

Q-angle, Pelvic width, and Intercondylar notch width as predictors of knee injuries in women soccer players in South Africa

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Abstract

Objective: To investigate the association between the three anatomical factors of Q-angle (QA), pelvic width (PW) and Intercondylar notch width (INW) and knee injuries among the U-23 female soccer players of South Africa

Methods: The study is a case-control prospective study design. Twenty four U-23 women soccer players of the South African team were purposively chosen to participate in this study. Participants were divided into two groups: group1 (Case) was those with knee injuries, while those without injuries were in group-2 (Control). PW and INW were measured after X-rays of the hip were taken while the QA was measured manually with the goniometer. Association between anatomical factors and knee injuries were tested with ANOVA.

Results: Q-angle ranged from 14^o to 18^o for both injured and non injured groups. PW was between 24 -29 cm for both injured and non injured groups. INW was between 1.3mm and 2.8mm for the right and between 1.4mm and 2.5mm for the left notch for the injured group, while INW for the right and left of the non injured group were between 1.7mm to 2.1mm and 1.8mm to 2.1mm, respectively No significant association between knee injuries and each of the anatomical factors was found QA (p= 0.74), PW (p=0.34), INW (right and left respectively) (p=0.142 & p=0.089).

Conclusion: The three anatomical factors of QA, PW and INW could not be used to predict knee injuries amongst the U-23 female players in South Africa.

Keywords: Pelvic width; Q-Angle; Intercondylar Notch Width; Female Soccer; Knee Injuries

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Introduction

Physical activity is very important for all human beings and the benefits are well-documented for both genders^{1,2} The level of physical activity will differ in frequency, intensity, and duration depending on gender, age, and type of physical activity. Sport is defined as physical activity involving a structured competitive situation governed by rules³. Soccer is one such example and is considered one of the most popular sport with women making up to 22% of world's soccer player⁴. According to Strong et al¹ numerous benefits of sport to women have been documented. 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, increased bone mass, cardiovascular function and weight control¹.

Over the last twenty years, women soccer has experienced tremendous improvement and growth with a series of events organized by FIFA and the Olympics. Examples of these are; the first women's football cup in China in 1991, Olympic Games in 1994, U-19/ U-23 World Championship in 2002⁵. Most countries including South Africa have national female teams and a local league. There are currently more than 300 women's soccer clubs registered by the South African Football Association (SAFA) and a pool of about 50 000 players. In Africa the first women's soccer tournament was held in 1995⁶. Generally, injuries abound in soccer and increasing incidences of injuries have been reported in female soccer. The most common injuries among female athletes are knee injuries, especially injury to the anterior cruciate ligament (ACL)⁷ Adolescent females suffer a disproportionate number of knee and

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anterior cruciate ligament (ACL) injuries compared to adolescent males. McAlindon⁸ found that female athletes have four to ten times more ACL injuries than male athletes. This was further reiterated by Ireland and Otto⁹ who stated that female athletes have an increased rate of ACL injuries and patellofemoral disorders compared with their male counterparts. Knee injuries in soccer also 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 maneuvers¹⁰. There have been many studies comparing injury rates between male and female players^{8,11,12}. It was found that women soccer players sustain more knee injuries than their male counterparts¹¹ with ACL, the medial collateral ligament (MCL) and acute injuries to the menisci as the most common¹³.

⁴More information on ACL injuries compared to other knee injuries have been documented¹³⁻¹⁵. ACL provides 85% of the total restraining force to anterior translation of the tibia¹⁴. Injuries to the ACL usually occur during a sudden deceleration, as it typically is a noncontact injury¹⁴. 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 players¹⁶. Giza et al¹⁷ analyzed 173 injuries that occurred during the 2001-2002 seasons of the Women's United Soccer Association (WUSA) and 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. Some theories have implicated internal factors such as differences in the anatomical configuration between genders, knee ligament, ligament laxity and muscle strength¹⁸ and external factors, such as conditioning, type of training and the development of muscle coordination¹⁹.

