.80 |
| INW-LEFT | .00 | 14 | 1.9286 | .12044 | .03219 | 1.8590 | 1.9981 | 1.80 | 2.10 |
| | 1.00 | 4 | 1.8500 | .31091 | .15546 | 1.3553 | 2.3447 | 1.40 | 2.10 |
| | 2.00 | 6 | 2.1167 | .25626 | .10462 | 1.8477 | 2.3856 | 1.80 | 2.50 |
| | Total | 24 | 1.9625 | .21020 | .04291 | 1.8737 | 2.0513 | 1.40 | 2.50 |

Table 4.12 **analysis of variance (ANOVA)**

| | | Sum of Squares | DF | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Age in complted years | Between Groups | .821 | 2 | .411 | .278 | .760 |
| | Within Groups | 31.012 | 21 | 1.477 | | |
| | Total | 31.833 | 23 | | | |
| Weight in KG | Between Groups | 14.702 | 2 | 7.351 | 1.466 | .254 |
| | Within Groups | 105.298 | 21 | 5.014 | | |
| | Total | 120.000 | 23 | | | |
| Height in CM | Between Groups | 38.036 | 2 | 19.018 | .951 | .402 |
| | Within Groups | 419.964 | 21 | 19.998 | | |
| | Total | 458.000 | 23 | | | |
| Q-ANGLE | Between Groups | .686 | 2 | .343 | .293 | .749 |
| | Within Groups | 24.554 | 21 | 1.169 | | |
| | Total | 25.240 | 23 | | | |
| P-WIDTH | Between Groups | 3.363 | 2 | 1.681 | 1.126 | .343 |
| | Within Groups | 31.364 | 21 | 1.494 | | |
| | Total | 34.726 | 23 | | | |
| INW-RIGHT | Between Groups | .295 | 2 | .147 | 2.144 | .142 |
| | Within Groups | 1.445 | 21 | .069 | | |
| | Total | 1.740 | 23 | | | |
| INW-LEFT | Between Groups | .209 | 2 | .105 | 2.724 | .089 |
| | Within Groups | .807 | 21 | .038 | | |

| | | Sum of Squares | DF | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Age in complted years | Between Groups | .821 | 2 | .411 | .278 | .760 |
| | Within Groups | 31.012 | 21 | 1.477 | | |
| | Total | 31.833 | 23 | | | |
| Weight in KG | Between Groups | 14.702 | 2 | 7.351 | 1.466 | .254 |
| | Within Groups | 105.298 | 21 | 5.014 | | |
| | Total | 120.000 | 23 | | | |
| Height in CM | Between Groups | 38.036 | 2 | 19.018 | .951 | .402 |
| | Within Groups | 419.964 | 21 | 19.998 | | |
| | Total | 458.000 | 23 | | | |
| Q-ANGLE | Between Groups | .686 | 2 | .343 | .293 | .749 |
| | Within Groups | 24.554 | 21 | 1.169 | | |
| | Total | 25.240 | 23 | | | |
| P-WIDTH | Between Groups | 3.363 | 2 | 1.681 | 1.126 | .343 |
| | Within Groups | 31.364 | 21 | 1.494 | | |
| | Total | 34.726 | 23 | | | |
| INW-RIGHT | Between Groups | .295 | 2 | .147 | 2.144 | .142 |
| | Within Groups | 1.445 | 21 | .069 | | |
| | Total | 1.740 | 23 | | | |
| | Between Groups | .209 | 2 | .105 | 2.724 | .089 |
| | Within Groups | .807 | 21 | .038 | | |
| | Total | 1.016 | 23 | | | |

