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Effect of Q angle on some performance parameters in adolescent female football players

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Abstract
QA (Q angle) is the line between the combined traction of the quadriceps and the patellar tendon and is associated with the biomechanical function of the lower extremity. The reason we're focusing on the Q angle in women in particular is that we think that in studies women show a higher average QA than men and can give a lot of ideas as a simple precursor parameter. This study aimed to study the effect of the Q angle in Adolescent Women's Footballers on lower extremity vertical jumping performance and the excentric power of the hamstring.
Method: A digital manual goniometer was used to measure the QA of individuals, and hamstring eccentric muscle strength NORDBORD device was used for measuring vertical jumping strength with a SmartSpeed Contact Mat half-squat vertical jump test (VJ TEST) The resulting data was normally distributed, and a Pearson correlation test and simple regression tests were applied to the analysis.
Results: When the results of simple linear regression analysis of Vertical Jump Performance according to the prediction of the Left Q angle variable were examined, it was seen that the Left Q angle was a significant predictor of the athlete's Vertical Jump performance. In addition, it is seen that there is a moderate positive relationship between Vertical Jump and Asymmetry.
Discussions: Football is a competitive game with different dynamics (sprint, change of direction, jumping, collision) and has a higher risk of disability than other sports.
Keywords: q angle; football; anaerobic peak force; eccentric; hamstring; biceps femoris; vertical jump;

Introduction

QA consists of the lines between the quadriceps and the joint traction of the patellar tendon (Cartwright, 2007) and is associated with the biomechanical function of the lower extremity. (Draper, 2011).

The studies showed a higher average QA for women than men (Teixeira, 2008). Women have a higher average of QA because the wider pelvic structure provides a wider area for the development of the fetus during pregnancy and causes an increase in the angle of the knee where the thigh and the knee bone merge. (Messier, 1988) Although standard values for quality assurance have

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been declared and accepted in many studies, there is still no firm idea of acceptable values. It ranges from 10° to 15° in males, 15° to 20° in females (Levangie, 2019). A QA beyond the normal value indicates an additional biomechanical stress tendency during recurring activities in which the directory is used, as this interferes with the normal movement of the patella in the femoral state, causing an increase in the neuromuscular response and reflex of the quadriseptic, a decrease in the explosive force and the vertical jump force (Chester, 2008, Witvrouw, 2000, Loudon, 2016, Chhabra 2016).

QA determination is important for athletic and physically active people (such as footballers). Because this measurement reflects the effect of the quadriseptic mechanism on the knee, it also gives an idea of how the hip muscles work, providing important data about the athlete's lower limb functional capacity (Daneshmandi, 2011; Ghalehgir, 2014). In football matches, for example, it is believed that the quadriseptic muscle group plays an important role in jumping and hitting the ball.(Fried, 1992) Basically, quadriceps plays a significant role in the movement of the knee joint, both during physical activity and when the joint is exposed to compression and cutting force over the absorption capacity (Cartwright, 2007).

Football is also a sport in which intensive activities are mixed in short intervals with lower intensity movements, intermittent and high intensity. Between high-intensity efforts, accelerations/slows, turns, and jumps are key determinants of competition. (Dolci, 2020)

Studies have shown that higher than normal Q angle values lead to increased neuromuscular responses and reflexes of the quadriceps, decreased explosive power and decreased vertical jump power. (Chester, 2008; Witvrouw, 2000).

In order to support high performance during the actions mentioned, players need sufficient levels of strength, strength and aerobic capacity (Buchheit 2010, Wing 2020, Cometti 2001) showed that football has been a key factor in winning the game, focusing on high intensity activities (variable sprints, tactics, low intensity jumps, and high-intensity jumps) over the past two decades.

According to this review, validity, and reliability for evaluating anaerobic strength are widely accepted by various vertical jumping and bicycle sprint tests (Carling 2012, Hammami 2017).

While previous studies on the vertical jump test focused on the jump height), mechanical force has recently emerged as a notable parameter for assessing the explosive forces of athletes' lower extremities. (Vandelle, 1987)

At the same time, the hamstring muscle complex is responsible for both hip extension and knee flexion and plays an important role in physical activities such as walking, running, cycling, and jumping (Schoenfeld, 2010).

Nordic Hamstring exercises showed more activation of semitendinosus muscles than other hamstring groups. The semitendinosus muscle is also a knee flexor and plays a role in the movement of the inner rotation of the knee joint. The semitendinosus indicates that he is more active in knee-weighted exercises (Sonay, 2020; Bourne, 2018). So, we included the eccentric hamstring force in our study, considering that the hamstring muscle group is responsible for the inner moment of the knee.