The higher QA in females is reported to influence knee injuries in female athletes²⁰. Horton and Hall²¹, reports a mean QA of 15.8 ± 4.5 degrees for women and 11.2 ± 3.0 degrees for men. Increase in QA might contribute to an increase in the contact pressure applied to the patellofemoral joint²². A valgus knee and a pronated foot are often implicated in knee injuries²³. A potential factor in knee injury is intercondylar notch configuration¹⁴. Studies have shown that players with smaller intercondylar notch dimensions are at greater risk for ACL injury because it accommodates the ACL^{14, 24-25}. On the contrary a

few studies found no relationship between the anatomical factors and predisposition to knee injuries^{26,27}. There is however, limited empirical information on the association between anatomical factors and knee injuries amongst female soccer players in South Africa. This study will attempt to establish the association between knee injuries and each of the following anatomical factors: QA, PW and INW.

Methods

The design for this study is a case-control prospective study design. All the 24 U-23 national female soccer players of South Africa were participants in this study. They were divided into two groups, 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).

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

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 for history of injury (if any). The third section sought information on management of the injury. The last section required information on other injuries.

Procedure for data collection

The objectives of this study were presented to the administrative section of the U-23 women soccer project of SAFA in March 2008 prior to obtaining permission to conduct this study. Approval to conduct the study was granted after the presentation. Two week later, participants were taken to Dr George Mukhari (DGM) hospital where all radiographs and anatomical measurements were taken.

Measurement of intercondylar notch width (INW)

Plain X-rays of both lower limbs were taken using Shimadzu, RAD speed Safire machine. The first X-ray used a conventional film for both pelvis and knees, from the anterior superior iliac spine to the patella of both lower limbs with participants in standing position. While the second one used digital film for the intercondylar notch with participants in 'tunnel view' position (which is semi prone with knee flexed

>80°). Machine measurements were (66-68KV, 25 MAS, 0.12 Sec) for both exposures. The intercondylar notch width was then measured as seen in figure 1 as reported by Shelbourne et al²⁸. The INW is the distance between. Point A and B)

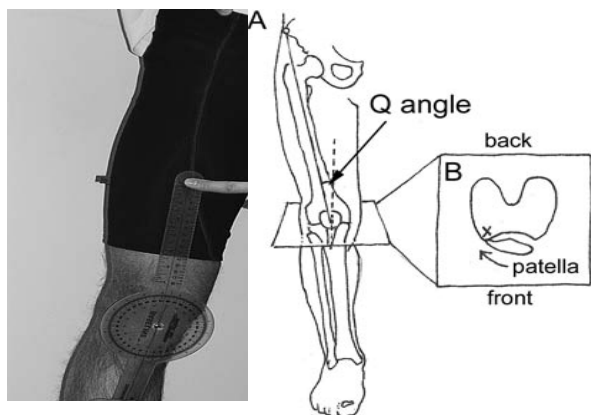
Figure 1: Measurement of INW according to Shelbourne et al²⁸



Measurement of Q Angle

The QA measurements were taken manually with the universal goniometer as described by Emami et al²⁹ and Smith et al³⁰. All measurements were taking with participants in standing with knees exposed in full extension (figure 2). The proximal arm of the goniometer was aligned to the anterior superior iliac spine, the axis at the midpoint of the patella, while the distal arm was aligned to the tibial tubercle. The intrarater reliability of the goniometer measurements was 0.90.

Figure 2: Measurement of Q-Angle according to Smith, Hunt Donell³⁰



Measurement of pelvic width

Tape measure was used to measure the distance between the left and the right anterior superior iliac spine and the width recorded in cm.

Pilot study

The data collection sheet was piloted on four players of the non-professional Garankuwa women soccer club side to test for clarity, ambiguity and time to complete.

Ethical consideration

This study was approved by the Research, Ethics and Publications Committee of the Faculty of Medicine, University of Limpopo (Medunsa Campus), DGM Hospital and the administration section of the women soccer project of SAFA. Informed consent was obtained from participants using the University of Limpopo (Medunsa Campus) consent form prior to the X-ray procedures. Participants were also provided with the information sheet which included the aims and objectives of the study and were given the opportunity to ask questions. It was made clear that the participation in this study was voluntary and that they may withdraw from it at any time without giving reasons.