Table 4.13 Multiple comparisons

| Dependent Variable | (I) GROUS | (J) GROUPS | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Q-ANGLE | 0.00 | 1.00 | -.17857 | .61304 | .774 | -1.4535 | 1.0963 |
| | | 2.00 | .32143 | .52762 | .549 | -.7758 | 1.4187 |
| | 1.00 | 0.00 | .17857 | .61304 | .774 | -1.0963 | 1.4535 |
| | | 2.00 | .50000 | .69798 | .482 | -.9515 | 1.9515 |
| | 2.00 | 0.00 | -.32143 | .52762 | .549 | -1.4187 | .7758 |
| | | 1.00 | -.50000 | .69798 | .482 | -1.9515 | .9515 |
| P-WIDTH | 0.00 | 1.00 | .72857 | .69286 | .305 | -.7123 | 2.1695 |
| | | 2.00 | .77857 | .59632 | .206 | -.4615 | 2.0187 |
| | 1.00 | 0.00 | -.72857 | .69286 | .305 | -2.1695 | .7123 |
| | | 2.00 | .05000 | .78886 | .950 | -1.5905 | 1.6905 |
| | 2.00 | 0.00 | -.77857 | .59632 | .206 | -2.0187 | .4615 |
| | | 1.00 | -.05000 | .78886 | .950 | -1.6905 | 1.5905 |
| INW-RIGHT | 0.00 | 1.00 | .11071 | .14870 | .465 | -.1985 | .4200 |
| | | 2.00 | -.21429 | .12798 | .109 | -.4804 | .0519 |
| | 1.00 | 0.00 | -.11071 | .14870 | .465 | -.4200 | .1985 |
| | | 2.00 | -.32500 | .16930 | .069 | -.6771 | .0271 |
| | 2.00 | 0.00 | .21429 | .12798 | .109 | -.0519 | .4804 |
| | | 1.00 | .32500 | .16930 | .069 | -.0271 | .6771 |
| INW-LEFT | 0.00 | 1.00 | .07857 | .11113 | .487 | -.1525 | .3097 |
| | | 2.00 | -.18810 | .09565 | .063 | -.3870 | .0108 |
| | 1.00 | 0.00 | -.07857 | .11113 | .487 | -.3097 | .1525 |
| | | 2.00 | -.26667* | .12653 | .047 | -.5298 | -.0035 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2.00 | 0.00 | .18810 | .09565 | .063 | -.0108 | .3870 |
| | | 1.00 | .26667* | .12653 | .047 | .0035 | .5298 |
| *. The mean difference is significant at the 0.05 level. | | | | | | | |

## 4.8 Summary

This chapter showed the result of this study. It also showed that the results were analyzed using statistical software SPSS 14.0 computer program. The information was presented in descriptive statistics i.e. mean, standard deviation, frequency tables, pie graphs, and bar charts for all variables in order to determine the distribution of variables. Three Hypotheses were tested statistically and no direct relationship was found between each of the anatomical factors Q-angle (p= 0.74), pelvic width (p=0.34) and intercondylar notch (p=014 &p=0.089) and knee injuries. Most of the three anatomical risk factors value was similar in injured and non injured groups.

# CHAPTER FIVE

# DISCUSSION

## 5.1 Introduction

This project sought to determine the prevalence of knee injuries in women soccer players and to establish the association between knee injuries and each of the three anatomical factors namely Q angle, Pelvic width and Intercondylar notch width.

Twenty-four players from the South African national team U-23 participated in the study. The results show that there was no effect of the age, weight and height on the prevalence of knee injury among the participants. The age of the participants was between 17and 22 years, the mean and standard deviation for the age was 18.92 $\pm$ 1.17. The weight of the participants stood between 55kg and 63, the mean and standard deviation for the weight was (58.5 $\pm$ 2.28).The heights of the participants were distributed between 157 and 172 cm and the mean and standard deviation for the heights were (165$\pm$4.46). Regarding the position of the players on the field, the midfielder and strikers got more injured 50% than the defenders 12.5%. There were two goal keepers, and both of them received knee injures.

## 5.2 The prevalence of knee injuries in women soccer players

In this study, the prevalence of knee injuries was significantly high 10/24 (42%). The contact injuries were most common among the knee injured group 6/10 (60%), while the non contact knee injuries were 4/ 10 (40%) of the knee injured participants, which represent (17%) of the total participants. These results are supported by previous studies (Dickl *et al.,* 2003; Giza *et al.,* 2005). Dick *et al.,* (2003) found that the highest rate of injury was ankle sprain (18.3%). while the knee rate of injuries stood second at (15.9%). The study of Dickl *et al.,* (2003) was conducted among intercollegiate players while the participants of this study were national team players who played for their teams as well as the national squad of U-23. Engaging in more games and training may result in more injuries to the players (Majewski *et al.,* 2006). Giza *et al*., (2005) investigated 110 women professional soccer players from women united soccer association (WUSA) during the season 2001 and 2002, and they found that the rate of knee injuries in women soccer players was 31% of the total body joint injuries, which is almost similar to our results. The objective of the study by Giza *et al.,* (2005) was to determine the incidence of injury, anatomical location of injuries related to player position. Unfortunately, they did not extend their study to investigate the causes for the increased rate of knee injuries among women soccer players. This study also found that elite female soccer players had an increased rate of knee injuries as compared to elite male soccer players, although the variations between this study and the current study was due to the inclusion of a larger sample in their study. Furthermore, the difficulty of interviewing many players was one of the main reasons why the sample size of the current study was smaller.