This study aimed to examine the effect of QA on vertical jumping performance and Hamstring eccentric power in young female footballers, based on the knowledge that it would affect certain performance parameters in young women's footballers.

Method

20 female athletes who played football actively volunteered to participate in the study. All methods are explained to all participants. The body mass indices of the participants were calculated using the formula BMI = Kilo kg / Size m2.

Data Collection Tools and Data Collection

The Quadriceps (Q) Angle

Q angle can be defined as a line representing the compound force line of the quadriceps, made by connecting a point close to the ASIS to the center of the Patella. The Q angle can be measured in an upright or overhead position (Brotzman, 2018; Insall, 1976; Smith 2008) In the back position, measurements performed with the knees extended and the quadriseptic muscle group loose are traditionally considered. The Q angle also provides important data on the athlete's lower extremity's functional mobility capacity. (Daneshmandi 2011, Ghalehgir S 2014)

Vertical Jump Test

The SmartJump Contact Mat (Reeve and Tyler, 2013.,) was used to measure vertical jump parameters. In the test, the athlete was asked to perform the highest jump that he could jump upwards while in a half squat position (knee angle 90°) with his hands on his waist. The best measurement was evaluated by using two replicates (Koca-Kosova and Kosova 2021, Söğüt 2022). In both groups, the anaerobic peak power of individuals was calculated in Watt(W) by adapting the vertical jump data to the Harman Formula (Harman et.al 1991).

Nordbord

Opar et al., recently developed a new field test device to evaluate the excentric force of the hamstring, called Nordbord, based on the widely used Scandinavian Hamstring exercise. Nordbord allows for the evaluation of the maximum eccentric knee flexor force (i.e. the Newton force captured by the load cells used as a measure of force) and the imbalances between the axes in less than 2 minutes per player. Each player was asked to perform 6 repetitions of Nordic curl exercises with maximum strength. Averages of these power values and the asymmetry values between the two legs were also taken.

Analysis of Data

The Shapiro Wilk test was taken into account in the normality tests because the number of participants was less than 30 (n=20). The normality test showed normal distribution of the data. Since the scala variables are parametric, the parametric tests (Pearson correlation tests and simple regression tests) have been applied in analyses carried out with SPSS 22.0.

Findings

Table 1. Demographic Information of Participants

	N	$\bar{X}$	S.s.
Height	20	161,40	8,475
Weight	20	51,10	5,119
Q Angle Right	20	15,605	2,8068
Q Angle Left	20	15,430	3,0636
VJ Test	20	22,7570	3,81391
L Max Force	20	220,68	39,521
R Max Force	20	227,16	37,445
L Average Force	20	199,11	28,635
R Average Force	20	204,21	28,334
Asymmetry	20	7,9337	5,21847

The weight, height, right Q angle left Q angle, VJ test, L Max Force, R Max Force and R Average Force are shown in the table. Based on these results, when the table was examined, 95 per cent of participants had a right leg dominant, 161,40 ± 8,475 height, and an average weight of 51,10 ± 5,119 kilograms. The measurement values for the study group were 15,605±2,8068 Right Q angle, 15,430±3,0636 Left Q angles, 22,7570±3,81391 VJ test, 71,50±7,990 L Max Force, 227,16±37,445 R Max force, 199,11±28,635 L Average Force, 204,21±28.334 R Average Force and 7,9337±5,21847 Asymmetry averages (Table 1).

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Table 2. Pearson Correlation Analysis

		Q Angle Right	Q Angle Left	VJ Test	L Max Force	R Max Force	L Average Force	R Average Force	Asymmetry
Q Angle Right	r								
Q Angle Left	r	,415							
VJ Test	r	-,403	**-,503***						
L Max Force	r	-,005	,019	-,170					
R Max Force	r	-,149	-,257	-,166	**,843****				
L Average Force	r	-,036	-,177	-,105	**,844****	**,804****			
R Average Force	r	-,178	-,453	-,089	**,657****	**,861****	**,872****		
Asymmetry	r	,141	-,173	**,457***	-,206	-,142	,032	,053	