Interpretation of the X-rays

A radiologist at the department of radiology at DGM Hospital interpreted all the X-rays in this study.

Data analysis

The data emanating from this study was analyzed with a statistical package of social sciences version 17. Descriptive statistics of means and standard deviation (SD), percentages were used to describe the demographic information of the participants while tables were used to present data. Inferential statistics of ANOVA was used test the relationship between the variables 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.

Results

Description of the participants

The participants were between 17 and 22 years, with a mean age of 18.92 years \pm 1.17 (SD), body weight of between 55kg and 63kg and a mean and SD of 58.5kg \pm 2.28, and height of between of 157 and 172 cm and a mean and SD of 165cm \pm 4.46 cm. Summary of measurements is presented in table 2.

They were no mean differences between the women who have sustained knee injuries (mean = 18.9 and SD = 1.19) and who have not sustained knee injuries

(mean = 19.0 and SD = 1.49). Both have the same median of 19 and a significant value of $p = 0.0023$ as shown in table 1.

Table 1: Characteristics of participants

Characteristics	Injured			Without knee injuries		
	Mean	Median	SD	Mean	Median	SD
Age	18.9	19	1.19	19.0	19	1.49
Position	3.6	4	1.95	3.36	4	4

P-value = 0.0023

Regarding playing position, a large number of respondents who were not injured were midfielder, 10 (71.4%), followed by defenders, 3 (21.1%). Large participants who sustained knee injury were forwards players 4(40%), 2 (20%) were goal keepers, defenders and midfielder. Please note that: Contact injuries are those sustained during tackles while non-contact are those sustained without contact/ tackle

About 6 (60%) of the incidents of knee injuries were due to contact injuries and the rest of knee injuries were due to non contact. Four (40%) of the injured players continued playing despite injury. Four participants did not respond to this question as indicated in table 2.

Table 2: Cause of Knee injuries

Cause of Injury	No.	%
Knee contact		
Yes	6	60
No	4	40
Continue to play		
Yes	4	40
No	2	20
No response	4	40

Q-angle

The values of the Q-angles were scattered between 14° up to 18° for both injured and non injured groups, while 5(50%) of the injured group have the same Q-angle of value 16° and 5(35.7%) of the non injured group has Q angles of 15° also 5(35.7) of the non injured group have the same Q-angle values of 16° (table3).

Pelvic width

The different values of pelvic width of the players started from 24cm up to 29cm for both injured and non injured groups. The most standard value was shown in between 26 and 26.9 (table 3).

Intercondylar notch

Injured group recorded Intercondylar notch values of between 1.3mm to 2.8mm for the right and 1.4mm to 2.5mm for the left. While the non injured recorded measurement of between 1.7mm to 2.1mm for the right and 1.8mm to 2.1mm for the left (table 3)

Table 3: Summary of the measurements of the anatomical factors

Anatomical Factors	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Mini-mum	Maxi-mum	
				Lower Bound	Upper Bound			
				Groups				
Q-Angle/ $^{\circ}$	0	14	16.0714	1.07161	15.4527	16.6902	15.00	18.00
	1	4	16.2500	1.25831	14.2478	18.2522	15.00	18.00
	2	6	15.7500	.98742	14.7138	16.7862	14.00	17.00
	Total	24						
Pelvic Width/cm	0	14	27.2286	1.28148	26.4887	27.9685	25.00	29.00
	1	4	26.5000	1.26754	24.4831	28.5169	25.00	27.60
	2	6	26.4500	1.01931	25.3803	27.5197	24.50	27.50
	Total	24						
INW-Right/mm	0	14	1.8857	.14601	1.8014	1.9700	1.70	2.10
	1	4	1.7750	.33040	1.2493	2.3007	1.30	2.00
	2	6	2.1000	.40988	1.6699	2.5301	1.60	2.80
	Total	24						
INW-Left/mm	0	14	1.9286	.12044	1.8590	1.9981	1.80	2.10
	1	4	1.8500	.31091	1.3553	2.3447	1.40	2.10
	2	6	2.1167	.25626	1.8477	2.3856	1.80	2.50
	Total	24						