In general, the highest rate of injuries was ankle injury with a rate of 58%, followed by knee injury which was 42%. Several studies found that the injuries most commonly experienced were ankle joint followed by knee injuries (Junge & Dvorak, 2007; Wong & Hong 2005; Bruce *et al.*, 2002; Majewski *et al.,* 2006 ;). Junge and Dvorak, (2007) found that the injuries most commonly experienced were lower extremity especially the ankle and knee joints (65% of the total body injuries).They found out that of the 387 injuries there was 61; 16% ankle sprain injuries and 23;6% injuries of knee ligaments. They concluded that injury history and playing position are the main causes for knee injuries in women soccer players.

Bruce *et al.,* (2002) stated that the incidence of knee injuries is considerably greater for female athletes in comparison with male athletes while in contrast, the disparity of ankle-ligament sprains between genders appears to be much smaller.

The occurrences of knee injuries among women soccer players are common. An increasing number of women in sport especially soccer, has increased the incidence of injuries. The situation needs to be assessed and scientific means sought and provided so as to improve the health of the athletes and their performance (Pollard *et al.,* 2004; Wong & Hong, 2005). Many studies have been undertaken in different countries in order to manage the problem (Dick *et al.,* 2003; Giza, *et al.*, 2005; Frobell *et al.*, 2007). However, such studies are limited in South Africa i.e. no documented data are available.

The difference among studies in population, sampling, precision of method, and measuring equipment may account for these differences in results. Besides, many other previous studies found a higher rate of knee injuries among women soccer players (Tallay *et al.*, 2004; Wong & Hong 2005; Louw *et al.*, 2006; Junge & Dvorak, 2007).

## 5.3 The association between knee injuries of three anatomical risk factors.

In the current study, the values of the Q-angles ranged from $14^0$ to $18^0$ for both injured and non injured groups. Furthermore, no clear link was indicated between the Q-angle and the increased rate of knee injuries (p-value = 0.74) in women U-23 soccer players. Several studies have also found no relationship between Q-angle and predisposition to knee injuries. Loudon *et al.*, 1996; stated that “Not only there is no clear link between knee injuries and Q-angle but there is no consensus in the literature as regards Q-angle measurement”.

Until recently, it was believed that the joint hyper laxity predisposes individuals to musculo-ligamentous lesions, particularly in both ankle and knee, suggesting that the increase of flexibility increases laxity, which perhaps, increases the incident of injuries for both genders (Brannan *et al.,* 1995).

In this study three Hypotheses were tested and no direct relationship was found between each of the anatomical factors Q-angle (p= 0.74), pelvic width (p=0.34) and intercondylar notch (p=014 &p=0.089) and knee injuries. Most of the three anatomical risk factors value was similar in injured and non injured groups.

In contrast, the relationship between higher Q-angle and the rate of knee injuries was proven by Emami *et al.,* (2007), but they concluded that the increased Q-angle alone was not responsible for this problem because 16% of the males and 20% of the females in their control group had abnormally high Q-angles values without any knee injuries. Although, another epidemiological study could not identify any statistically significant intrinsic risk factors, it could relate the changes in the Q-angle to an increased prevalence of patellofemoral pain syndrome (Tallay *et al.,* 2004).

Values of the pelvic width were shown to be varied in this study for both injured and non injured groups (24-29 cm). Results of this study revealed that there were no differences in the pelvic width between the knee injured women soccer players and the non-injured (P = 0.34) individuals. The reputation of the same pelvic width values between the two groups decreased the possibility of the pelvic width being a risk factor for the knee injuries among women soccer players.

Many researches suggested that, pelvic width is a risk factor for knee injuries in women, but they compared pelvic width between genders and related to the body biomechanics as well as the body movement (Ireland, 1999; Ireland *et al*., (2002); Moeller &Lamb, (1997).

Ireland *et al.*, (1999) suggested that a wider female pelvis increases knee injury risk by creating a greater coxa Vara/ geno valgum alignment with concurrent increase in tibio-femoral rotation force, thus imposing greater stress on the ACL. Unfortunately no research was presented by this author to substantiate this comment.