*p<0.05 **p<0.01

When examining the Pearson Correlation Analysis in Table 2, the correlation between the right Q angle, the left Q angle, the VJ test, the Posteromedial, Posterolateral, Anterior, the L Max Force, the R Max Force, and the R Average Force is shown. According to the results, a medium-level relationship between the VJ test and the left Q angle was detected in the negative direction (r=-,503, p=,024). However, there is a positive middle-level relationship between the VJ test and Asymmetry (r=457, p=049). When the painting is examined. The relationship between the L Max Force variable and the R Max Force is observed at a positive high level (r=,843, p=,000); between the l Max Force and the L Average Force, the positive high point (r =,844, p=.000); and between the r Max Force, and the r Averages, a positive mid-level (r=2,557, r=,002). The relationship between the R Max Force and the L Average Force variable has been detected at a positive high level (r=804, p=,000) and again between R Max Force and R Averages Force (r =,861, p =,000). Finally, a positive high-level relationship is observed between the L Average Force and the R average force (r=,872, p=,000).

Table 3. Simple Linear Regression Analysis for VJ Estimation

	B	Standard Deviation	β		
Q Angle Right	31,305	4,643		6,742	,000
	-,548	,293	-,403	-1,869	,078
$R= ,403^a$ $R^2= ,163$	F=3,493 p=.000				
Q Angle Left	32,418	3,986		8,133	,000
	-,626	,254	-,503	-2,469	**,024***
$R= ,503^a$ $R^2= ,253$	F=6,095 p=.000				

When examining table 3, the results of the simple linear regression analysis of VJ's prediction of the right-angle Q variable were found to have no significant effect (R=,403a, R2=,163, F=3,493, p=.000). When the table is examined, the results of the simple linear regression analysis of VJ's prediction of the left Q angle variable show that the Left Q angle is a significant indicator of the athlete's VJ (R=,503a, R2=,253, F=6,095, p=.000). In VJ, 25% of the total variance is explained by the value of the left Q angle.

Table 4. Simple Linear Regression Analysis Relating to L and R Max Force Prediction

	B	Standard Deviation	β	t	P
Q Angle Right	221,803	52,871		4,195	,001
	-,072	3,328	-,005	-,021	,983
$R= ,005^a$ $R^2= ,000$	F= ,000 p=.000				
Q Angle Left	216,605	53,061		4,082	,001
	,270	3,458	,019	,078	,939
$R= ,019^a$ $R^2= ,000$	F= ,006 p=.000				

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Q Angle Right	257,510	49,533		5,199	,000
	-1,941	3,118	-,149	-,623	,542
R= ,149[a] R^2= ,022 F= ,388 p=.000					
Q Angle Left	279,627	48,593		5,754	,000
	-3,474	3,167	-,257	-1,097	,288
R= ,257[a] R^2= ,066 F= 1,203 p=.000					

A simple linear regression analysis of L Max Force's prediction based on the right Q angle variable is presented in Table 4. Accordingly, when the regression analysis results were examined, no significant effect of the right Q angle on the L Max Force was detected (R=,005a, R2=,000, F=,000, p=.000). A simple linear regression analysis of L Max Force's prediction based on the left Q angle variable is presented in the table. Accordingly, when the regression analysis results were examined, no significant effect of the Left Q angle on the L Max Force was detected (R=,019a, R2=,000, F=,006, p=.000). A simple linear regression analysis of R Max Force's prediction based on the right Q angle variable is presented in the table. Accordingly, when the regression analysis results were examined, no significant effect of the right Q angle on the R Max Force was detected (R=,149a, R2=,022, F=,388, p=.000). A simple linear regression analysis of R Max Force's prediction based on the left Q angle variable is presented in the table. Accordingly, when the regression analysis results were examined, no significant effect of the left Q angle on the R Max Force was detected (R=,257a, R2=,066, F= 1,203, p=.000).

Table 5 Simple Linear Regression Analysis Relating to L and R Average Force Prediction

	B	**Standard Deviation**	**β**	**t**	**p**
Q Angle Right	204,768	38,283		5,349	,000
	-,362	2,410	-,036	-,150	,882
R= ,36[a] R^2= ,001 F= ,023 p=.000					
Q Angle Left	226,717	37,846		5,990	,000
	-1,828	2,466	-,177	-,741	,469
R= ,177[a] R^2= ,031 F= ,549 p=.000					
Q Angle Right	231,529	37,304		6,207	,000
	-1,747	2,348	-,178	-,744	,467
R= ,178[a] R^2= ,32 F= ,554 p=.000					
Q Angle Left	274,227	33,914		8,086	,000
	-4,635	2,210	-,453	-2,097	,051
R= ,453[a] R^2= ,206 F= 4,398 p=.000					