Group 0 = Players without knee injuries
 Group 1 = Players with knee injuries without contact
 Group 2 = Players with knee injuries with contact

Table 4: The relationship between anatomical factors and knee injuries

Anatomical factors		Sum of Squares	DF	Mean Square	F	Sig.
Q-angle	Between Groups	.686	2	.343	.293	.749
	Within Groups	24.554	21	1.169		
P-width	Between Groups	3.363	2	1.681	1.126	.343
	Within Groups	31.364	21	1.494		
In w-right	Between Groups	.295	2	.147	2.144	.142
	Within Groups	1.445	21	.069		
In w-left	Between Groups	.209	2	.105	2.724	.089
	Within Groups	.807	21	.038		

INW= Intercondylar Notch width

There was no significant association between knee injuries and each of the anatomical factors Q-angle ($p=0.74$), pelvic width ($p=0.34$) and IN (right and left respectively) ($p=0.142$ & $p=0.089$)

Discussions

This study sought to establish the association between knee injuries and each of the three anatomical factors of QA, PW and INW. Q-angles ranged between 14° to 18° for both injured and non injured groups. No significant association between Q-angle and knee injuries ($p\text{-value} = 0.74$) was found in this study. This finding agrees with those of Loudon et al²⁶, who reported no clear link between knee injuries and Q-angle. Until recently, it was believed that the joint hyper laxity predisposes individuals to musculo-ligamentous lesions, particularly in both ankle and knee, suggesting that increase of flexibility leads to increases laxity, which perhaps, increases the incident of knee injuries for both genders³¹.

There were similarities in the three anatomical risk factors in both the injured and non injured groups. This findings contradicts those of Emami et al²⁹ and Tallay et al³² found a significant association between higher Q-angle and the rate of knee injuries. However, higher QA alone might not be responsible for knee injuries as revealed by Emami et al²⁹ who found that 16% of the males and 20% of the females with abnormally high QA did not present with knee injuries.

PW ranged between 24 -29 cm for both injured and non injured groups with no significant association between PW and knee injuries ($P = 0.34$). This finding is at variance with those of previous

authors^{16,19,32,33} who found a significant association between PW and the risk of knee injuries amongst women. Ireland et al¹⁶, and Hirst et al³⁴, opined that the structural differences of the wider female pelvis increases the risk of knee injury by creating a greater coxa Vara/ geno valgum alignment with concurrent increase in tibio-femoral rotation force, thus imposing greater stress on the ACL.

The present study revealed scattered INW values of between 1.3mm to 2.8mm for the right and 1.4mm to 2.5mm for the left notch for the injured group, while the values for the right and left of the non injured group were between 1.7mm to 2.1mm and 1.8mm to 2.1mm, respectively. No significant association between knee injuries and INW ($p\text{-values}$ of the right and left were $p=0.14$ and $p=0.89$, respectively) was found. Though, there was no attempt to compare INW with those of the male counterparts in this study, some other factors such as the differences in the ligamentous width geometry and materials of the ACL between genders might be linked to knee injuries^{35,36}. It is therefore recommended that this should be further investigated.

A possible limitation in this study is the relatively small sample size and unequal sizes in all the groups. This might affect the generalization of the outcome to a larger population. Following a larger group for a longer period of time may produce a more generalisable outcome. Another possible factor that might affect the result of this study is participants' bias in recalling actual injury dates and time. This might have influenced the link between anatomical factors and the presence and /or absence of knee injuries.

Conclusion

Further studies should consider documenting only knee injuries identified by team doctors or physiotherapists during the season and not those that are obtained prospectively from the players. These knee injuries might also be identified pre-seasonally by performing standardized screening tests.

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