Hirst *et al.*, (2007) stated that women are different from men structurally. For example, women have a wider pelvis and a more flexible hip than men, leading to more rotation. Furthermore, men are usually much stronger than women. The muscles around the knee are crucial in stabilizing the knee and preventing injuries to the ACL. They go on to say that the increased values of the pelvic width in women to flexibility may alter the biomechanics of the body, leading to knee injuries in women, which means the biomechanics of the female athlete should be considered as a risk factor more than the pelvic width itself.

The dimensions of the intercondylar notch have been the most discussed anatomical feature in the published literature in relation to acute ACL injuries (Renstrom *et al*, 2008). Geometric differences in the size and shape of the ACL have not been well characterized, however. In general, studies on ACL geometry and notch dimensions are difficult to interpret because of the lack of standardized methods to obtain data (Griffin, 2006).

The result of the present study showed scattered intercondylar notch values (between 1.3mm to 2.8mm) for the right intercondylar notch and 1.4mm to 2.5mm for the left intercondylar notch of the knee injured group, while the values for the right and left intercondylar notch of the non knee injured group were between 1.7mm to 2.1mm and 1.8mm to 2.1mm, respectively. P-values of the right and left Intercondylar notches were p=0.14 and p=0.89, respectively and that excluded the Intercondylar notch from being a risk factor of knee injuries in women soccer players' team U-23 in South Africa.

Recent reports have concluded that the ACL is geometrically smaller in women than in men when normalized by body mass index. The properties of the ACL material may differ between gender (Renstrom *et al.,* 2008).These differences between the two genders made a reasonable ratio between the ACL size and the Intercondylar notch. In general the female has a smaller notch accommodating a smaller ACL, while the male has a larger notch accommodating a larger ACL. This fact has been confirmed by Shelbuorne *et al.,* (1998). The authors believe that a narrower notch is indicative of smaller ACL within the Intercondylar notch. The smaller the ACL the weaker it is, making it susceptible easier.

Bahr and Krosshaug, (2005) stated that "there are two major theories on how the notch width could influence injury rates. One is a possible association between notch width and the ligament width. The other hypotheses involves the interaction between an internal risk factor (that a narrow intercondylar notch can lead to impingement of the ACL on the medial aspect of the femoral condyle) and the injury mechanism (that this may be more likely to occur when the knee is loaded in valgus and external rotation of the tibia).As has been mentioned previously, it is even possible that this is more likely to occur on high friction floors (external risk factor ) or to athletes with suboptimal neuromuscular control ( internal risk factor ). Bahr and Krosshaug, (2005) used the previous model of Intercondylar notch to study the interaction between the external and internal risk factors and they proved the relationship between the external and internal risk factors.

Souryal and Freeman (1993) conducted a study of more than 900 male and female high school athletes and found out that noncontact knee injuries occurred in athletes with a smaller notch-width index than in athletes whose cruciate ligaments tore in contact activities. A smaller notch is more likely to cause impingement on a normal sized ligament. LaPrade *et al.*, (1994) correlated intercondylar notch stenosis and anterior cruciate injuries in a prospective study and found that no conclusive evidence referable to female knee injuries could be made. This study recorded no evidence of the role of notch width index or notch width in knee injuries. Robert, (1999) mentioned that previous studies relating width to width, that is, width of the notch to width of the anterior cruciate ligament. Recent reports have concluded that the ACL is geometrically smaller in women than in men when normalized by body mass index (Renstrom *et al.,* 2008). The properties of the ACL material may differ between genders (Renstrom *et al.,* 2008).These differences between the two genders made a reasonable ratio between the ACL size and the intercondylar notch. In general, female has smaller notch accommodating smaller ACL while male has larger notch accommodating larger ACL. This fact had been pointed previously by Shelbuorne *et al.,* (1998).

## 5.4 Summary

This chapter presented a discussion of the results of the study in relation to the literature that was reviewed in Chapter Three. The prevalence of knee injuries among South Africa women who play soccer for the national team (U-23) was relatively high, while this study could not identify any significant relation between anatomical risk factors and the incidences of knee injuries among the participants. The next chapter includes the limitations, conclusions, and recommendation of this study.

# CHAPTER SIX

# CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

## 6.1 Introduction

This chapter will describe the limitation of the study, which should give an indication of what should be avoided in subsequent studies. The conclusion of the study, in terms of what the relevant results were and how they related to the objectives of the study also will be included. Finally, recommendation for further studies will be presented.