A simple linear regression analysis of L Average Force's prediction based on the right Q angle variable is presented in Table 5. Accordingly, when the regression analysis results were examined, no significant effect of the right Q angle on the L Average Force was detected (R=,36a, R2=,001, F=,023, p=.000). A simple linear regression analysis of the estimation of L Average Force based on the left Q angle variable is presented in the table. Accordingly, when the regression analysis results were examined, no significant effect of the left Q angle on the L Average Force was detected (R=,177a, R2=,031, F=,549, p=.000). A simple linear regression analysis of R Average Force's prediction of the right Q angle variable is presented in the table. Accordingly, when the regression analysis results were examined, no significant effect of the right Q angle on the R Average Force was detected (R=,178a, R2=,32, F=,554, p=.000). A simple linear regression analysis of the estimation of R Average Force based on the left Q angle variable is presented in the table. Accordingly, when the regression analysis results were examined, no significant effect of the left Q angle on the R Average Force was detected (R=,453a, R2=,206, F= 4,398, p=.000).

Tablo 6 Simple Linear Regression Analysis Relating to Asymmetry Prediction

	B	**Standard Deviation**	**B**	**t**	**p**
Q Angle Right	3,927	6,911		,568	,577
	,256	,435	,141	,589	,564
R= ,141[a] R^2= ,020	F= ,347 p=.000				
	12,865	6,901		1,864	,080
Q Angle Left	-,326	,450	-,173	-,726	,478
R= ,173[a] R^2= ,030	F= ,527 p=.000				

A simple linear regression analysis of Asymmetry's prediction of the right-angle Q variable is presented in Table 6. Accordingly, when the regression analysis results were examined, no significant effect of the right Q angle on Asymmetry was detected (R=,141, R2=,020, F=,347, p=.000). A simple linear regression analysis of Asymmetry's prediction based on the left Q angle variable is presented in the table. Accordingly, when the regression analysis results were examined, no significant effect of the left Q angle on Asymmetry was detected (R=,173a, R2=,030, F=,527, p=.000). As a result, the lower the Left Leg QA of individuals, the higher the vertical jumping performance.

Conclusion and Discussion

Football is a fight-based game with different dynamics (sprint, change of direction, jumping, collision and has a higher risk of injury than other individual disciplines (Krustrup, 2010; Emery, 2006; Caine, 2008). Injury is also common among young footballers, especially during periods of rapid change in growth and maturity (Read, 2018; Renshaw, 2016; Kolstrup, 2016). Women are 2-8 times more likely to experience ACL disability in football than men, and this is quite a remarkable figure. Dynamic motion patterns are very important factors that contribute to ACL injury (Ireland, 2002).

The reason we focus on the Q angle in female football players is that women suffer joint and ligament injuries, mainly to the knee and ankle (Robles, 2022 and they stressed that women players should focus on movement mechanics, core force and joint stability to prevent these disabilities. The reason we've studied the relationship with vertical jumping is that the relationship between the Q angle and vertical jumps is controversial, although there are few studies in the literature. Given that the knee joint and the quadriseptic muscle group are the key elements in jumping (Chiu, 2012; Hubley 1983; Luhtanen P 1978; Nagano A, 2001) an excessive Q angle causes a loss of mechanical efficiency in the forces created by quadriceps muscles in the knees and consequently affects the jumping performance.

In a football game, the quadriseptic muscle group has been recognized to play an important role in jumping and hitting the ball (Fried, 1992). They also found that the jump height was associated with a smaller Q angle (Daugherty, 2021). Jones (2013) wanted to study the relationship between Q angle and vertical jumps in 15 female athletes and found that there was no relationship between the Q angle, and the vertical jump. A study of female athletes at the university found that there was no correlation between vertical jumping and Q angle (Bradley 2013, Hewett 1999) measured the relationship between the Q angle and the vertical jump and found that there was no relation between the q angle and vertical jumps. Increasing the strength of the hamstring is considered an important component of rehab and prevention of frontal cross ligament injury, and injuries prevention programs, including strength training, reduce the risk of injuries (Hewett, 2006; Yoo 2009). Furthermore, hamstrings play a role similar to the frontal cross bond, which can be vital for and rotational stabilizers of the tibium (Kwak, 2000). In conclusion, in our study, the left Q angle appears to be an important indicator of participants' Vertical Jump Performance, a result different from studies in the literature. In addition, no relationship was found between Hamstring eccentric muscle strength and Q angle and Vertical Jump Performance.

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