## 6.2 Limitations of the study

Limitation of this study may summarize into two points:

- The number of subjects investigated and the observation period were relatively small. Following a larger group for a longer period of time may have produced more generalized results. However, this is the first study on injuries risk factors in elite female soccer players in South Africa.
- The number of injuries and participation time may not have been measured precisely because players had to recall information from the past. Athletic exposure time was not measured with precision and may have influenced the accuracy of the injury incidence rate.

## 6.3 Conclusions

- In South African women soccer players under 23 years, there is noticeable number of knee injuries reaching to 40% of the total and the reason behind that is not clear.

- There is no clear relationship between the anatomical factors (Q-angle, pelvic width, and intercondylar notch width) and the high rate knee injuries in women soccer players. Most of the knee injuries in women soccer players were contact injuries.

## 6.4 Recommendations

- In order to provide better scientific knowledge in this area, further studies are needed with larger sample size as well as additional and extrinsic risk factors.
- Athletes with predisposing factors for knee injuries must be identified pre-seasonally by performing screening tests. Physiotherapists, doctors and coaches should be involved.
- Further studies should be conducted to compare between female athletes, rather than comparing female to male athletes.
- Protective mechanism should be considered such as protective gear for ladies or strapping and bandaging

# REFERENCES

Alizadeh, A. & Kiavash, V. 2008. Mean Intercondylar Notch Width Index in Cases With and Without Anterior Cruciate Ligament Tears. *Iran Journal of Radiology*, 5(4); 205-208.

Abdulla, A. & Abdullah, F. 2005. Preventing knee injuries in female athlete. *Patient Care* 16:35-38.

Arendt, E. & Dick, R.1995. Knee injury pattern among men and women in collegiate basketball and soccer. *American Journal of Sport Medicine*, 23:694-701.

Austermuehle, P. D**.** 2001. Common knee injuries in primary care. *Nurse Practitioner*. 26: 26-41.

Bahr, R. & Krosshuag, T. 2005. Understanding injury mechanisms: A key component of preventing injuries in sport, *British Journal of Sport Medicine,* 39: 324-329.

Bayramoglu, A. Bayramoglu, D., & Demiryurek, D. 2007. Anatomical Basis of Knee Injuries. *British Association of clinical anatomists*, 29; 23-31.

Boden, P.B., Griffin, Y.L., William, E., & Garrett Jr. 2000. Etiology and Prevention of Noncontact ACL Injury. *The Physician and Sport Medicine,*28-(4):4-6.

Bowerman, S.J., Smith D.R., Carlson, M., & King, G.A. 2006. A comparison of factors influencing ACL injury in male and female athletes and non-athletes. *Physical Therapy in sport,*7; 144-152.

Brannan, M.S., Tori, L. Schulthies, S.S., Myrer, W., Durrant, E. 1995. A comparison of anterior knee laxity in female intercollegiate to normal population .*American Journal of Athletic Training,* 30: 298-301.

Bruce, D., Beynnon, D., Murphy, F., Denise, M. 2002. Predictive Factors for Lateral Ankle Sprains. *Journal of Athletic Training* by *the National Athletic Trainers' Association*, Inc2002; 37(4):376–380.

Caspersen, C., Powell, K.E. & Christenson, G.M.1985. Physical Activity, exercise and physical fitness: *definitions and distinctions for health related research*,100:126-130.

Cox, J. S. & Lenz H.W.1994. Women midshipmen in sports. *American journal of Sports Midicine*,12 (3): 241-243

Dick, R., Putukian, M., Agel, J., Evan, T. A. & Marshal S. W. 2003. Descriptive epidemiology of collegiate women's soccer injuries: National collegiate Athletic Association injury surveilliance system.1988-1989 through 2002-2003.*Journal of Athletics Training,* 42 (2):278-285.

Emami, M. J., Ghahramani, M. H., Abdinejad, F., & Namazi, H..2007. Q-angle: An Invaluable Parameter for Evaluation ofAnterior Knee Pain. *Archives of Iranian Medicine,* 10(1): 24 – 26.

Emery, C.A., Meeuwisse, W.H., & Hartmann, S.E. 2005. Evaluation of risk factors for injury in adolescent soccer: implementation and validation of an injury surveillance system. *American Journal of Sports Medicine*: 33; 1882–91.

Ferretti, A., papandrea, P., & conteduca, F., 1992. Knee ligament injuries in volleyball players. *American Journal of Sports Medicine,* 20 (2): 203-207.

Frobell, R. B., Lohmander, L.S., & Roos, H. P. 2007. A cute rational trauma to the Knee: Agreement between clinical Assessment and MRI Finding. *Scandinavian Journal of Medicine and Science in sport*, 17(2): 109- 114.

Giza, E., & Micheli, L. J.2005. Soccer Injureis. *Medical sport science*, 49: 140-69.

Giza, E., Mithofer, K., Farrell, L., Zarins, B., & Gill, T.2005. Injuries in women's professional soccer. *British Journal of Sport Medicin*e. 39(4):212-6

Griffin, L.Y., Albohm, M.J, & Arendt, E. ,2006. Update on ACL prevention: theoretical and practical guidelines. *American Journal of Sports Medicine*, 34:1512–32.

Hahn, T., & Foklspang, A.1997. The Q-angle and sport.*Scandinavian journal of medical science of sports,* 7, 43-48.

Hertel, J., Dorfman, J.H., & Braham, R.A. 2004. Lower Extremity Malalignments and Anterior Cruciate Ligament Injury History. *Journal of Sport Science and Medicine*, (3): 220-225.

Hewett, T.E., Myer, G.D., & Ford K.R. 2004. Decrease in neuromuscular control about the knee with maturation in female athletes. *Journal of Bone Joint Surgery*, 86-A: 1601–1608.

Hirst, H.E., Armaeue, E., & Parsh, T. 2007. Recognizing ACL tear in female athlete. What every primary care practitioner should know. *The International journal of Allied Health Science and practice*, 5(1):169-203

Horton, M.G., & Hall, T.L. 1989. Quadercips femoris muscle angle: Normal values and relationships with gender and selected skeletal measures, *Physical therapy*, 69(11):897-901.

Ireland, M. L., & Otto, S. M .2004. Special concerns of the female athlete. *Clinical Sport Medicine*. 23(2):281-98.

Ireland, M .L. 2002. The female ACL: Why is it more prone to injury? *Orthopeidic Clinic North America,* 33(4): 637-42. .

Ireland, M.L. 1999. Anterior Cruciate ligament Injury in female Athlete: Epidemiology .*Journal of Athletic Ttraining*. 34: 150-154.

Junge, A., & Dvorak J. 2007. Injuries in female football players in top-level international tournaments. *British Journal of Sport Midicine.* 41 (supplement) i3-i7; doi:10. 1136.

LaPrade, R.F., & Burnett, Q.M. 1994: Femoral intercondylar notch stenosis and correlation to anterior cruciate ligament injuries:a prospective study. *American Journal of Sports Medicine,* 22(2):198-203.

Lewis, L. (2000). Anterior Cruciate Ligament Injury in Female athete: Why women are so vulnerable? Literature review. *Physiotherapy*. 86 ( 9): 464-472.

Li, G., DeFrate,L.E., Zayontz, S., Park, S.E., & gill, T. J. 2004. The effect of tibio-femoral joint kinematics on patello-femoral contact pressures under simulated muscle loads. *Journal of orthopedic Research,* 22, 801-806.

Loudon, J.K., Jenkins, W. & Loudon, K.L. (1996). The relationship between static posture and ACL injuries in female athletes. *Journal of Orthopedic and Sports Physical Therapy,* 24: 91-97.

Louw, Q.A., Manilall, J., & Grimmer, K.A. 2006. Knee movement patterns of injured and uninjured adolescent basketball players when landing from a jump: A case-control study. *British Midical Clinic of Musculoskelet Disorder.* 7(22). : PMC1450282.

Majewski, M., Habelt, S., & Klaus, S. 2006. In Epidemiology of athletic knee injuries. *The knee*, (13): 184-188.

Mandelbaum, B.R., & Putukian, M.1999. In Medical concern and specification in female soccer players. *Science and sport*, 14: 254-60.

McAlindon, R. 1999. ACL Injuries in Women. *Hughston sport medicine foundation*. *Hughston Sport Medicine Foundation*, 11(3): 12-5.

Moeller, J.L., & Lamb, M.M. 1997. Anterior cruciate ligament injuries in female athlete: Why are women more susceptible? *The physician and sportsmedicine,* 25(4).1-10

Moore, K.L., & Dally, A.F.2005. Lower limbs. *Clinically Oriented Anatomy*, 5:555-724. *Lippincott Williams and Wilkins*.

Olsen, O.E., Myklebust, G., Engebretsen, L., & Bahr. R., 2004. Injury mechanisms for anterior cruciate ligament injuries in team handball: A systematic video analysis. *American Journal of Sports Medicine. 32*: 1002– 1012.

Pollard, C.D., Davis, I .M., & Hamill J. 2004. Influence of gender on hip and knee mechanics during a randomly cued cutting manoeuver. *Clinical Biomechanics* 19: 1022-1031.

Putukian, M.1998. The female athlete trail. *Clinic in sport medicine*, 17:675-96.

Renstrom, P., Ljungqvist, A., Arendt, E., Beynnon, B., Fukubayashi, T., Garrett, W., T Georgoulis, T., Hewett, T. E., Johnson, R., Krosshaug, T., Mandelbaum, B., Micheli, L., Myklebust, G., Roos, E., Roos, H., Schamasch, P., Shultz, S., Werner, S., Wojtys, E., & Engebretsen L.2008. Non-contact ACL injuries in female athletes: an International Olympic Committee current concepts statement. *British Journal of . Sports Medicine*, 42:394-412.

Robert, B., 1999.Anterior Cruciate Ligament Injuries in Female Athletes. *Connecticut Medicine*, 63(11): 657-660)

Roush, J., Bustillo, K., & Low, E. 2008. Measurement Error Between a Goniometer and NIH Image Programme for measuring Quadriceps Angle. *The International Journal of Allied Health Science and Practice*, 6(21): 1540-580.

Shelbuorne, k..D., Davis, T.J., & klootwyk,TE.1998. The relation between the Intercondylar notch width of the femur and the incedance of ACL tears. Retrieved jan23, 2005, *American Journal of Sport Medicine*, 26(3):402.

Souryal, T.O., & Freeman, T.R. 1993. Intercondylar notch size and anterior cruciate ligament injuries in athletes: a prospective study. *American Journal of Sports Medicine,* 21(4):535-539.

Souryal, T.O., Moore, H.A., & Evans J.P.1988. Bilaterality in anterior cruciate ligament injuries: Associated intercondylar notch stenosis. *American Journal of Sports Medicine*, 16(5):449 .

South Africa Football Association,2006.Women football in South Africa. Web site, www.SAFA.co.za

Staeubli, H.U., Adam, O., Becker, W., Burgkart R. 1999. In Anterior cruciate ligament and Intercondylar notch in the coronal oblique plane: Anatomy complemented by magnetic resonance imaging in cruciate ligament-intact knees. *The Journal of Arthroscopic and Related Surgery*, 15(4):349–359

Steinacker, T., Steuer, M., & Holtke, V.2005. Injuries and overload-damages at players of the German lady-soccer-national-team..*Sportverletz Sportschaden*, 19(1):33-6.

Stephanie, L. S..2002. Anterior Cruciate Ligament Injuries in Female Soccer Players. *Hughston Sport Medicine*, 14(4): 2-3.

Strong, W.B., Malina, R.M., Blimkie, C.J., Daniel, S.R., Dishman, R.K., Gutin, B., Hergenroeder, A.C., Mus,t A., Nixon, P.A., Pivarnk, J.M., Rowland, T., Trost, S., & Trudeau, F. 2005.Evidence based physical activity for school- age youth. *The journal of Pediatrics*,146;732-7.

Struwig, F.W., & Stead, G.B. 2001. Applying methods for collection data in Planning, designing and reporting research. *Pearson Education South Africa*, 3(43).96-102

Tallay, A., Kynsburg, A., Toth, S., Szendi, P., Pavlik, A., & Balogh, E.2004. Prevalence of patellofemoral pain syndrome. Evaluation of the role of biomechanical malalignments and the role of sport activity. *Hungarian Orvosi Hetilap*, 145**(**41): 2093 – 2101.

Teitz, C.C., Lind ,B.K., & Sacks, B.M.1997.Symmetry of the femoral notch width index; *American journal of sports Medicine*, 25(5):687-600.

Tilton, B**.**1998. Imagine a big hinge. *Backpacker*. 12:26-30.

Wojtys E.M., Huston L.J, 1996. Neuromuscular performance characteristics in elite female athletes. *American Journal of Sports Medicine*, 24:427–

Wong, P., & Hong,Y.2005 . Soccer injury in the lower extremities. *British Journal of Sports Medicine,* 39:473-482.